COMMUNITY BASED VULNERABILITY ASSESSMENT OF SOCIO ENVIRONMENTAL IMPACTS OF CLIMATE CHANGE ON PAGHMAN DISTRICT, KABUL PROVINCE, AFGHANISTAN

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بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

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A thesis submitted in partial fulfillment of the requirements of the degree of Master Studies in Environmental Science of the International Islamic University, Islamabad

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DEDICATION

I dedicate my work to my beloved parents and my family

DECLARATION

I ***Mohammad Mustafa*** candidate for the degree of MS in Environmental Science of International Islamic University, Islamabad under Registration # 269-FBAS/MSES/F15 hereby declare that the work presented in this dissertation entitled ***Community Based vulnerability Assessment of Socio Environmental Impacts of Climate Change on Paghman District, Kabul province, Afghanistan*** is my own work and has not been published or submitted as thesis or research work in any other university or institute.

Signature of testifier

Date 28-05-017

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Mohammad Mustafa Sahebazda

ABSTRACT

In this study a community based vulnerability assessment of socio environmental impacts of climate change on Paghman district of Kabul province in Afghanistan was carried out. The analyses and measurements obtained from the assessment of land covers indicate about 800 ha increase in residential area in the district, although the district had 80 ha residential area in 1993. The climatic variability analysis of the district indicates negative change or decrease in precipitation, which is "- 0.1806 mm", and positive change or increase in temperature, which is "0.0183 °C", changes in the climatic conditions of the district, as a result decline in snowfall and a little rise in temperature have been observed, in the meantime, climatic variability shows alterations in precipitation pattern, as in previous years the district usually received precipitation especially snowfall in late December and January months, but now it has been shifted to late January and February months, moreover, snowfall has been declined in last four years, which caused various negative social, environmental and economic impacts to the wellbeing of the district residents especially to farmers. Whereas, UNDP future climatic models and projection for Afghanistan, predicts nearly 1.4 °C raise in temperature and little or no decrease in rainfall up to 2030, specifically, AIB and A2 climate change projection scenarios project decrease in precipitation and increase in temperature, while B1 climate change projection scenarios projects increase in precipitation and very little change in temperature, actually these figures are only for the time series of 2030, although the overall climatic projection (till 2099) represents about 2 to 6 °C raise in temperature, as well as a decline of 10 to 40 mm in precipitation is forecasted, along with rainless situations in southern parts of the country. The overall results show that both, residents and natural systems of the district have been affected due to recent climate changes, additionally, the water and agriculture sectors in the district have been affected from recent climatic variability experienced in the area, in the meantime these sectors are at high risk and the most vulnerable to climate change. It is concluded that climate variability, change and its induced impacts have drastically affecting the environmental, social and economic well-being of local communities in the district.

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LIST OF ABBREVIATIONS

AGS	Afghanistan Geological Survey
AFS	Afghani (national currency) 1.00 Afghani = 0.015 US Dollar
AICC	Afghan International Chamber of Commerce
ANDS	Afghan National Development Strategy
ANDMA	Afghanistan National Disaster Management Authority
AILA	Afghanistan Independent Land Authority
AFs	Affected Families
AREU	Afghanistan Research and Evaluation Unit
CBNRM	Community Based Natural Resource Management
CDC	Community Development Council
CDM	Clean Development Mechanism
COP	Conference of the Parties
CSO	Central Statistics Office
DFID	Department for International Development
GEF	Global Environment Facility
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GoA	Government of Afghanistan
MEW	Ministry of Energy and Water
MoF	Ministry of Finance
MAIL	Ministry of Agriculture Irrigation and Livestock
MRRD	Ministry of Rural Rehabilitation and Development
MoLSAMD	Ministry of Labour, Social Affairs, Martyrs and Disabled
MAIL	Ministry of Agriculture, Irrigation and Livestock
LLE	Law on Land Expropriation
LMLA	Law on Managing Land Affairs
NEPA	National Environmental Protection Agency
NGO	Non-Governmental Organization
NRVA	National Rural Vulnerability Assessment
NPA	National Protected Area
PEACE	Pastoral Engagement, Adaptation and Capacity Enhancement

SEI	Stockholm Environment Institute
SDGs	Sustainable Development Goals
USGS	United States Geological Survey
UNDP	United Nations Development Program
UNFAO	United Nations Food and Agriculture Organization
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WB	World Bank
WCS	Wildlife Conservation Society
WMO	World Meteorological Organization

Local terms used in the Text

Jerib	Local unit of land measurement in Afghanistan (1 Jerib is equal to 2,000 square meters of land and 5 jeribs equivalent to 1 hectare
Karez	Underground water channel for irrigation and drinking purpose
Kaley	Village
Taskara	National Identity Proof

1. INTRODUCTION

Recent climate change and its associated impacts have increased the considerations and intentions of policy makers, politicians, economist and environmental scientists at worldwide levels, about the negative consequences of prevailing climate change induced risks and vulnerabilities. At the present time most of countries and people have understood and accepted global warming and climatic changes and consider them as a global and shared issue, intergovernmental panel on climate change (IPCC), admitted than manmade activities are enhancing atmospheric concentrations of GHGs due to the significant amount of gases being released to the atmosphere, thus these emissions will drastically affect both social and environmental systems (Houghton et al, 2001).

On the other hand, climate change models and projections indicate significant climatic variations and changes at local and regional scales as well their associated impacts might be different depending on the nature and severity of impacts. On the average basis, future climate change models and projection are mathematic and physical models, established and developed on the basis of past climatic trends, local and regional conditions and lifestyle of the residents of a society, these models and projections give an insight and anticipate the upcoming challenges and risks, and aware policy makers and government officials to act wisely in combating, adapting and mitigating the prevailing changes. Although there will be some differences and incorrectness in these models and projections as they are predication and developed on past trends and present conditions Analysis and assessment of future climate change vulnerability largely depend on the current status and condition of socio-environmental systems and their interrelationship.

Therefore, it is very important in a research study or decision making to formulate and develop the adaptive capacity of a society or region, in the climate change adaptation and mitigation at local, regional and global contexts. Furthermore, climate change vulnerability assessment recently practiced and its quite new approach, which analyze and assess the vulnerability of both social and environmental systems to prevailing climate change and its associated risks, in addition, this method is very helpful in

familiarization of public involvement in decision making as adding value and intentions to sustainable development and nature's care. Although, climate change vulnerability assessment and analysis are still localized and in micro level, however several frameworks, methods and techniques have developed for climate change vulnerability assessment but due to coverage and scope of climate change its difficult to carry out assessment in macro levels.

Finally, the sole objective of carrying out this research study is to identify impacts resulted from recent climatic changes, seasonal variations, temperature rise and alterations in precipitation patterns, to the residents of Paghman district and to country at all, as well to identify the vulnerability status of district to climate change and its adaptive capacity in the adoption of suitable climate change adaptation and mitigation strategies and measures. In addition, to recommend best suitable and community based climate change adaptation and mitigation measures and policy insights at local and national levels.

1.1 Vulnerability

The term vulnerability is commonly used in climate change, natural disasters water and food resources management and so on; as well it is increasingly used in the climate change vulnerability assessment and analysis. There are several explanations about vulnerability, on overall basis it refers to anticipate, describe, gives insights and recommend suitable adaptation and mitigation options for combating any likely risk or danger (Blaikie, 1994), however, in case of details vulnerability assessment is composed from two groups of thought, first group of thoughts is based on environmental or natural system, which admits that all changes, variations and disasters occurred, occurring or will be occurred, relate to the self-functioning of natural system. On the other hand, second group of thoughts is based on social systems, which admits that some changes belong to nature's self-functioning, while others are due to anthropogenic activities which altered or altering natural systems.

Therefore, based on above mentioned methods, vulnerability could be define, as a particular set of social, political, economic and environmental systems which heavily regulate and have influence on human beings.

1.2 Climate Change Vulnerability

Regardless to the IPCC declarations of human beings influence and direct relation to global warming and recent climate change and future climate change modeling and projections of IPCC is based on variables which most of them relate to human lifestyle and nature's response, although these future projections are not realistic and have various limitations, (Arnell, 2004)

Even though, these future climate change projections and models give an insight and picture of upcoming climate change hazards and risks, in case of careless and unsustainable development continuity, in the meantime, these projections recommend suitable options for the prevention or reduction of climate change vulnerability as well suitable climate change adaptation and mitigations strategies and measures. (Parry et al, 2001).

Climate change vulnerability largely depends on the intensity, magnitude and exposure of change which is being occurring, thus less intensity and exposure will cause less damage and it will need basic control, while more intensity and exposure will cause more damage thus it will need complex control, in addition climate change vulnerability is also depend on the local conditions like economy and infrastructure, strong economy and infrastructure will ease climate change vulnerability, while fragile economy and infrastructure will boost up climate change vulnerability. Therefore climate change vulnerability depends on both social and environmental systems. (Hulme et al, 1999)

Furthermore, climate change vulnerability assessment and analysis in line with future climate change projections. (Pelling, 2000). Anticipate and recognize intensity and exposure of climate change and vulnerability status as well they identify and highlight most vulnerable regions and societies thus they will bring simplicity during decision making and prioritization, still, climate change vulnerability assessment is not fully conceptualized thus it need further improvements, however social and environmental

based climate change vulnerability assessment studies yielded quite good results as social and environmental systems are being analyzed on the basis of ground realities and observation. (Parry and Carter, 1998).

Such significance states are in fixed term, it's reflecting relies on the dynamic interaction of a range of social and economic practices which affect the ability of people, society, regions, and natural system to adapt with several biophysical and socio-economic defects (Comfort, 2005) and (Leichinko, at el. 2000). Majority of people which are at high risk have defined, who are largely confront to the climate change induced impacts, these people have less resources to adopt climate change adaptation and mitigation measures as well climate change resilience to prevent or reduce climate change vulnerability and risks. Another meaning of vulnerability concentrates on the concepts about fragility, adaptability, defenselessness & risks (Liverman, 2009).

As a result, climate change vulnerability refers to a multi-function of socioeconomic, ecological, political and technological adverse impacts on the livelihood and well-being of social and natural systems, which results from alteration in climate or atmospheric cycles. (Peter et all, 2000).

On this case, it relies on the magnitude and scale of queries, which is in macro levels, would be the most significant in identifying and distribution of entitlements. In respect to climate induced impacts, several communities could adopt suitable climate change mitigation and adaptation measures to prevent or reduce climate change risks and its associated impacts. (Amy, 2005)

In contrast, locally the role NGOs and welfare associations have a considerable impact on obtaining home and community based climate change adaptation and mitigation as well natural resources management or conservation. However still nations do not conceptualized a thorough obligation and step towards climate change adaptation and mitigations.

On the average basis, developing countries have highly vulnerable to climate change induced factors and impacts due to magnitude and severity of climate change as well due to fragile infrastructure, therefore social and environmental sectors are at high risk. Past

droughts and recent climate changes and seasonal variations experienced in last two decades in Afghanistan gives a clear image of climate change and its associated impacts, and its highly accepted that Afghanistan is highly vulnerable to climate change. (USAID, 2014a)

Natural disasters and recurrent floods heavily affected arable land and due to dependency of local communities on agriculture sectors several farmers received huge economic losses. Even though, very few communities (supported by government) have started climate change adaptation and adopted micro climate change mitigation measures which could reduce the extensity and magnitude of climate change vulnerability and risks. (NEPA, 2008).

Afghanistan is a land-locked country, located in Central West Asia. It is mountainous comprising the greater part of the massive Hindu Kush range at the western end of the Himalayas and several smaller ranges. It lies between Iran and Pakistan in its central and southern regions, with borders of around 936 and 2430 km respectively. Neighbors in the north include PR China with a 76 km border at the top of the Wakhan corridor, Tajikistan (1206 km), Uzbekistan (136 km) and Turkmenistan (744 km).The country extends from 61° to 74° east and from 29° to 38° north. (GoA, 2011). It averages around 850 km east to west and 750 km north to south. The lowest point in the country is on the Amu Darya where it leaves Jozjan province in the north at 258 meters above sea level. The highest point is Noshak Mountain at 7485 m. Afghanistan's land area is about 652,700 km^2, of which 80% is mountain and desert. About 12% of the land is arable, of which less than 6% currently is cultivated, with less than 2% under forest cover and about 82% rangeland and bare land. (GoA, 2008a & 2008b)

Afghanistan has dry or semi-dry weather and climatic conditions, due to presence of mountainous topography, it resulted climatic differences, therefore the country has and receives less precipitation, even though some parts of the country receive smaller amount (<300 millimeter) annual precipitation, although with exclusion of east parts of the country, which they are in the effect of monsoon seasons. More than 60 percent of precipitation occurs in winter and spring and the remaining percentage falls in summer

and autumn seasons, on the average basis northern and central parts of the country receives more precipitation than southern and western parts. Snow melts in mid spring season from central and northern parts of the country which results and create suitable conditions for agriculture and farming practices in eastern, western and southern parts of the country, (MEW, 2014).

1.3 The Conceptual Framework for Assessing Vulnerability in this Research

There are several methods, conceptual frameworks and techniques available for analyzing and assessing vulnerability or climate change vulnerability, in performing or carrying out research projects or studies, although, when we deal with social and environmental vulnerability assessment we have to analyze and assess the interrelationship between each of them, as social system's vulnerability depends on public demand and use of natural resources as well their lifestyles which leads to influence and sensitivity of social system in confront with natural system, therefore humans lifestyle develops influences and risks or hazards which is the precondition in vulnerability assessment and analysis, thus it should be keep in mind.

Furthermore, associated and anticipated impacts of climate change relies on the severity and intensity on the type of vulnerability, on the other hand adaptive capacity of a society to climate change is largely depends on the status (economic and infrastructure) of the society, if a society has poor and fragile infrastructural and economic status than the vulnerability to climate change will be high, although, if a society has good infrastructure and economic status than the status of vulnerability will be less and could easily prevented or reduced, therefore well-established social system may play an important role in combating climate change vulnerability and its associated impacts.

At the present time, several afghan communities haven't taken adaptive or mitigation measures for combating climatic changes which resulted various negative impacts and may enhance the vulnerability of climate change in near future, yet the impacts of climate change are localized and at micro level, though, achievement and development of suitable adaptation and mitigation measures need behavior change as well intention for adopting climate change adaptation and mitigation strategies and measures.

It is highly believed that Afghanistan is far away from developing climate change resilience and reducing its associated impacts, although, on general basis nature of adaptive and combating capacities rely on the climate change induced factors which determine the status of vulnerability and its associated risks for adopting suitable adaptive measures.

Climatic variability trends and data are very important in future climate change projection and modeling, though without past climatic data, there will be challenges in the development of suitable climate change adaptation and mitigation strategies, as well it will be difficult to analyze and formulate the adaptive capacity of a region or community as well future climate change vulnerability and its associated risks could not be realistically established.

Even though, awareness and information dissemination regarding climate change and its adaptation and mitigation, could play an important role in adaptation basic or community based climate change adaptation and mitigation measures. Conceptual framework for climate change vulnerability assessment is further illustrated in below figures in detail.

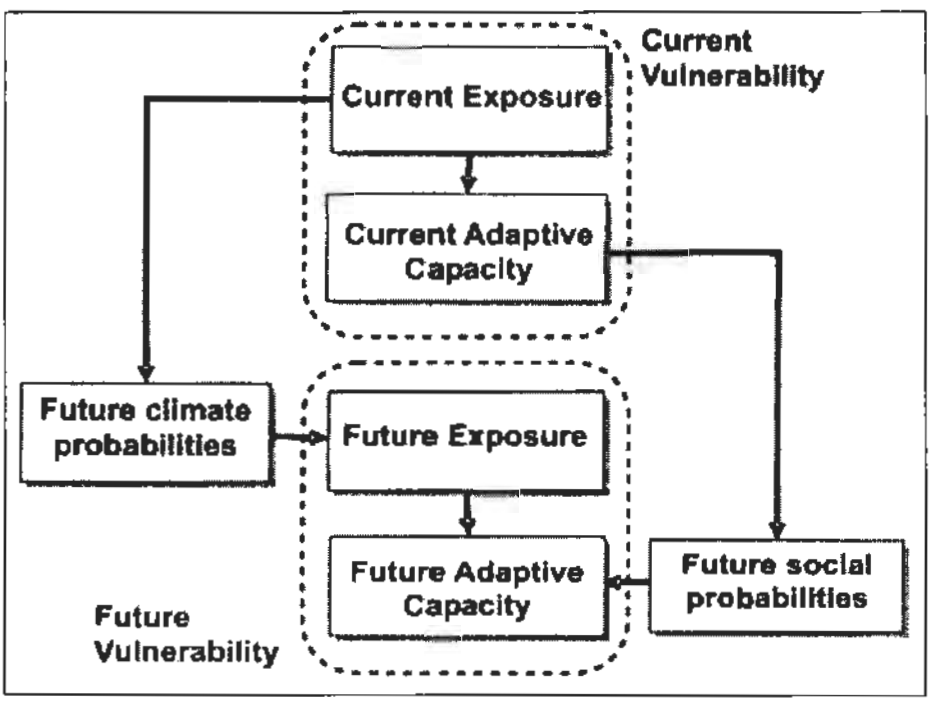


Figure-1: A Framework for the vulnerability assessment of communities to risks

associated with climate change (Source: Ford and Smith, 2004.)

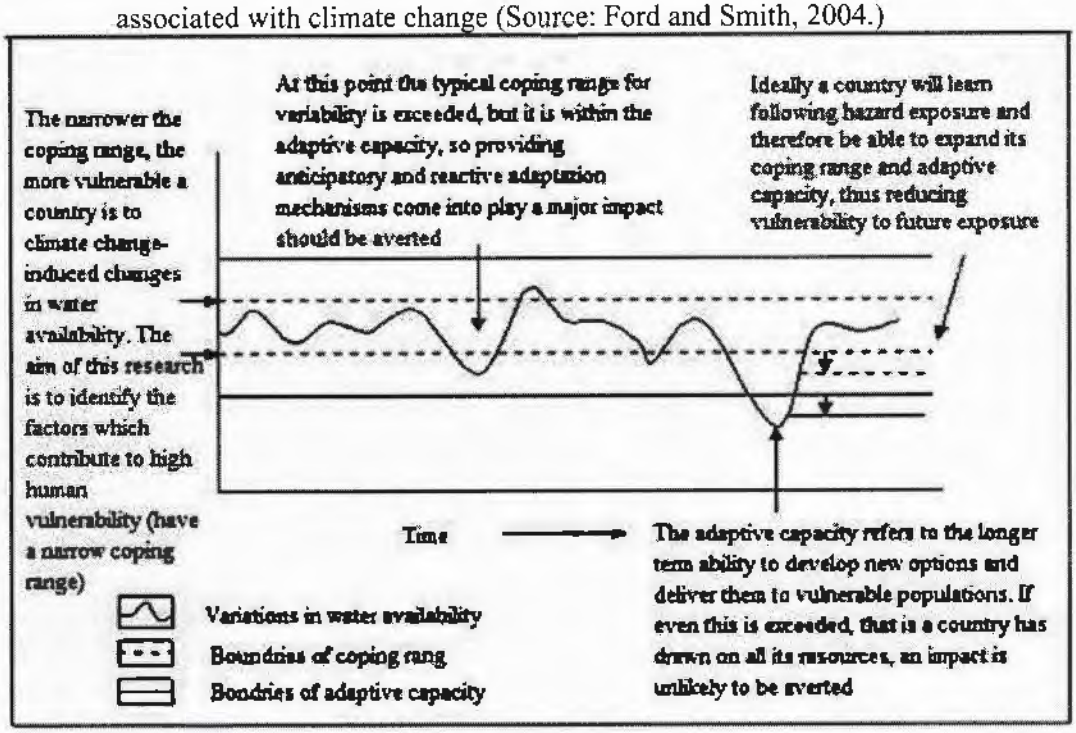


Figure-2: Illustrative diagram of the theoretical framework for vulnerability assessment, combating range and adaptive capacity (*source*: *Smith, 2001*)

1.4 Climatic Regions of Afghanistan

In general terms Afghanistan's climate is sub-arctic, as the country has warm summer and cold winter seasons. Temperature always changes rapidly hence most parts of the country have warm and dry summer and cold winter seasons with little precipitation, however the highlands or mountainous regions (central parts) receive about 950-1000 (mm) precipitation on annual basis, while flat regions (southern parts) receive 100-150 (mm) precipitation on annual basis. Afghanistan has six climatic zones/regions based on Koppen climate zone/region classification for Afghanistan where the central parts have cold desert climate, southern parts have warm and semi-arid climates, northern parts have cold desert and cold semi-arid climates, eastern parts have warm Mediterranean and warm continental climates and western parts have cold semi-arid climate.

Paghman district lie in central part on the country which has cold desert climate as well receives more precipitation. Large portion of the district is covered by mountains, which is attached to Hindu-Kush mountain system/range.

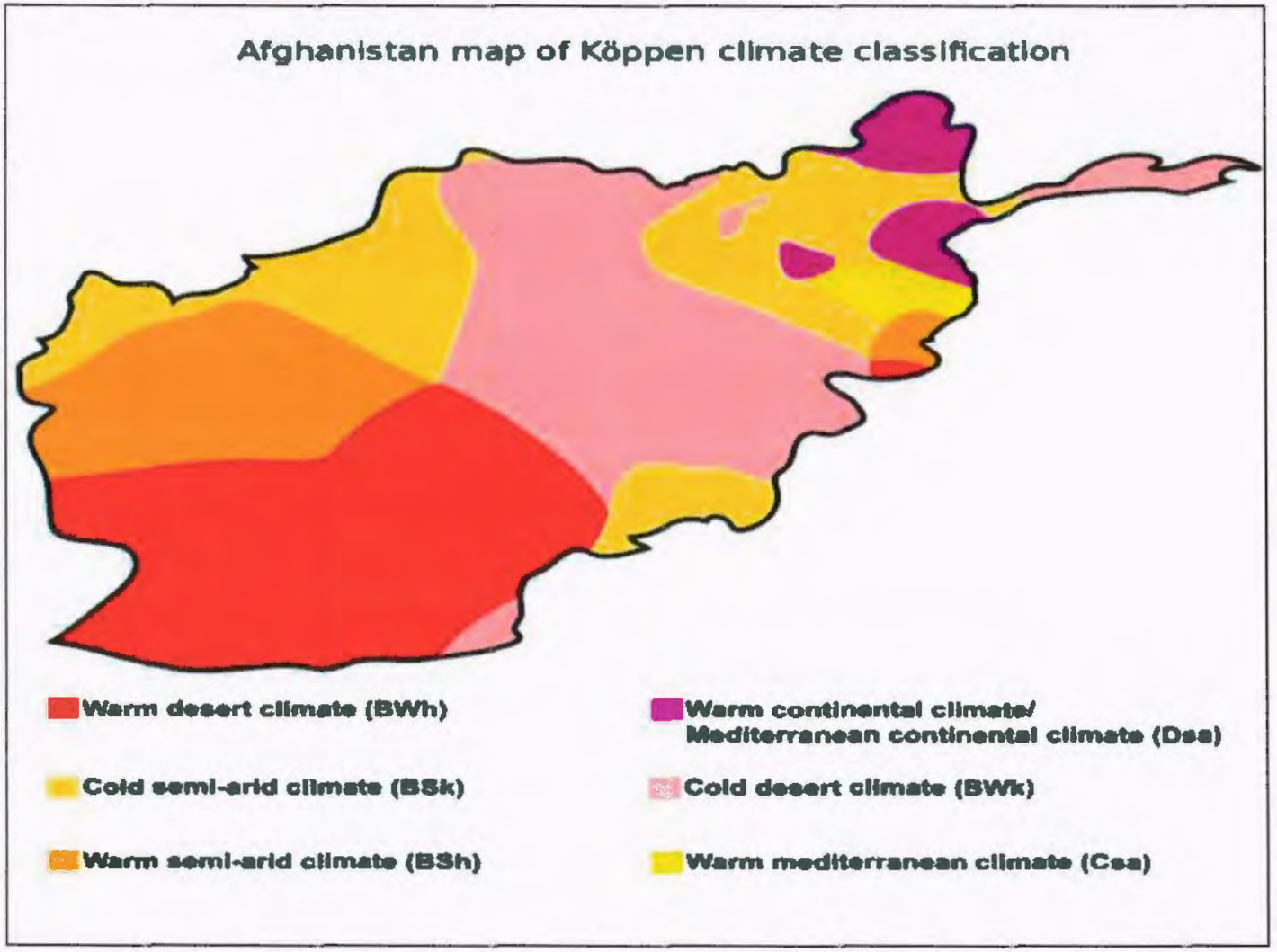


Figure 3: Climatic region of Afghanistan
(*Source: Koppen climate classification for Afghanistan*)

1.5 Historical Trends and Vulnerabilities of Climate Change in Afghanistan

Afghanistan is an arid or semi-arid country and the climate is dry in various parts of the country, thus the country has cold winter and hot summer seasons, the annual average perception is between 180-200 mm and the annual average temperature is 20 °C however the highest average temperature is 25 °C and the lowest average temperature is -9 °C , in the meantime the country does not have sea or ocean, even it does not have border with sea or ocean to ensure moderate or riskless climate, in addition the climate is not stable and it's so much vulnerable to prevailing climatic change in the region and at global level at all.

More 70% of Afghanistan population are engage in agricultural activities and livestock husbandry, major portion of agricultural practices depends of precipitation and surface water, due to recent climatic variability and weather alterations reduced the surface water and various pastures and rangelands vanished due to landslides and recurrent floods, in the country. Due to poor infrastructure and absence of good disaster reduction preventing or controlling measures and mechanisms and early warning systems, large pieces of agricultural lands have destroyed in various parts of the country as well due to soil erosion and excessive of sedimentation have raised rivers depth and the catchment area have shrunken, on the other hand, MAIL's national report (2006) documented that about 70% of land have been decertified in western, northern and southern parts of the country.

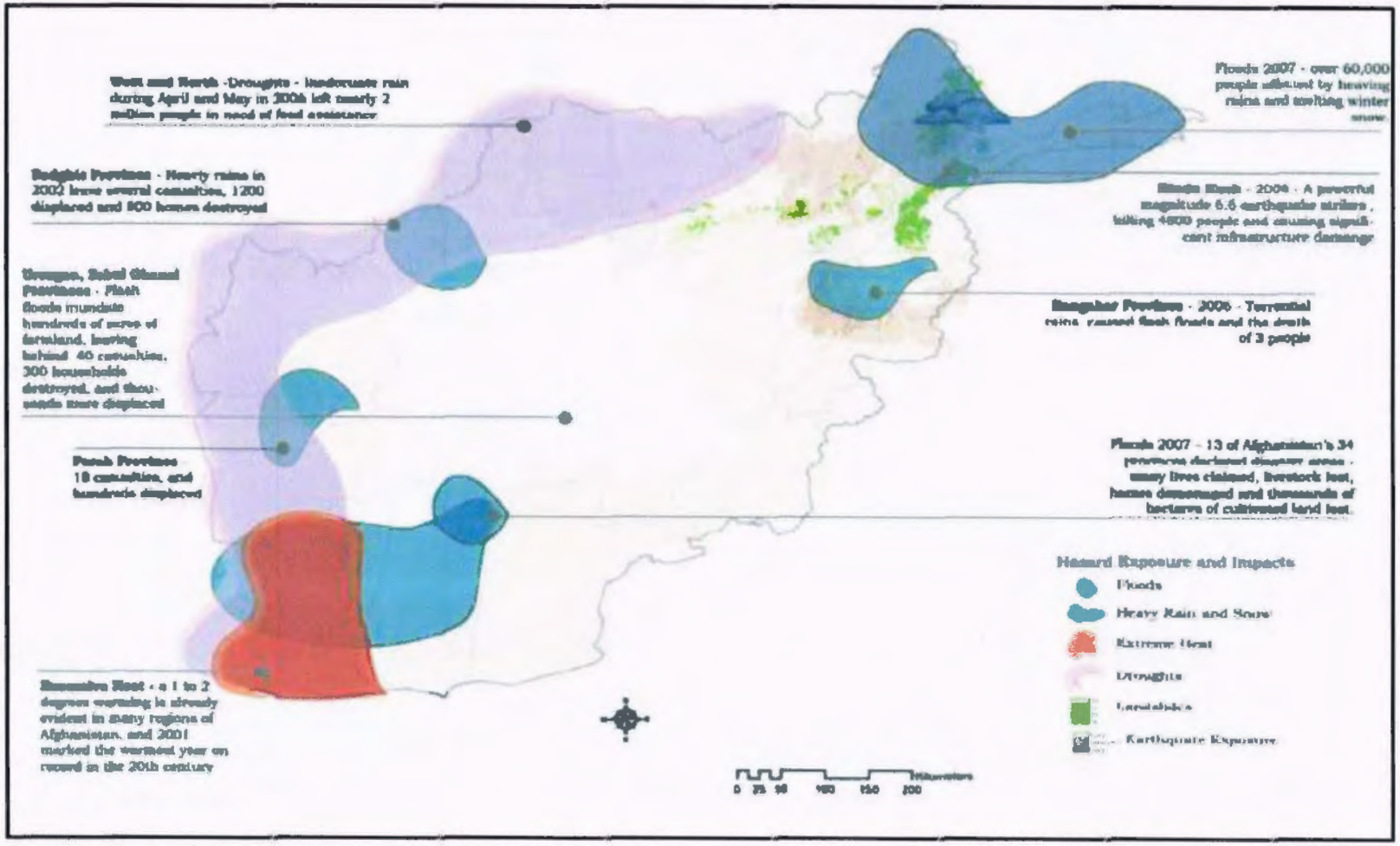


Figure 4: Latest Climate Induced Natural Disasters in Afghanistan
(Source: SEI & DIFID, Socio-economic Impacts of climate change in Afghanistan)

Afghanistan experienced severe droughts since 1990s, according to ADB analysis about climate change and drought, stated that southern and central provinces have significantly affected from the recent droughts and famine and according to UNEP, more than 6 million people affected from droughts in 1995-2002, furthermore, due to water and food scarcity in southern parts of the country various families migrated to other provinces.

The recent climate induced natural disaster happened in Afghanistan gives a clear sign of its vulnerability and fragileness against climatic changes happening in the world, according to the information and statistics provided by ANDMA and DIFID, documented that almost all 34 provinces have been affected by recent climatic changes in the country, in the meantime future climate change projections and physical models predicts, that Afghanistan will face more climate induced natural disasters in next 20 years, the most significant impact will be drought and floods.

According to GERMANWATCH, (Global Climate Risk Index, 2016) report, Afghanistan ranked number two among top three countries which are the most affected countries in the world, adversely affected from climatic changes and alteration in weather patterns (precipitation, storms, floods, landslides and heat waves) in 2014. Afghanistan got Climate Risk Index (CRI) 10.67 score after, 434 death tolls and 337.085 million US dollars, absolute losses.

Furthermore analysis of GERMANWATCH from 1995-2014 years ranked Honduras, the most affected country in the world adversely affected from climatic changes and alteration in weather patterns (precipitation, storms, floods, landslides and heat waves) in last two decades or 20 years. Fortunately Afghanistan ranked in 12th number in terms CRI scores and other relevant impacts from climate change in last two decades.

Below map shows countries affected from climatic changes and alteration in weather patterns (precipitation, storms, floods, landslides and heat waves) in last two decades.

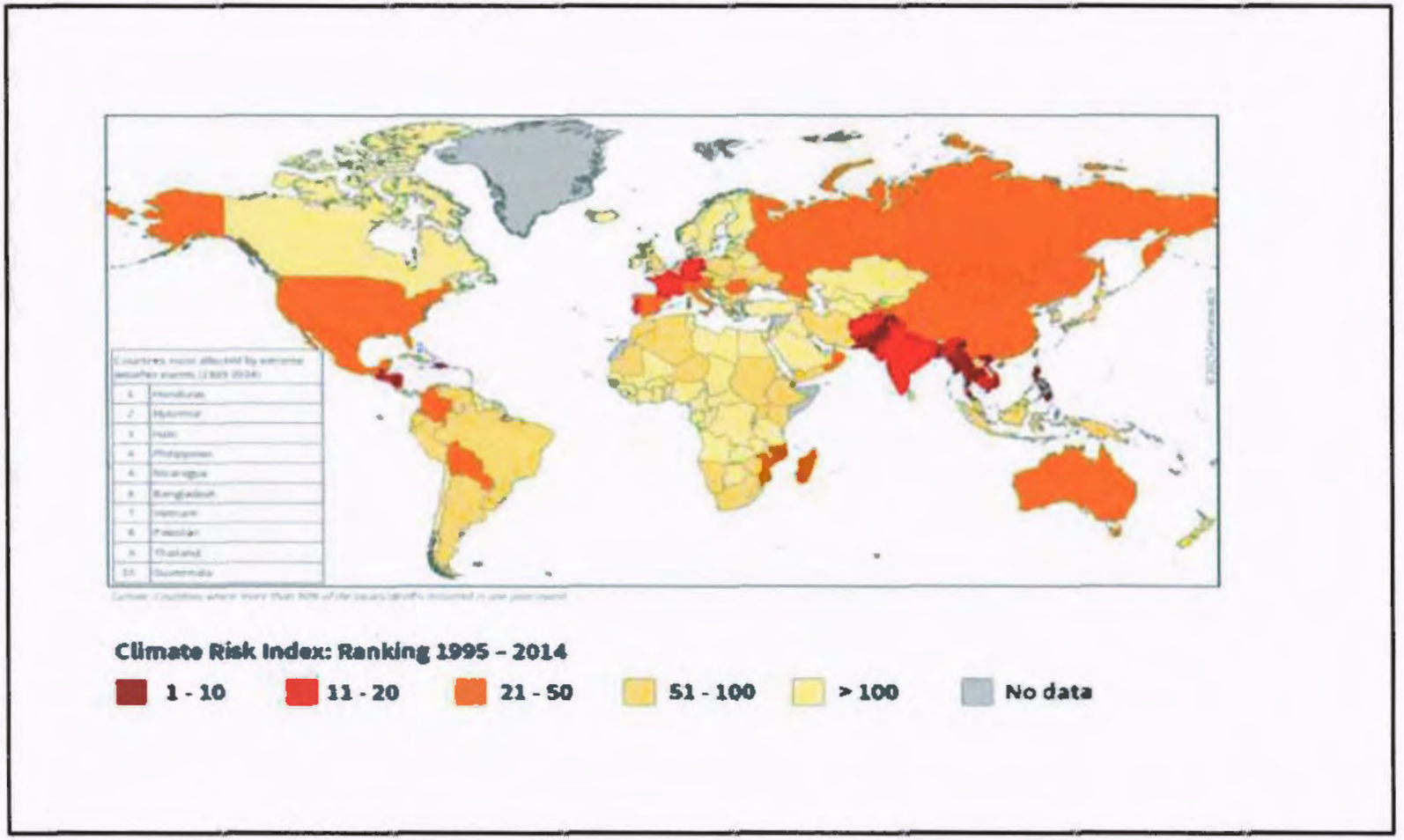


Figure-5: Map of global Climate Risk Index from 1995-2014 years.
(Source: GERMANWATCH, Global Climate Risk Index Report, 2016)

1.6 Problem Statement

Climate Change is any long-term significance change in the weather patterns of any an area, especially a change due to an increase in the average atmospheric temperature. Climate Change can be both natural or caused by changes human have made to the land formation or activities which is altering global atmospheric concentration of greenhouse gases (GHGs) i.e. carbon dioxide (CO2),There is now general acceptance that the world has entered a period of rapid anthropogenic (man-made/human activity) climate change. Afghanistan in common with other Himalayan regions and the Arctic/Antarctic has already experienced rapid increase in temperature (IPCC 2014 p1335), with predictions of an increase in the late 20th Century levels of up to 4°C over the next 50 years. Such an increase would cause changes including (a) rise in the snowline and reduced snow cover, (b) glacier thaw and (c) increase in evaporation and evapotranspiration, increasing crop water use and reducing runoff and accession to groundwater, (Samadi AR, 2011). The net effect of these changes will be reduction in river flow, and in the water available for irrigation, power generation and groundwater recharge. To some extent all of the impacts of climate change do not contribute only to the negative impacts while there would be positive impacts of climate change as well such as increased temperatures and CO_2 levels can lead to more rapid plant growth and too much crop yield. (World Bank, 2013)

Due to previous droughts and climatic variability experienced in the country, have decreased surface and ground water bodies as well shrunken Glaciers thickness, statistics indicate about 30% decrease in major Glaciers of Pamir and Hindukush mountainous since 1960s, therefore various small glaciers have been completely disappeared. Furthermore, about 3 million residents of the country have been negatively affected from the droughts of 1990s and most others are confront and vulnerable to the prevailing climate change and its induced impacts, (UNEP, 2008).

Paghman district has been drastically affected due to past droughts and recent climate variability experienced in the district, most residents of the district perform agriculture activities and agriculture sector is directly dependent on water resources, while both of these sectors have been affected by recent climate induced factors and variability,

these changes and variability negatively affected the social and environmental wellbeing of residents and the district at ll.

Community based climate change adaptation and mitigation are the available options for combating and reducing the intensity and vulnerability, however they have certain financial and technical constrains, if proper climate change mitigation and adaptation measures and strategies are not taken into account it will further affect the social, environmental and economy of the district, in case we take and adopt proper community based and cost-effective climate change mitigation and adaptation measures, these will be help fruitful in preventing and reducing anticipated climate change risks and vulnerabilities.

1.7 Significance of the Study

Generally social and environmental impacts analysis and study describe that an anticipated development or prospect progress i.e. climate change will affect the livelihood of present and forthcoming generations of a society. Methods to be used for measuring and scaling climate change induced and associated impacts on social and environmental impacts of an anticipated development or prospect progress includes the followings.

- Changes in community demographics
- Changes in quality of life/lifestyle
- Change in public services
- Changes in employment
- Changes in profits
- Changes in the natural quality of the environment

Detailed analysis from the above mentioned influences are the main mechanisms in social and environmental vulnerability analysis, meanwhile, observations and insights of residents regarding the anticipated change or progress, that could affect their well-beings is a chief part in social and environmental vulnerability assessment as it adds value in decision making, in controlling the change. Furthermore, public consultation and their knowledge regarding social and environmental systems are the prime stage in carrying out a social and environmental vulnerability assessment.

Social and environmental impacts from prevailing change in a society could starts from the time it begins, although the results may observe after some time due to gradual progress and or new development. On the other hand, the immediate impacts or changes could be observed whenever a particular sector or system is vulnerable to the proposed change, to which well-beings and livelihood of a society is more dependent, or the need for taking suitable controlling measures felt.

Social and environmental vulnerability analysis is a complex, thus important part in impact assessment related to change or progress, usually impact to the social and natural systems and wellbeing of a society could be noteworthy, as these are always interrelated to each other thus it is difficult to identify the associated change or impacts, although, it should not consider that social and environmental vulnerability analysis shall not be considered the vital part in development impact analysis.

On the other hand, this very important to remember all groups of people (wealthy, poor, and vulnerable) living in a community, during decision making and impact analysis as poor and vulnerable groups are highly vulnerable to the anticipated and prevailing climate changes and its induced impacts, therefore it is highly needed to involve all relevant stakeholders in decision making processes. Methods and techniques for social and environmental impacts analysis and public involvement may vary due to interrelation of each other.

In conclusion, this is very essential to indicate that social and environmental vulnerability assessment not only predicates impacts, as well it should also identify means and resources to mitigate and adapt adverse impacts along with adaptive capacity of the environment. Mitigation and adaptation may contain measures and struggles for preventing or reducing climate change associated impacts via professional and community based projects and initiatives for climate change resilience, natural resource management and its efficient and effectives use.

1.8 Expected Results

This project has highlighted the significance of socio-environmental impacts along with observed impacts resulted from the climate change and its related impacts in Paghman district, particularly related to agriculture and water resources.

Population and urban growth in the district have been analyzed with the comparison and analysis of 1993, 2010 and 2015 land covers, in the meantime suitable community based climate change adaptation and mitigation measures for combating climatic changes have been given with the help of ten years climate (temperature and precipitation) data variability assessment of Paghman district along with UNDP's future climate change projections for Afghanistan based on Special Report on Emission Scenarios (SRES) and IPCC 4th and 5th assessment reports.

Meanwhile, comprehensive vulnerability assessments along with the current and future adaptive capacity of the district have performed on the basis of presence of natural resource, climate change adaptation and mitigation measures and community contribution.

1.9 Objectives of the Study

This research study was envisaged to achieve the following objectives:

a) To assess current adaptation capacity of the local communities to climate variability; and
b) To project future adaptation capacity of the local communities to projected climate change scenarios.

2. LTERATURE REVIEW

2.1 Introduction

Climate change is probably the most urgent problem facing our society. We know that Mankind activities are causing the earth to warm, but we also know that we can solvc this problem. It's a complex issue and there is a lot of information that gets circulated, not all of it very helpful. Here wc will try to boil it down to the most relevant facts.

Our planet's atmosphere is part of a global system that keeps the temperature of our planet within a habitable range. Over the last 200 years or so, humans have been altering the composition of the atmospherc by burning fossil fuels, including coal, oil and gas. When these are burned, CO_2 is produced and builds up in the atmospherc, creating what is known as the greenhouse effect. Other 'greenhouse gases' that contribute to this effect include methane produced from livestock and N_2O from nitrogen-based fertilizers, although CO_2 is the most prevalent. The greenhouse effect traps energy from the sun, and raises the temperature of the earth; it is similar to what happens when a car is left in the sun. This rising temperature is what most pcople are referring to when they say 'global warming' or 'climate change'.

The impacts of climate change are wide-ranging and are going to be felt ecologically, economically, and socially. All of these impacts are interlinked; a worsening of one problem can also exacerbate another. However, this also means that tackling one area can create overlapping benefits in other areas as well. (Parry et all, 2007)

There is still time for us to choose a future without the worst of climate change. The solution is to move away from fossil fuels in every aspect of our lives, and adopt renewable energy sources. This is critical, because a rising temperature on earth is going to have profound effects on all life, including humans. Entire ecosystems are changing, and many species are going extinct because they cannot adapt quickly enough. Our civilization will have to undergo profound changes both to mitigate the worst of climate change, and to adapt to the global impacts that have already started to occur.

2.2 Climate Change

Earth's atmosphere is made up of oxygen, a large amount of nitrogen and a small percentage of greenhouse gases. Greenhouse gases act like a blanket around the Earth. They trap warmth from the sun and make life on Earth possible. Without them, too much heat would escape and the surface of the planet would freeze. However, increasing the concentration of greenhouse gases in the atmosphere causes the Earth to heat more and the climate to change. This process is often called global warming but it is better to think of it as climate change because it is likely to change other aspects of climate as well as temperature, and also bring about more extreme climate events such as floods, storms, cyclones and droughts. (UNEP, 2001).

2.3 Rational Evidence Shows Climate Change is Happening

There are many evidences that tell us the average temperatures of the world's atmosphere and oceans have increased over the last 150 years.

Evidence includes:

- Direct temperature measurements on land;
- Changes in the dates when lakes and rivers freeze and their ice melts;
- A reduction in the extent of snow cover in the Northern Hemisphere;
- A reduction in glaciers;
- Extended growing seasons of plants;
- Changes in the heat stored in the ocean;
- Changes in rainfall patterns resulting in more floods, droughts and intense rain; and
- A number of biological changes have also been observed.

These include:

- Shifts in the ranges of some plant and animal species;
- Earlier timing of spring events such as leaf-unfolding, bird migration and egg-laying for some species; and
- Together these indicators provide clear evidence that the climate is changing.

2.4 Human Contribution to Climate Change

It is true that climate change has been driven by natural causes in the past. Our climate has undergone many changes over millions of years — from ice ages to tropical heat and back again. Natural changes over the past 10,000 years have generally been gradual which has enabled people, plants and animals to adapt or migrate, although some prehistoric climate changes may have been abrupt and are likely to have led to mass extinction of species. (Skoufias et all, 2011).

However, over the past 150 years there has been a marked and growing increase in greenhouse gas producing activities such as industry, agriculture and transportation. These human-induced activities are increasing the level of greenhouse gases in our atmosphere and causing the Earth not only to heat up, but to heat up at an unprecedented rate. This recent warming can only be explained by the influence of humans. (Wisner Ben, 1998).

2.4.1 Increase in Green House Gases

The levels of carbon dioxide and methane in the atmosphere have increased as the result of human activities and are now higher than they have been in at least 800,000 years.

We know this from a number of ice core studies. Snow traps tiny bubbles of air as it falls and is compressed into ice. Over the years, more and more ice layers stack up on top of each other. Drilling into ice sheets in Antarctica and Greenland provides a record of what the atmosphere was like back in time. (Nelson et al, 2010).

Direct measurements of atmospheric concentrations of greenhouse gases show how our global greenhouse gas emissions have grown in past decades.

These analyses provide very clear and consistent results that today's greenhouse gas concentrations are far higher than they were at any time during the past 800,000 years

The Earth's temperature is changing at a rate unprecedented in recent history:

Globally, our climate has been relatively stable for the past 10,000 years. If the world does not take action to reduce greenhouse gas emissions, the global average temperature is very likely to change more rapidly during the 21st century than during

any natural variations over the past 10,000 years. This will make it difficult for plants and animals to adapt to climate change.

Limiting climate change will require substantial reductions of greenhouse gas emissions future climate change will largely depend on the total sum of greenhouse gases emitted since the start of the industrial revolution. Greenhouse gas emissions have continued to increase over past decades and limiting climate change will mean reversing this trend.

The effects of climate change will continue even after emissions are reduced. The climate system takes time to change, and human activities have already released large amounts of greenhouse gases into the atmosphere. As a result, the effects of climate change will continue even if we reduce emissions now. For example, the deep oceans take centuries to heat up when the atmosphere above them warms. This means that oceans will continue to heat up, and therefore expand causing sea-levels to rise, even if greenhouse gas concentrations in the atmosphere are no longer increasing. Although we cannot avoid climate change entirely, reducing our emissions can limit its impact. (Richard, 2009)

2.5 Uncertainties about Future Climate Changes

How the climate will change in the future depends on the amount of greenhouse gases we release into the atmosphere. It also depends on how the Earth responds to the increased heating. So we cannot be precise about future climate change. But we are generally sure of the direction of change (eg, the world will become warmer and global average sea-levels will rise). We can also give plausible ranges for those changes. For example, scenarios of future climate change looked at by the Intergovernmental Panel on Climate Change (IPCC) show the world's average temperature is expected to increase by between 0.9 and 5.4 degrees Celsius at the end of the 21st century, relative to the average temperature from 1850-1900. (IPCC, 2012)

2.6 Worldwide Climate Change Impacts

Human basic needs, such as food, water, health, and shelter, are affected by climate. Changes in climate may threaten these needs with increased temperatures, sea level rise, changes in precipitation, and more frequent or intense extreme events. Climate change will affect individuals and groups differently. Certain groups of people are

particularly sensitive to climate change impacts, such as the elderly, the infirm, children and pregnant women, native and tribal groups, and low-income populations. Climate change may also threaten key natural resources, affecting water and food security. Conflicts, mass migrations, health impacts, or environmental stresses in other parts of the world could raise economic, health, and national security issues for the United States. Although climate change is an inherently global issue, the impacts will not be felt equally across the planet. Impacts are likely to differ in both magnitude and rate of change in different continents, countries, and regions. Some nations will likely experience more adverse effects than others. Other nations may benefit from climate changes. The capacity to adapt to climate change can influence how climate change affects individuals, communities, countries, and the global population. (NRC, 2010), (Melillo et all, 2014) and (Crimmins et all, 2016).

2.6.1 Impacts on Basic Needs

Impacts on Agriculture and Food

Changes in climate could have significant impacts on food production around the world. Heat stress, droughts, and flooding events may lead to reductions in crop yields and livestock productivity. Areas that are already affected by drought, such as Australia and the Sahel in Africa, will likely experience reductions in water available for irrigation. (Melillo et all, 2014).

At middle to high latitudes, cereal crop yields are projected to increase slightly, depending on local rates of warming and crop type. At lower latitudes, cereal crop yields are projected to decrease. The greatest decreases in crop yields will likely occur in dry and tropical regions. In some African countries, for example, wheat yields could decline by as much as 35% by 2050. Climate change is affecting many fisheries around the world. Increasing ocean temperatures have shifted some marine species to cooler waters outside of their normal range. Fisheries are important for the food supply and economy of many countries. For example, more than 40 million people rely on the fish caught in the Lower Mekong delta in Asia, which is the largest freshwater fishery in the world. Projected reductions in water flows and increases in sea level may negatively affect water quality and fish species in regions like these, affecting the food supply for communities that depend on these resources. (FAO, 2008a).

Climate change is very likely to affect global, regional, and local food security by disrupting food availability, decreasing access to food, and making utilization more difficult. (Brown et all, 2015). Climate risks to food security are greatest for poor populations and in tropical regions. The potential of climate change to affect global food security is important for food producers and consumers in the United States.

Impacts on Water Supply and Quality

Semi-arid and arid areas (such as the Mediterranean, southern Africa, and northeastern Brazil) are particularly vulnerable to the impacts of climate change on water supply. Over the next century, these areas will likely experience decreases in water resources, especially in areas that are already water-stressed due to droughts, population pressures, and water resource extraction. (Melillo et all, 2014).

As climate changes, water is very likely to become scarce at least part of the time in many areas, but more plentiful part of the time in some areas as well. The availability of water is strongly related to the amount and timing of runoff and precipitation. With a 2.7°F rise in global mean temperature, annual average stream flow is projected to increase by 10-50% at high latitudes and in some wet tropical areas, but decrease by 10-50% in some dry regions at mid-latitudes and in the subtropics. As temperatures rise, snowpack is declining in many regions and glaciers are melting at unprecedented rates, making water less available in areas that depend on it from melting snow and glaciers during spring and summer. Droughts are likely to become more widespread. When it does rain, more precipitation is expected to fall in extreme heavy precipitation events. Increases in heavy precipitation events would not increase water supply, but instead result in increased flooding, except in river basins with large dams able to hold excess water until it is needed.

Water quality is important for ecosystems, human health and sanitation, agriculture, and other purposes. Increases in temperature, changes in precipitation, sea level rise, and extreme events could diminish water quality in many regions. Large rainstorms may cause large amounts of pollutants to enter rivers and estuaries, as excess water may overwhelm wastewater systems and natural buffers. Increased pollution as well as increasing water temperatures can cause algal blooms and potentially increase bacteria in water bodies. In coastal areas and small islands, saltwater from rising sea level and storm surges threaten water supplies. These impacts may require

communities to begin treating their water in order to provide safe water resources for human uses. (NRC, 2010).

Impacts on Human Health

The risks of climate-sensitive diseases and health impacts can be high in countries that have little capacity to prevent and treat illness. There are many examples of health impacts related to climate change. (NRC, 2010).

- Increases in temperatures are linked to more frequent and severe heat stress.
- Worsened air quality that often accompanies heat waves or wildfires can lead to breathing problems and exacerbate respiratory and cardiovascular diseases.
- Impacts of climate change on agriculture and other food systems can increase rates of malnutrition and foodborne illnesses.
- Climate changes can influence infectious diseases. The spread of meningococcal (epidemic) meningitis is often linked to climate changes, especially drought. Areas of sub-Saharan and West Africa are sensitive to the spread of meningitis, and will be particularly at-risk if droughts become more frequent and severe.
- The spread of mosquito-borne diseases such as malaria, dengue, and West Nile virus may increase in areas projected to receive more precipitation and flooding. Increases in rainfall and temperature can cause spreading of dengue fever. (Smith, K.R., A. Woodward, at all, 2014).
- Changes in precipitation patters and extreme weather events can lead to cascading health impacts, particularly when power, water, or transportation systems are disrupted. Diarrheal diseases from contaminated water and food sources are a major concern, particularly for children.
- The effects of global climate change on mental health and well-being are integral parts of the overall climate-related human health impacts. Mental health consequences of climate change range from minimal stress and distress symptoms to clinical disorders, such as anxiety, depression, post-traumatic stress, and suicidal thoughts. (NRC, 2010)
- Certain groups of people in low-income countries are especially at risk for adverse health effects from climate change. These at-risk groups include urban people living in poverty, older adults, young children, traditional societies,

subsistence farmers, and coastal populations. Many regions, such as Europe, South Asia, Australia, and North America, have experienced heat-related health impacts. Rural populations, older adults, outdoor workers, and those without access to air conditioning are often the most vulnerable to heat-related illness and death. (Smith, K.R., A. Woodward, at all, 2014).

Impacts on Shelter

Climate change affects the migration of people within and between countries around the world. A variety of reasons may force people to migrate into other areas. These reasons include conflicts, such as ethnic or resource conflicts, degraded ecosystem services, such as lack of viable agricultural land or fresh water, and extreme events, such as flooding, drought, and hurricanes. Extreme events displace many people, especially in areas that do not have the ability or resources to quickly respond or rebuild after disasters. Many types of extreme events are becoming more frequent or severe because of climate change, which exacerbates existing conflicts. This will likely increase the numbers of people migrating during and after these types of events. (Adger, W.N., at all 2014).

Coastal settlements and low-lying areas are particularly vulnerable to climate change impacts, such as sea level rise, erosion, and extreme storms. Rising ocean temperatures and acidity may also threaten coastal ecosystems. As coastal habitats (such as barrier islands, wetlands, deltas, and estuaries) are destroyed, coastal settlements can become more vulnerable to flooding from storm surges and erosion. Both developing and developed countries are vulnerable to the impacts of sea level rise. For example, Bangladesh, the Netherlands, and Guyana are particularly at-risk.

2.6.2 Impacts on Vulnerable Populations

Indigenous groups in various regions--such as the United States, Latin and South America, Europe, and Africa--are already experiencing threats to their traditional livelihoods. Rising sea levels and extreme events threaten native groups that inhabit low-lying island nations. Higher temperatures and reduced snow, ice, and permafrost threaten groups that live in mountainous and polar areas. Climate effects in these areas can affect hunting, fishing, transport, and other activities. (NRC, 2010)

Approximately 1.4 billion people, close to one fifth of the world's population, live below the World Bank's measure of extreme poverty, earning less than US $1.25 a day. Many lower-income groups depend on publicly provided resources and services such as water, energy, and transportation. Extreme events can affect and disrupt these resources and services, sometimes beyond replacement or repair. Many people in lower-income countries cannot afford or gain access to adaptation mechanisms such as air conditioning, heating, or disaster insurance. This lack of adaptive capacity makes the world's poor especially vulnerable to the impacts of climate extremes, exacerbating existing conditions of poverty and inequality, and ultimately leading to more poverty. (Adger, W.N. at all Spring 2014).

Older and younger people are also especially sensitive to climate change impacts. Children's developing immune, respiratory, and neurological systems make them more sensitive to some climate change impacts, including more frequent or severe extreme events, increased heat, and worsened air quality. Elderly populations are also at risk due to frail health and limited mobility. Extreme heat and storm events can disproportionately affect older people. (Crimmins et all, 2016) and (Smith, K.R., A. Woodward, at all, 2014).

Climate change impacts can differ according to gender. Worldwide, women have a higher rate of mortality than men from severe storms or other extreme events, although there is regional variation. In some regions, working-age men who work outdoors are more vulnerable to heat-related deaths. Women developing countries women may be particularly vulnerable to extreme events due to differences in poverty and physical vulnerability due to under nutrition or pregnancy. As climate change causes extreme events to become more frequent or severe, women may be disproportionately affected. (Smith, K.R., A. Woodward, at all 2014).

2.6.3 Regional Impacts

Highlights of recent and projected regional impacts are shown below.

Impacts on Africa

- Africa may be the most vulnerable continent to climate variability and change because of multiple existing stresses and low adaptive capacity. Existing stresses include poverty, food insecurity, political conflicts, and ecosystem degradation;

- By 2050, between 350 million and 600 million people are projected to experience increased water stress due to climate change. Urban population is also projected to triple, increasing by 800 million people, complicating urban poverty and access to basic services;
- Climate variability and change is projected to severely compromise agricultural production, including access to food, in many African countries and regions;
- Toward the end of the 21st century, projected sea level rise will likely affect low-lying coastal areas with large populations, including Senegal, Liberia, and Mozambique; and
- Climate variability and change can negatively impact human health. In many African countries, existing health threats – such as malnutrition, malaria and other vector-borne diseases -- can be exacerbated by climate change. (Niang et all, 2014).

Impacts on Asia

- Glaciers in Asia are retreating at faster rates than ever documented in historical records. Some glaciers currently cover 20% of the land that they covered a century ago. Melting glaciers increase the risks of flooding and rock avalanches from destabilized slopes;
- Climate change is projected to decrease freshwater availability, especially in central and southeast Asia, particularly in large river basins. With population growth and increasing demand from higher standards of living, this decrease could adversely affect more than a billion people by 2050;
- Increased flooding from the sea and, in some cases, from rivers threatens coastal areas, especially heavily populated delta regions in south and southeast Asia;
- The impacts of climate change on crop yields are likely to vary drastically depending on region, crop type, and regional changes in temperature and precipitation. For example, by the mid-21st century, climate change could increase crop yield up to 20% in east and southeast Asia, while decreasing yield up to 30% in central and south Asia; and

- Sickness and death due to diarrheal disease will likely increase in east, south, and southeast Asia due to projected changes in the hydrological cycle associated with climate change. (Hijioka et all, 2014).

Impacts on Australia and New Zealand

- Water security problems are projected to intensify with a 1°C global average warming in southwestern and southeastern Australia, and in the northern and some eastern parts of New Zealand;
- Biodiversity within some ecologically rich sites, including the Great Barrier Reef and Queensland Wet Tropics, will be at significant risk by 2050;
- Sea level rise and more severe storms and coastal flooding will continue to affect coastal areas. Coastal development and population growth in areas such as Cairns and Southeast Queensland (Australia) and Northland to Bay of Plenty (New Zealand), would place more people and infrastructure at risk;
- Increased drought and fire are projected to cause declines in agricultural and forestry production over much of southern Australia and the northern and eastern parts of New Zealand;
- Cascading and interacting economic, social, and daily life circumstances have accompanied prolonged drought in rural regions. Drought-related worry and psychological distress increased in drought-declared Australian regions, particularly for those experiencing loss of livelihood and industry. Long-term drought has been linked to increased incidence of suicide among male farmers in Australia;
- Extreme storm events are likely to increase the failure of dikes, levees, drainage, and sewerage systems. They are also likely to increase the damage from storms and fires;
- More heat waves are likely to cause more deaths and more electrical blackouts; and
- Indigenous populations are more exposed the risks of climate change than most other Australians and New Zealanders. (Reisinger et all, 2014).

Impacts on Europe

- Wide-ranging impacts of climate change are already being documented in Europe, including retreating glaciers, sea level rise, longer growing seasons; species range shifts, and heat wave-related health impacts;
- Future impacts of climate change will likely negatively affect nearly all European regions, with adverse social, health, and infrastructure effects. Many economic sectors, such as agriculture and energy, could face challenges;
- In southern Europe, higher temperatures and drought may reduce water availability, hydropower potential, summer tourism, and crop productivity, hampering economic activity more than other European regions;
- In central and eastern Europe, summer precipitation is projected to decrease, causing higher water stress. Forest productivity is projected to decline. The frequency of peatland fires is projected to increase; and
- In northern Europe, climate change is initially projected to bring mixed effects, including some benefits such as reduced demand for heating, increased crop yields, and increased forest growth. However, as climate change continues, negative impacts are likely to outweigh benefits. These include more frequent winter floods, endangered ecosystems, and increasing ground instability from thawing permafrost. (Kovats et all, 2014).

Impacts on Central and South America

- By mid-century, increases in temperature and decreases in soil moisture are projected to cause savanna to gradually replace tropical forest in eastern Amazonia;
- In drier areas, climate change will likely worsen drought, leading to salinization (increased salt content) and desertification (land degradation) of agricultural land. The productivity of livestock and some important crops such as maize and coffee is projected to decrease in some areas, with adverse consequences for food security. In temperate zones, soybean yields are projected to increase;
- Sea level rise is projected to increase risk of flooding, displacement of people, salinization of drinking water resources, and coastal erosion in low-lying areas. These risks threaten fish stocks, recreation, and tourism;

- Changes in precipitation patterns and the melting of glaciers are projected to significantly affect water availability for human consumption, agriculture, and energy generation;
- Climate change and land use changes are expected to increase the rates of species extinction; and
- Warmer weather, milder winters, and changes in precipitation may increase incidence of some vector-borne diseases, such as the chikungunya virus, which is transmitted by mosquitoes. (Magrin et all, 2014).

Impacts on North America

- Warming in western mountains will decrease snowpack, increase winter flooding, and reduce summer flows, exacerbating competition for over-allocated water resources;
- Disturbances from pests, diseases, and fire are projected to increasingly affect forests, with extended periods of high fire risk and large increases in area burned;
- Moderate climate change in the early decades of the century is projected to increase aggregate yields of rain-fed agriculture in northern areas, but temperature increases will reduce corn, soy, and cotton yields in the Midwest and South by 2020. Crops that are near the warm end of their suitable range or that depend on highly utilized water resources will likely face major challenges. High emissions scenarios project reductions in yields by as much as 80% by the end of the century;
- Increases in the number, intensity, and duration of heat waves during the course of the century are projected to further challenge cities that currently experience heat waves, with potential for adverse health impacts and increased stress on energy systems. Older populations are most at risk; and
- Climate change will likely increasingly stress coastal communities and habitats, worsening the existing stresses of population, development, and pollution on infrastructure, human health, and the ecosystem. (Romero-Lanka et all, 2014).

Impacts on Polar Regions

- Climate changes will likely reduce the thickness and extent of glaciers and ice sheets.

- Changes in natural ecosystems will likely have detrimental effects on many organisms including migratory birds, mammals, and higher predators as marine species shift their ranges;
- In the Arctic, climate changes will likely reduce the extent of sea ice and permafrost, which can have mixed effects on human settlements. Negative impacts could include damage to infrastructure and changes to winter activities such as ice fishing and ice road transportation. Positive impacts could include more navigable northern sea routes;
- The reduction and thawing of permafrost, sea level rise, and stronger storms may worsen coastal erosion and disrupt both natural and social systems;
- Climate change effects—such as increases in coastal erosion, changes in the ranges of some fish, increased weather unpredictability—are already disrupting traditional hunting and subsistence practices of indigenous Arctic communities, and may force relocation of villages; and
- Terrestrial and marine ecosystems and habitats are projected to be at risk to invasive species, as climatic barriers are lowered in both Polar Regions. (Larsen et all, 2014).

Impacts on Small Islands

- Small islands, whether located in the tropics or higher latitudes, are highly vulnerable to extreme weather events, changes in sea level, increases in air and surface temperatures, and changing rainfall patterns;
- Deterioration in coastal conditions, such as beach erosion and coral bleaching, will likely affect local resources such as fisheries, as well as the value of tourism destinations;
- Sea level rise is projected to worsen inundation, storm surge, erosion, and other coastal hazards. These impacts would threaten vital infrastructure, settlements, and facilities that support the livelihood of island communities;
- By mid-century, on many small islands (such as the Caribbean and Pacific), climate change is projected to reduce already limited water resources to the point that they become insufficient to meet demand during low-rainfall periods; and
- Invasion by non-native species is projected to increase with higher temperatures, particularly in mid- and high-latitude islands. (Nurse et all , 2014).

2.7 Climate Change in Afghanistan

Afghanistan is characterized by a continental climate, though its mountains cause many local variations. The annual distribution of rainfall shows a picture of an essentially arid country, with more than 50% of the territory receiving less than 300 mm of rain and/or snow annually. With the exception of the eastern border regions, which are at the far edges of monsoon influence, about 50% of the precipitation occurs in winter (January to March), much of which falls in the form of snow in the central mountainous regions. A further 30% falls in spring (April to June). From June to October, Afghanistan receives little precipitation. Runoff from snow melt, in the spring and summer seasons are high, where water is the essence of Afghan agriculture. (MEW 2014).

There is now general acceptance that the world has entered a period of rapid anthropogenic (induced by human activity) climate change. Afghanistan in common with other Himalayan regions and the Arctic/Antarctic has already experienced rapid increase in temperature, with predictions of an increase over late 20th Century levels of up to 4°C over the next 50 years. Such an increase would cause changes including (i) rise in the snowline and reduced snow cover, (ii) glacier retreat and (iii) increase in evaporation and evapotranspiration, increasing crop water use and reducing runoff and accession to groundwater. The net effect of these changes will be reduction in river flow, and in the water available for irrigation, power generation and groundwater recharge. However, not all of the impacts of climate change are negative – increased temperatures and CO_2 levels can lead to more rapid plant growth.

A series of recent droughts and increasing air temperatures have reduced the size of glaciers in Afghanistan, posing additional long-term problems due to climate change. In the past 50 years, larger glaciers in the Pamir and the Hindu Kush Mountains have shrunk by 30 per cent, while some smaller ones have vanished altogether. More than 2.5 million people in Afghanistan are already affected by drought [in drought years] or are vulnerable to the impacts of recurrent drought and water shortages. The number may increase further due to global warming and further aridization. (UNEP 2008 p11)

The decline in river flow will inevitably affect the volumes of water flowing to downstream neighboring countries. It is also anticipated that the climate will

experience more extreme rainfall events and droughts with significant impacts on agriculture and flood-affected towns and villages. It is not yet clear how severe the change will be, but it is noted that Afghanistan has experienced severe flooding in every year since 2010 except 2012 when there was some localized flooding in the Hari Rud basin.

In Afghanistan, impacts are likely to be particularly severe due to the arid and semi-arid nature of the country and the extreme poverty within which a large proportion of the Afghan population currently lives.

Afghanistan signed the UNFCCC on 12 June 1992 as a Non-Annex I Party to the Convention (ratification took place on 19 September 2002 by the Transitional Authority and the Convention entered into force on the 18th 16th National Capacity Needs Self-Assessment for Global Environmental Management (NCSA) of December 2002).

Afghanistan is yet to accede to the Kyoto Protocol (and is therefore currently unable to become a Clean Development Mechanism - CDM – host country). The ultimate objective of the UNFCCC and any related legal instruments that the Conference of the Parties (COP) have adopted/ may adopt is: ...to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

2.8 Climate Change Vulnerability

Despite the IPCC's conclusion that anthropogenic climate change is a real phenomenon, there is a large amount of uncertainty relating to the nature of these changes. Projections of change are dependent on global climate models that simulate elements of the climate system and can be forced according to particular plausible scenarios of emissions (SRES) (e.g. Arnell et al, 2004; Parry et al, 2001; Hulme et al, 1999). In addition to changing distributions of temperature and rainfall, other potential impacts include changes in the patterns, nature and intensity of climate-

related natural hazards, such as hurricanes and droughts. Whilst uncertainty is an important consideration, the incremental nature of climate change also differentiates it from natural hazards, most of which are discrete events after which populations have a chance to recover and reduce their vulnerability levels.

However, even if the exposure to climate change is similar there will be variation in the impacts due to the differential vulnerability of ecosystems to such changes. Investigating the potential effects of changing climate has occurred for different ecosystems and sectors in various locations on a case study basis. Essentially such studies are predicated upon a simple linear relationship between hazard and impact, and vulnerability is referring to the sensitivity of natural environments to projected changes in climate, or their biophysical vulnerability.

With the negative impacts that exposure might bring to individuals or human systems (Pelling, 2000). This broader approach has thus highlighted the importance of assessing the complex reality of vulnerability when predicting future impacts of environmental change as the most vulnerable people may not be in the most vulnerable places: poor people can live in resilient biophysical environments and be vulnerable, and wealthy people can be in fragile physical environments and live relatively well. Understanding the impacts of climate change is thus inextricably linked with the human conditions that create a resilience or vulnerability to that event (Parry and Carter, 1998).

This recognition has consequences for vulnerability and impacts assessments, and there has been a growth in theoretical and conceptual studies aimed at highlighting the nature of vulnerability to climate change. Social and environmental vulnerability, in contrast to being seen as an outcome, is viewed more as a potential state of human societies that can affect the way they experience natural hazards. This potential state is in constant flux, reflecting its dependence on the dynamic interaction of a range of economic and social processes which influence the capacity of individuals, social groups, sectors, regions and ecosystems to response to various socio-economic and biophysical shocks (Leichenko and O'Brien, 2002; Clark et al, 2000; Comfort et al, 2005). The most vulnerable are considered those who are most exposed to perturbations, who possess a limited coping capacity and who are least resilient to

recovery. Other definitions of vulnerability focus on concepts of marginality, susceptibility, adaptability, fragility and risk (Liverman, 2009).

Vulnerability is therefore a function of economic, social, political, environmental and technological assets. Who, where, and when vulnerability and disaster strike is determined by the human and physical forces that shape the allocation of these assets in society (Pelling, 2001). This is dependent on the scale of enquiry. On the large-scale macro processes will be most important in determining the distribution and production of entitlements. In the face of exposure to climate change, some populations will be able to draw on their entitlements to adapt to the risk, for example through awareness and preparation, insurance for losses, and diversifying livelihoods. In contrast, on the local scale the role of human agency has a greater influence in access to resources and household-level social status. In such cases entitlements are socially and spatially differentiated according to such factors as gender, ethnicity, religion, class and age. Developing countries are particularly vulnerable to climate change impacts because of exposure and sensitivity to climate change and because some elements of the capacity to adapt may be limited: hence biophysical and social vulnerability.

3. RESEARCH METHODS

3.1 Study Area

The study area has chosen for the study purpose of climate variability analysis, vulnerability assessment of the environmental and social systems to climate change induced factors and identification of observed impacts of climate change along with the analysis of adaptive capacity of local communities against climate variability.

Paghman district is one of the 14 districts of Kabul province, it is located in the western side of the province, the district has more than 124,436 residents (CSO, 2015), where about 75 % are Pashtuns and remaining are Tajeks.

3.1.1 Geography

Paghman district is located in the western part of Kabul province it has boundaries with Maidan-warkdak and Parvan provinces, as well to some district of Kabul province in the western and southeastern parts.

3.1.2. Mountain system

Almost 60 % of Paghman is covered by mountains and hills as the district is a valley; mountains are attached to Hindu-Kush mountain system/range.

Paghman district lies in the range of Hidu-kush Mountain, in the meantime Kabul River feds by Paghman Mountains, most parts of the district covered by mountains and hills, thus the district is greener compared to other districts of Kabul province.

3.1.3. Elevation

Elevation of Paghman district is ranging from 4350 to 1950 meters, the highest point is 4350 meters and the lowest point is 1950 meters. Most parts of the district have high elevation as it's a valley; see below contour map of the district for more details.

3.1.4. Longitude and latitude

Paghman district lies under below angle points, for more details see below contour map of the district.

Longitude: 68° 57′ 30.75″

Latitude: 34° 35′ 24.24″

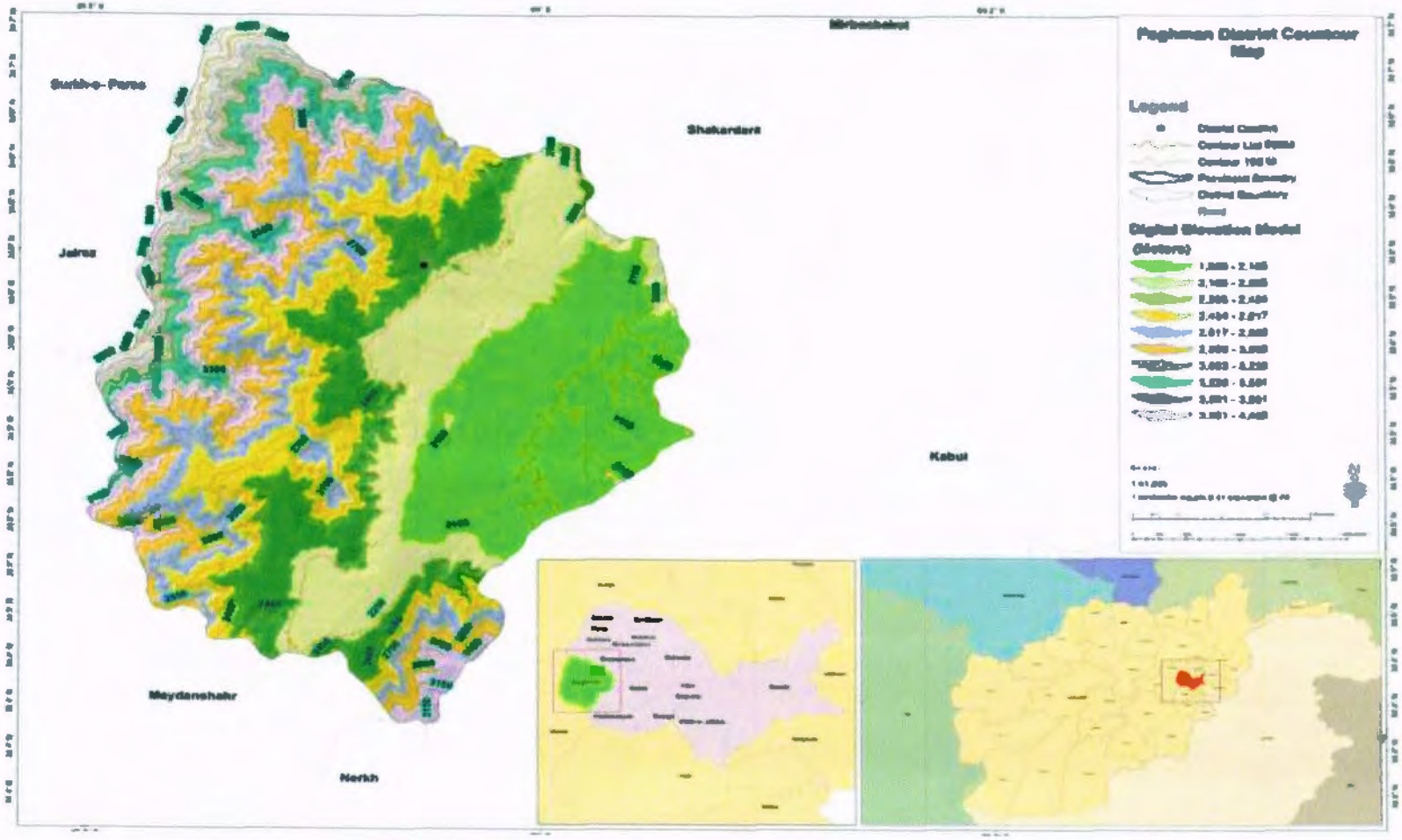


Figure-6: Contour map of Paghman district

3.1.5. Socio-economic Profile of Paghman District

Paghman district is one of the fourteen districts of Kabul province, located in western and southwestern parts of Kabul province, Paghman district has about 124,436 (CSO, 2015), most residents of the district perform agricultural and farming practices, while less percentage of residents are engaged in public and labor works, all these are main occupations and major sources of income.

Population

Paghman district has about 124,436 (CSO, 2015) residents, it has 4% of the total population of Kabul province, the population density compared to land area is relatively low compared to Kabul city and other district of province, although the current situation is changing rapidly, due to existing war and security problems in the country most people migrated to the Kabul province, therefore most of IDPs migrated from Wardak and Ghazni provinces inhabit in Paghman district.

Age and Sex Ratio

Paghman district (total population-124,436) also has more males (64,050) than females (60,386); the sex ratio for the district is 51.47% males and 48.53% females. Similar to Kabul province most residents of Paghman district are young people, thus the average age is 25 years.

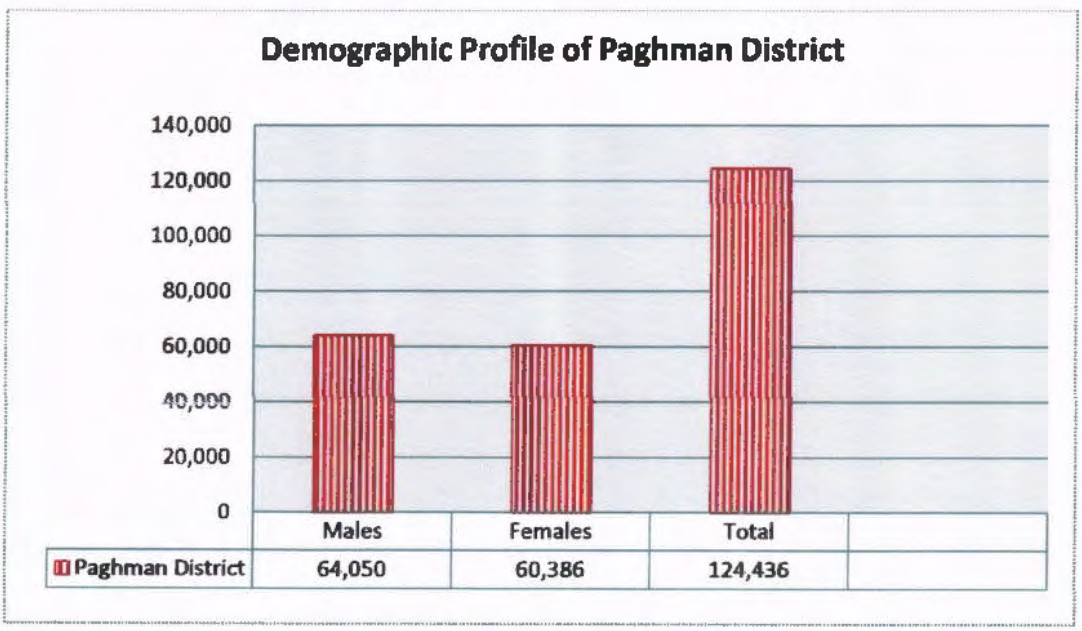


Figure-7: Demographic profile of Paghman district.

Living Condition

Residents of Paghman district have good living conditions as the district is near to Kabul city as well a picnic place. Beside that Paghman district is a greener place thus it has enough water and suitable condition for agricultural activities and livestock husbandry.

Educational Services

Paghman district is quite so good in terms of educational services and accessibility is easy compared to district as the district is located near to Kabul city, however most residents of the district engage in agricultural activities, thus in the past people only acquired primary education. Presently the district has various educational centers like primary schools, high school (for both boys and girls), vocational institutes and private educational centers.

Literacy

Paghman district is located near to Kabul city and it has various educational facilities and attainments, the literacy rate of Paghman district is 59%, while literacy rate of Kabul city is nearly 70 %.

Health Services

Paghman district has various public clinics and medical center at district and village levels; in addition people can easily visit public and private hospitals in Kabul city.

Economic Setup

In general term Paghman district has good economic condition due to suitable conditions for agricultural activities and livestock husbandry, in the meantime Paghman district is commercially well developed and it is the picnic place for large numbers of families and people coming from Kabul city in the weekends. Paghman district ranked number one among the all districts of Kabul province, with huge production of fruits, vegetables and dairy products. Based on National Risk Vulnerability Assessment (NRVA) (2013) report Kabul province poverty rate is about 30%, however large numbers of people lives in urban areas, though the figures might be different in rural areas.

Physical Infrastructure

Paghman district has good condition in terms of infrastructural facilities thus villagers have easy access to fundamental and basic needs. Paghman district is in well condition among other districts of The district has asphalt roads, clinics, banks, police stations, picnic sites, electricity, primary and secondary schools, super markets and shopping centers, hotels and restaurants.....etc.

3.2 Data Collection

This study is carried out based on a combination of techniques and approaches as including primary, secondary sources of data, GIS based analysis of changes in land use from 1990s till 2015 along with variability assessment of climatic data of Paghman district of 10 years. The main results of this research is based on observed impacts of climate change, in-depth interviews, focus group meetings with local communities (both structured and unstructured) and with government officials especially with Ministry of Agriculture, Irrigation and Livestock (MAIL), Ministry of Energy and Water (MEW), National Environment Protection Agency (NEPA), metrological departments and donors like Work Bank, United Nations Development Program (UNDP), Food and Agriculture Organization of the United Nations (FAO).

3.2.1 Primary Data Collection

Primary sources of data include questionnaire, in-depth interviews and focus group meetings with local communities and interviews (both structured and unstructured) with government officials especially with MAIL, MEW, NEPA, UNDP, FAO and donors like World Bank, also analysis of observed impacts from climate change.

3.2.1.1 Questionnaire

Questionnaire was used for collection of primary data. The questionnaire was compiled in accordance with the objectives of the study, the questions were both open and close ended, open ended technique brings flexibility and freedom in responses and it also played a major role in bringing different views and suggestions of the local villagers about the climatic changes, however it would not be easy to capture it from close ended questions.

Questionnaire was filled during the interviews with government officials from various ministries and departments such as MEW, MAIL, NEPA and Metrological department. These interviews yield an in depth understanding about the government attention to climate change and their efforts in its adaptation and mitigation.

3.2.1.2. In-depth interviews

Local communities and villagers of Paghman district were interviewed collectively and individually, for the in-depth analysis both old and youth people were interviewed, most of them were farmers, community elders, vulnerable groups, landless households and government officials of Paghman district, regarding their understanding and knowledge about climate change, seasonal variations, temperature rise and alterations in precipitation patterns, in the meantime they were asked about their occupation, literacy level, education, sources of income, health, livestock, land ownership, house structure, and infrastructural facilities available in the district for the demographic and socioeconomic study.

3.2.1.3. Focus Group Meetings

Focus group meetings were also conducted in between carrying out the questionnaire, FGM were held with villagers collectively to give awareness about the climate change, adaptation and mitigation to climate change, global warming, greenhouse gases, water scarcity and shortages, food and water security, natural disasters and other relevant information and knowledge of climate change and also the researcher collected their suggestions and recommendation about community based climate change adaptation and mitigation, in addition most of them did not have information about climate change and its associated risks.

3.2.2. Secondary Data Collection

Secondary sources of data formed from, data related specifically to Paghman district's administration, (demography, population profile, geography and information about natural resources and the environment) and literature review from published books, articles, relevant journals and other relevant websites about climate change adaptation and mitigation, community based vulnerability assessment, social and environmental impacts resulted from climate change, as well about natural disasters, food and water

security, drought, CBNRM, IWRM, land use change and other relevant parameters of Afghanistan and about other countries

3.3 Analysis of Current Climate Condition

3.3.1. Climatic Data Analysis for Variability Assessment of Paghman District

Ten years (from 2006 to 2015) climatic data (both precipitation and temperature) of Paghman district has analyzed for variability assessment and analysis to point out changes in temperature and rainfall, which have observed in past ten years.

3.3.2. GIS based Analysis for Changes in Land Use

Geographic Information System (GIS) based Analysis has conducted for the land covers of 1993, 2010 and 2015, each of them respectively analyzed in ArcGIS version 10.4 software for the identification of changes occurred in the 20 years, and yet it is a main part in this research to analyze and highlight the changes occurred in land use in Paghman district from 1993, 2010 and 2015 land covers, to highlight urban growth, transfer of Agriculture land and Rangelands into urban and residential places.

3.3.3. Assessment of Current Climate Change Adaptation Capacity

Current climate change adaptation of Paghman district has been assessed on the basis of natural, physical and financial aspects.

3.4 Analysis of Future Climate Condition

3.4.1. Review of Future Climate Change Projection of Afghanistan

Review of Inter-governmental Panel on Climate Change's (IPCC) Special Report on Emissions Scenario (SRES) based future climate change projections for Afghanistan were analyzed and assessed for the purpose future climate change, the future projections were developed based on IPCC fourth assessment report on emission scenario A1B, A2 and B1 under General Circulation Model (GCM), for 2030s.

3.4.2. Assessment of future Climate Change Adaptation Capacity

Future climate change adaptation capacity of Paghman district has been assessed on the basis of institutional and governance processes, natural, physical and financial aspects.

4. RESULTS AND DISCUSSION

The final results were obtained following the proper procedures through different relevant scientific and traditional research material and methods for the community based vulnerability assessment of socio environmental impacts of climate change in the given study area. The overall results shows that water and agriculture sectors in Paghman district have been affected from recent climatic variability experienced in the area, in the meantime these sectors are at high risk and the most vulnerable sectors to climate change, although some initiative and important projects are being implemented in the district for water and food security purposes. Hereupon the socio environmental impacts of climate change in Paghman district have shown in tables, graphs, charts, pie charts, radar, percentages and maps, in this chapter.

4.1 Current Climatic Condition of Paghman District

4.1.1. Climatic Variability of Paghman District from 2006 to 2015

Afghanistan's climate has changed and it is being changing, the temperature has increased, water bodies (both surface and ground) are shrinking and seasonal variations has been observed in last two decades, based on historic climatic data resorted by Pastoral Engagement, Adaptation and Capacity Enhancement (PEACE), a raise of 0.6 °C is observed in temperature since 1960s, on the other hand precipitation has decreased about 2%, thus the hydrosphere especially surface water bodies have drastically and severely affected by the recent climatic changes happened in the country.

Apart from other provinces of Afghanistan, Kabul has different climatic conditions, the province has cold winter and pleasant summer seasons, however similar to annual pattern of Afghanistan climate, on the average basis, from May to October months are dry, while January to March months are consider as humid and months of precipitation, the average annual temperature of Kabul province is 20 to 25 °C maximum and 5 to 10 °C minimum, while the average annual precipitation of Kabul province is 320-350 mm.

Although, Paghman district has different climatic conditions as the district's average annual precipitation is ranging from 450 to 500 mm and the average maximum temperature is 15 to 20 °C while the average minimum is temperature is 0-5 °C to.

4.1.2. Precipitation and Temperature

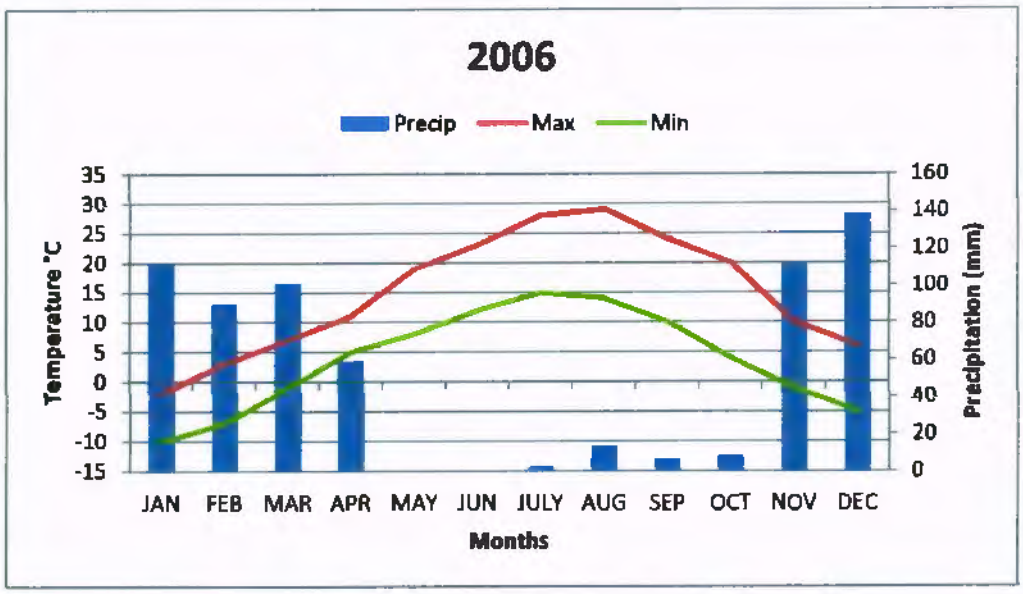
Precipitation data of ten years (from 2006 to 2015) were respectively analyzed for the identification of variability occurred in the past 10 years, precipitation data of Paghman district was provided by the ministry of agriculture, irrigation and livestock (MAIL), and Ministry of Energy and Water (MEW) as these two ministries have installed hygrometry station units in the district (complete precipitation of the district is available in annexes).

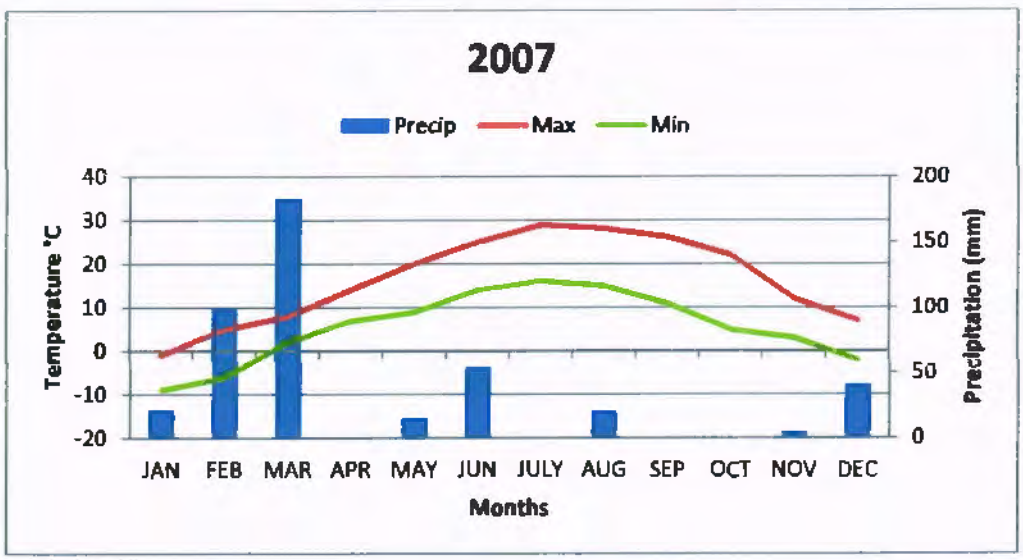
Variability analysis from precipitation data of the district, indicates highs and lows as in first four years (after each two years) the district received more precipitation, like in 2006 the annual precipitation was about 640 mm as well in 2009 the annual precipitation was recorded about 850 mm, although in remaining six years the average precipitation was about 450 mm, in the meantime 2009 received highest annual precipitation which was about 850 mm, while 2011 received lowest annual precipitation which was about 339 mm.

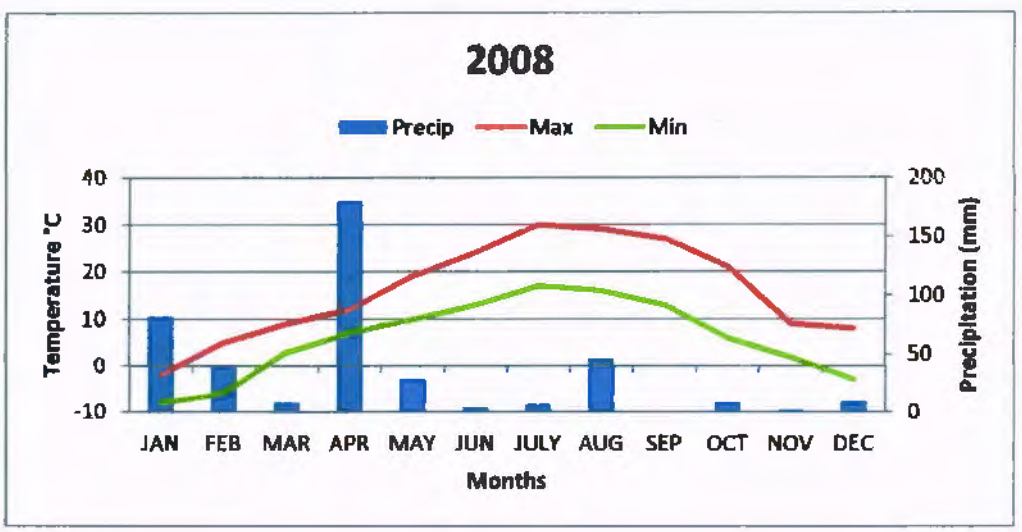
Temperature data of ten years (from 2006 to 2015) were respectively analyzed for the identification of variability occurred in the past 10 years, temperature data of Paghman district was provided by the metrological department as the department has installed weather station units in the district (complete temperature data of the district is available in annexes).

Variability analysis from temperature data of the district, also indicates highs and lows as well it has direct relationship with precipitation, as in 2006 and 2009 low temperature was recorded due high precipitation in these two year, while in 2011 and 2012 the temperature was recorded high due to less precipitation in these two years, even though in remaining years the temperature remained normal.

Meanwhile, trend analysis of precipitation data of the district for the time series of "2006-2015" indicated negative change or decrease, which is "- 0.1806", on the other hand, trend analysis of temperature data of the district for the time series of "2006-2015" indicated positive change or increase, which is 0.0183, for more details see figure-9 and annexes.


2006
Precip
Max
Min
Temperature °C
Precipitation (mm)
35
30
25
20
15
10
5
0
-5
-10
-15
160
140
120
100
80
60
40
20
0
JAN FEB MAR APR MAY JUN JULY AUG SEP OCT NOV DEC
Months


2007
Precip
Max
Min
Temperature °C
Precipitation (mm)
40
30
20
10
0
-10
-20
200
150
100
50
0
JAN FEB MAR APR MAY JUN JULY AUG SEP OCT NOV DEC
Months


2008
Precip
Max
Min
Temperature °C
Precipitation (mm)
40
30
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10
0
-10
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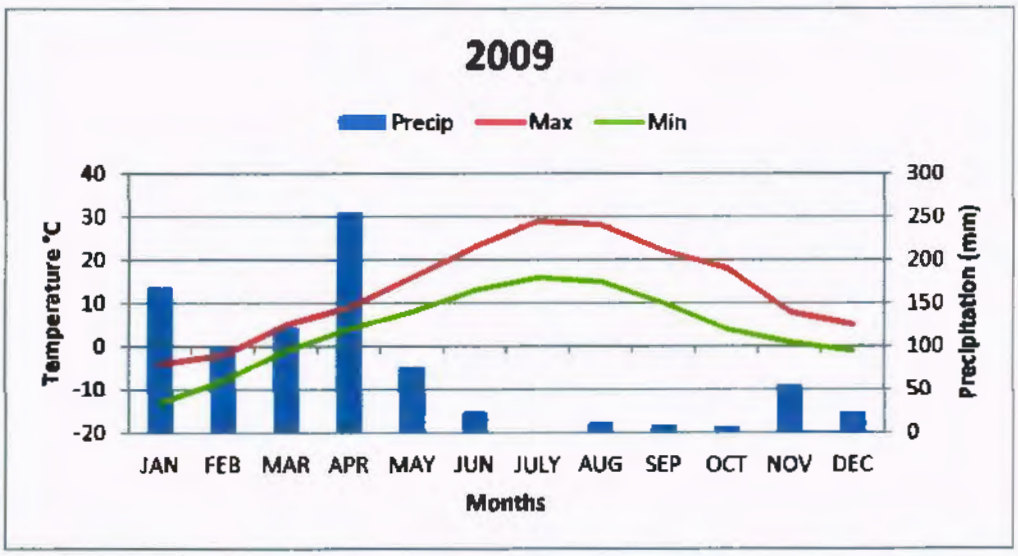
150
100
50
0
JAN FEB MAR APR MAY JUN JULY AUG SEP OCT NOV DEC
Months


2009
Precip
Max
Min
Temperature °C
Precipitation (mm)
40
30
20
10
0
-10
-20
300
250
200
150
100
50
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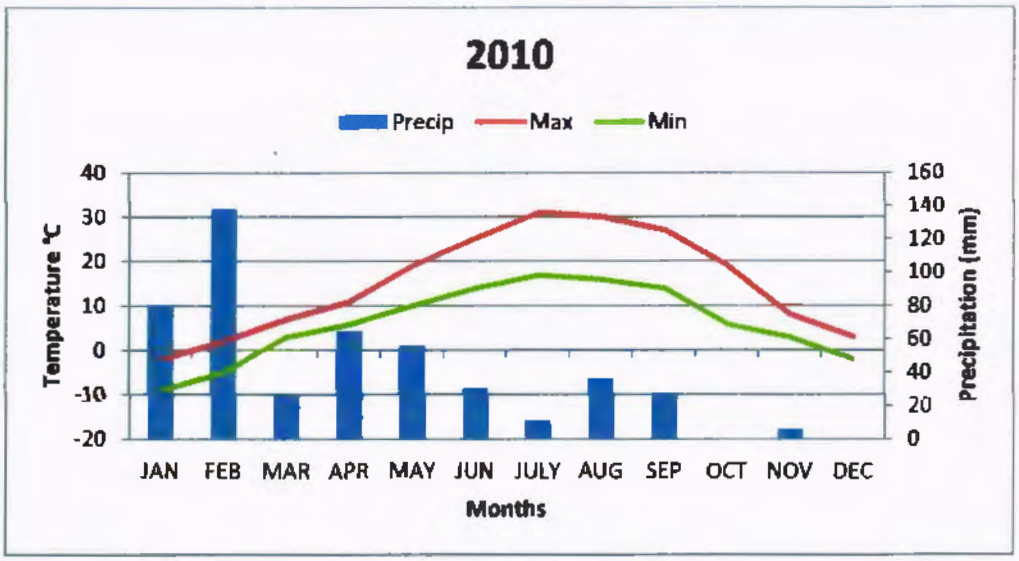
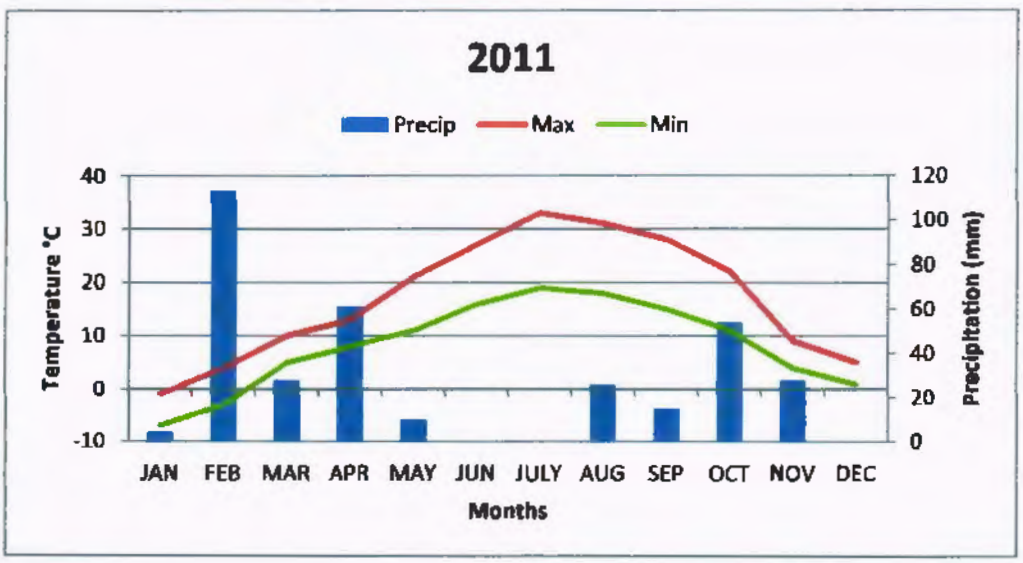
JAN FEB MAR APR MAY JUN JULY AUG SEP OCT NOV DEC
Months


2010
Precip
Max
Min
Temperature °C
Precipitation (mm)
40
30
20
10
0
-10
-20
160
140
120
100
80
60
40
20
0
JAN FEB MAR APR MAY JUN JULY AUG SEP OCT NOV DEC
Months


2011
Precip
Max
Min
Temperature °C
Precipitation (mm)
40
30
20
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-10
120
100
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40
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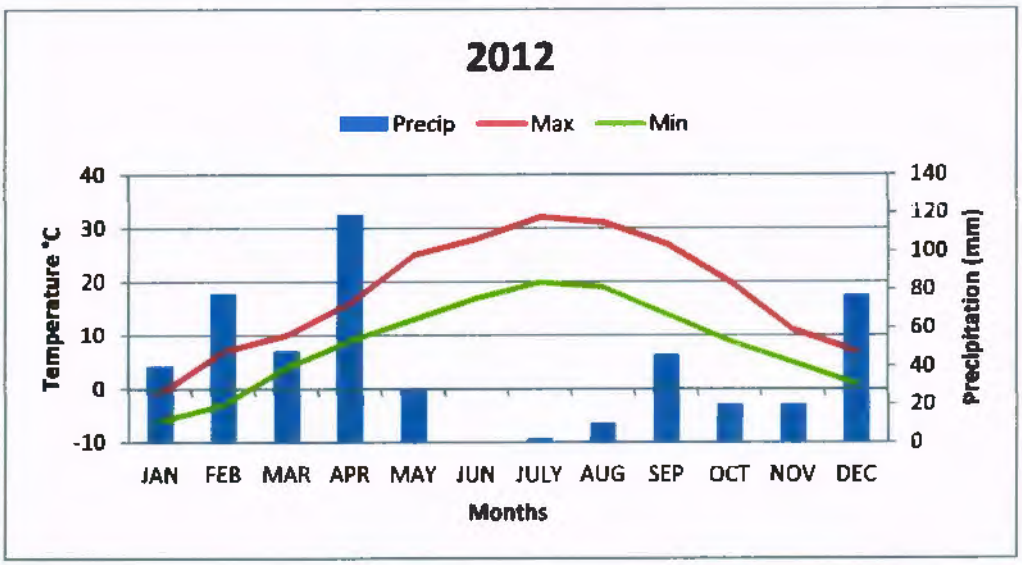
JAN FEB MAR APR MAY JUN JULY AUG SEP OCT NOV DEC
Months


2012
Precip
Max
Min
Temperature °C
Precipitation (mm)
40
30
20
10
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140
120
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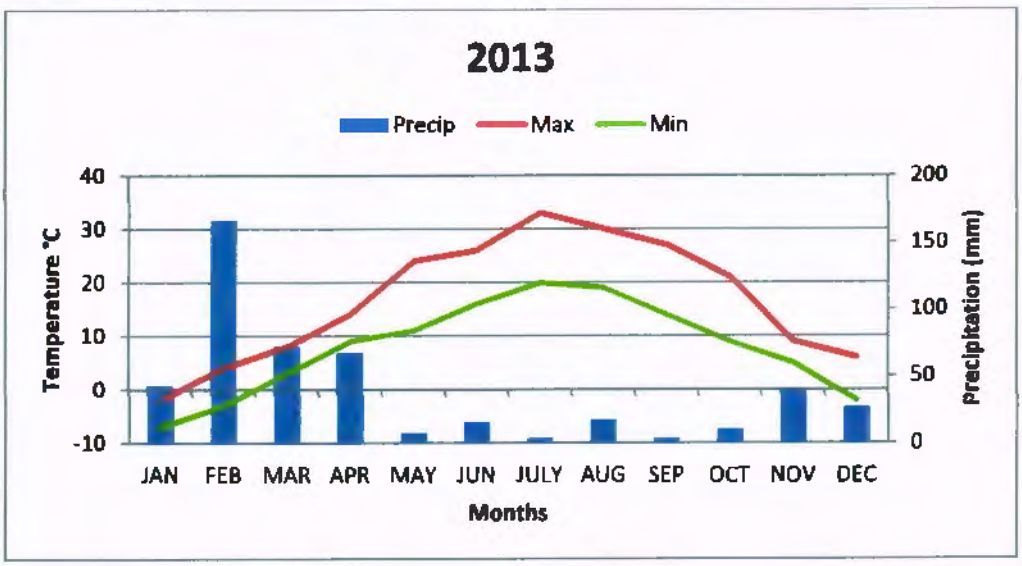
40
20
0
JAN FEB MAR APR MAY JUN JULY AUG SEP OCT NOV DEC
Months


2013
Precip
Max
Min
Temperature °C
Precipitation (mm)
40
30
20
10
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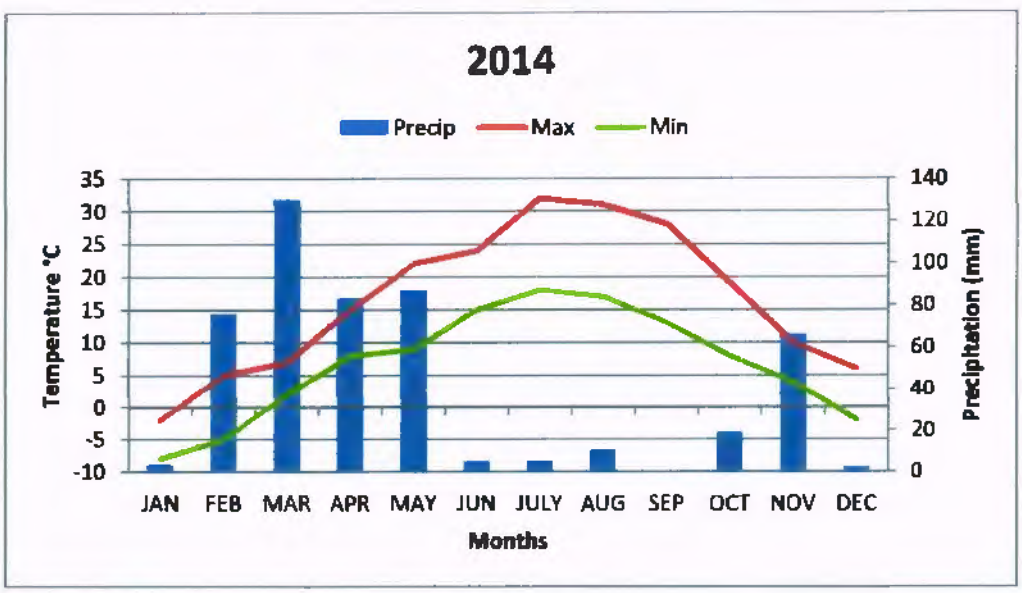
-10
200
150
100
50
0
JAN FEB MAR APR MAY JUN JULY AUG SEP OCT NOV DEC
Months


2014
Precip
Max
Min
Temperature °C
Precipitation (mm)
35
30
25
20
15
10
5
0
-5
-10
140
120
100
80
60
40
20
0
JAN FEB MAR APR MAY JUN JULY AUG SEP OCT NOV DEC
Months

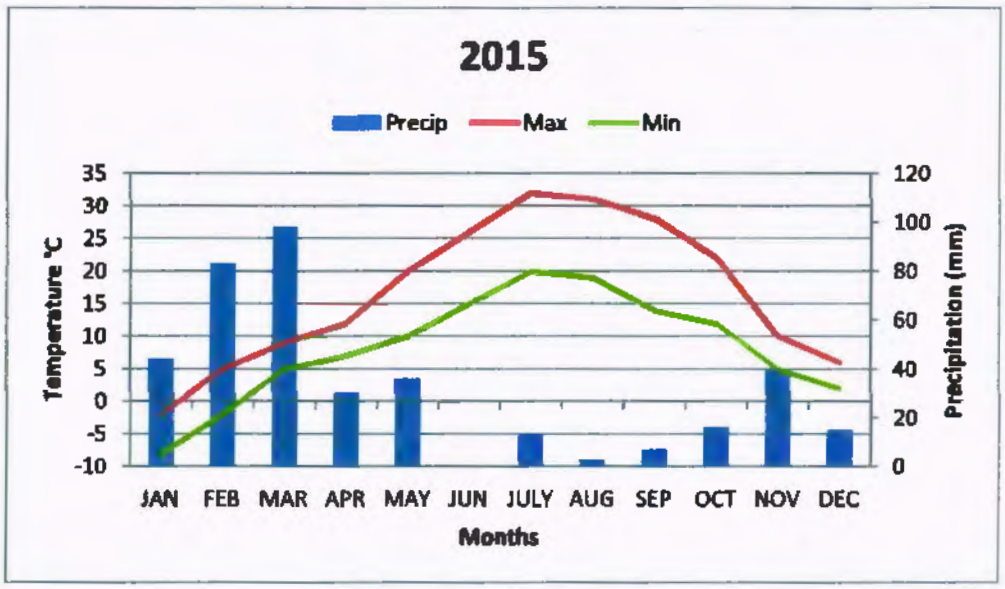


Figure-8: Climate variability of Paghman district from 2006 to 2015

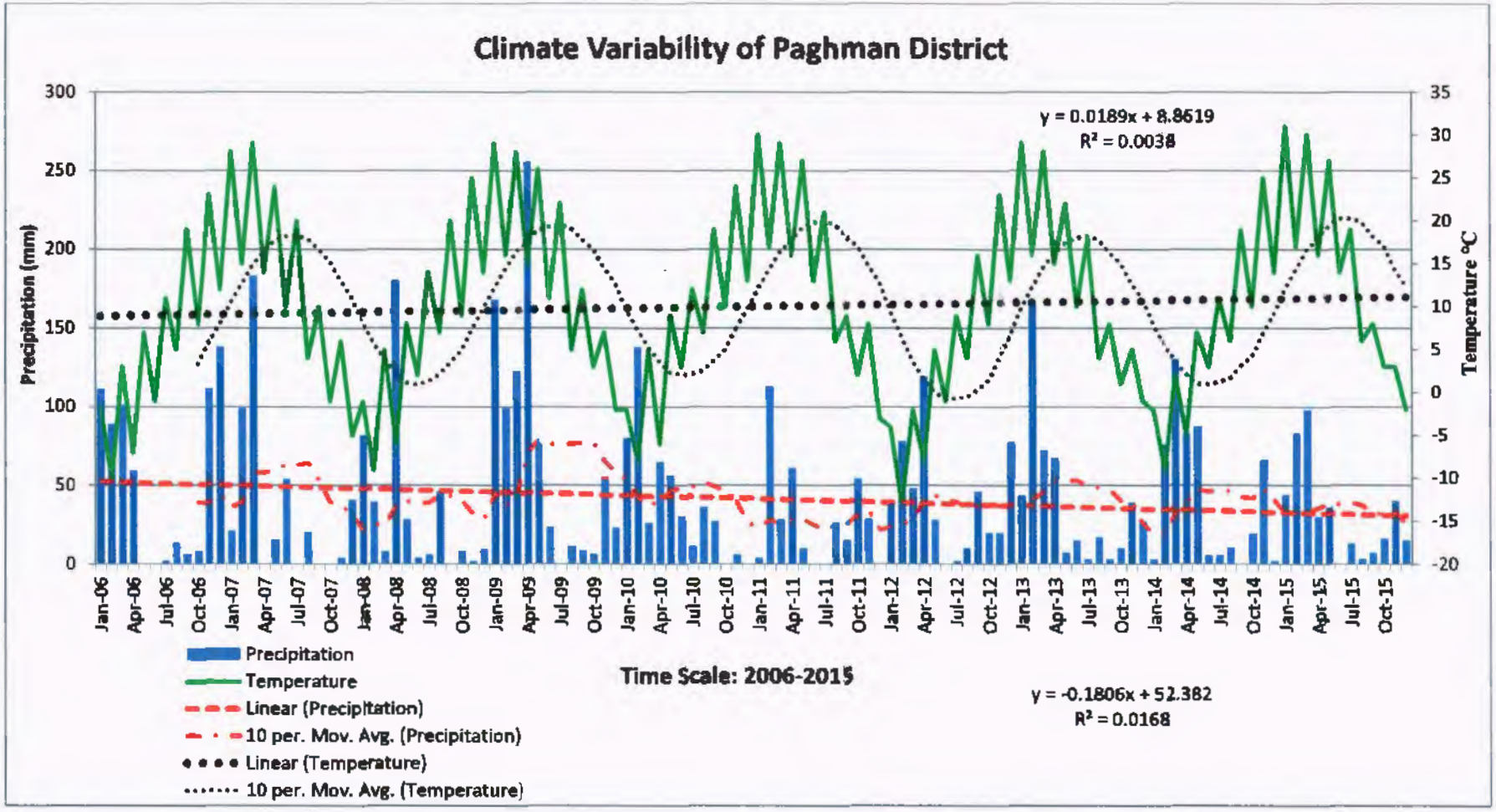


Figure-9: Trend Analysis of Climate Variability of Paghman district from 2006 to 2015

4.2 Changes in Land use a comparison of 1993, 2010 and 2015 Land Covers

Land covers of 1993, 2010 and 2015 of Paghman district were respectively analyzed in Arc GIS software for the identification of changes occurred in land use especially in urban growth in the 20 years, attribute data of the land covers was provided by GIS unit at MAIL (attribute data and other land cover parameters data are available in annexes).

Since 2000s changes in land use/pattern have observed, due to fragile and insecurity situations in Afghanistan various Internally Displaced Persons (IDPs) from unsecure provinces keen to live in Kabul province, as the result many families came to Kabul provinces and they left they hometowns, IDPs came from Wardak, Ghazni and from other southern provinces of Afghanistan have settled in Paghman district, thus various agricultural and range lands shifted to residential and business areas (counties and townships), analysis and statistics obtained from land covers (1993, 2010 and 2015) point out a 800 hectare increase in settlements or residential area in Paghman district, although the district had (in 1993 land cover) very little 80 ha residential area , for further details see land cover maps available in next page(s).

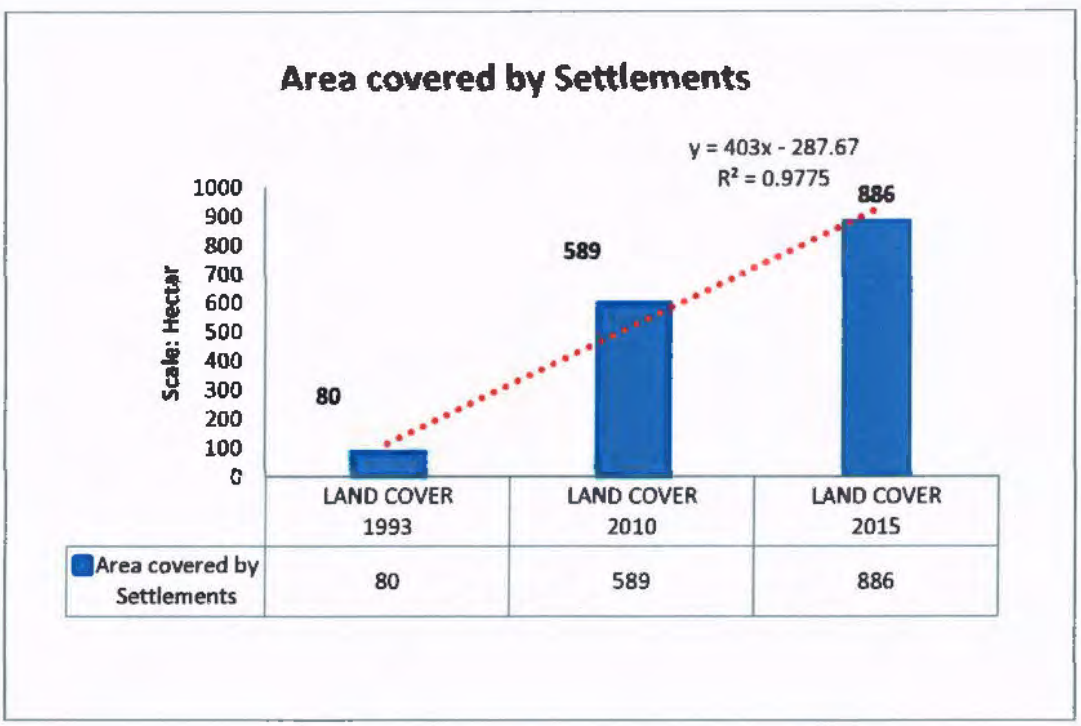


Figure-10: Comparison between 1993, 2010 and 2015 land covers

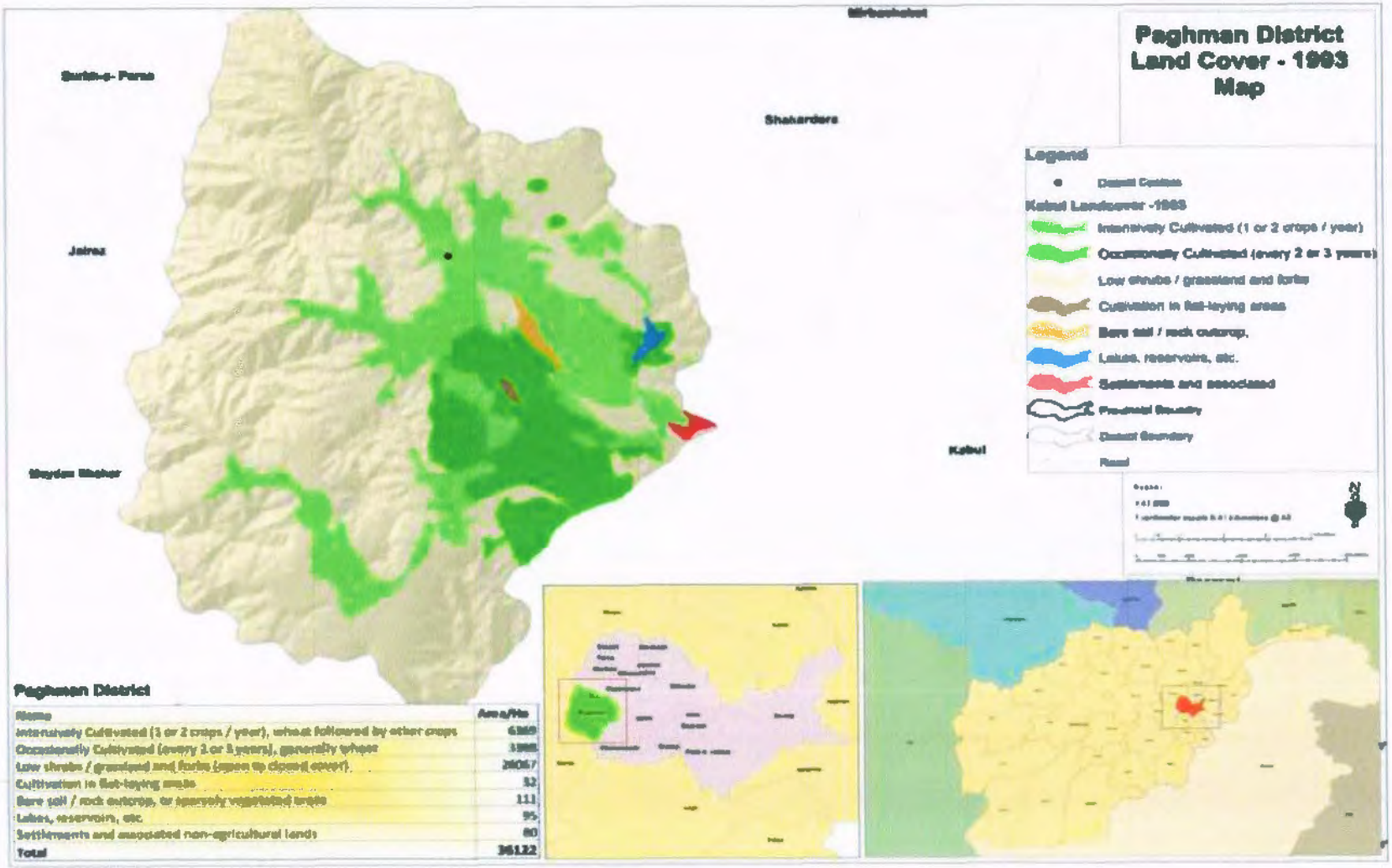


Figure-11: 1993 land cover of Paghman district

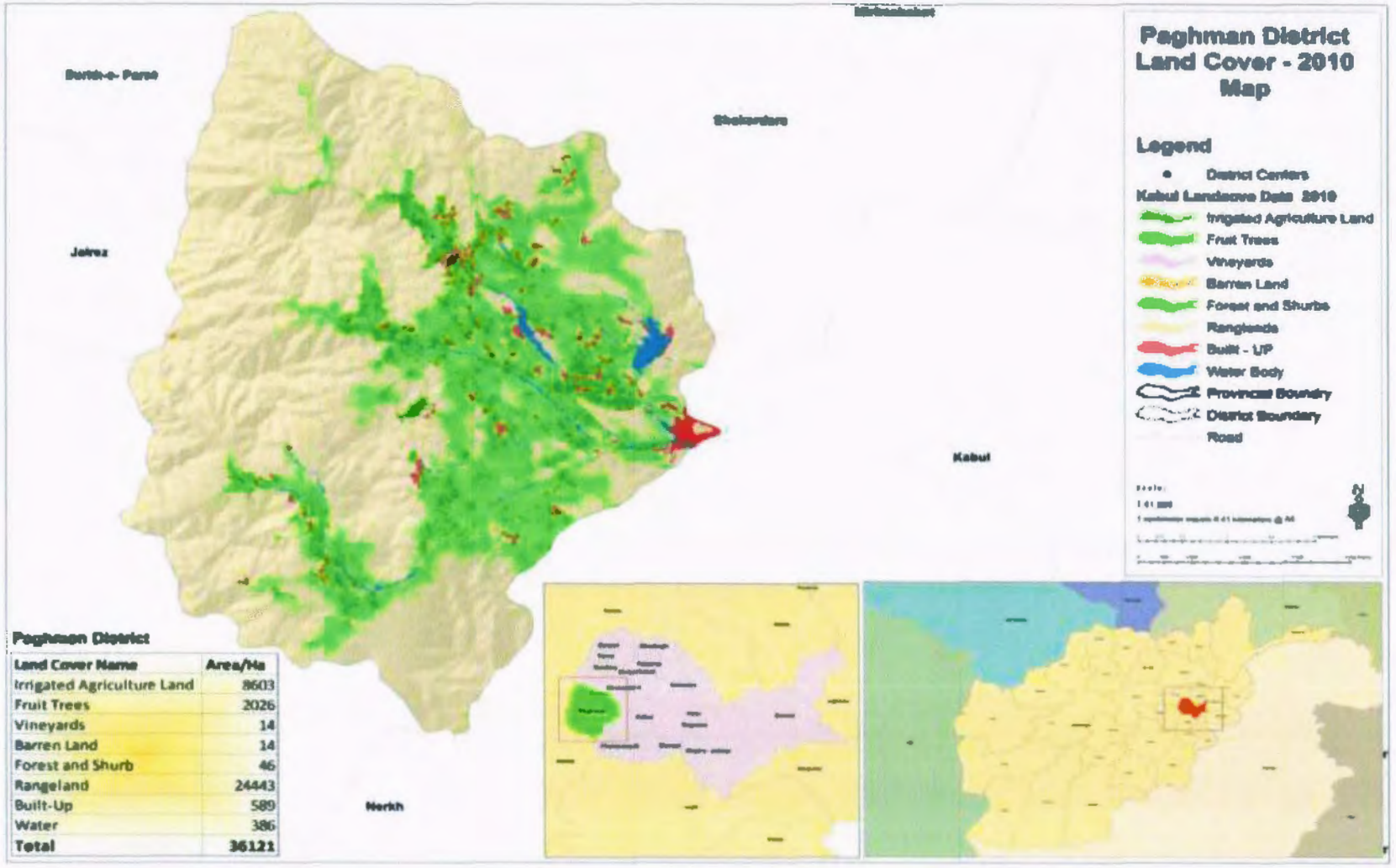


Figure-12: 2010 land cover of Paghman district

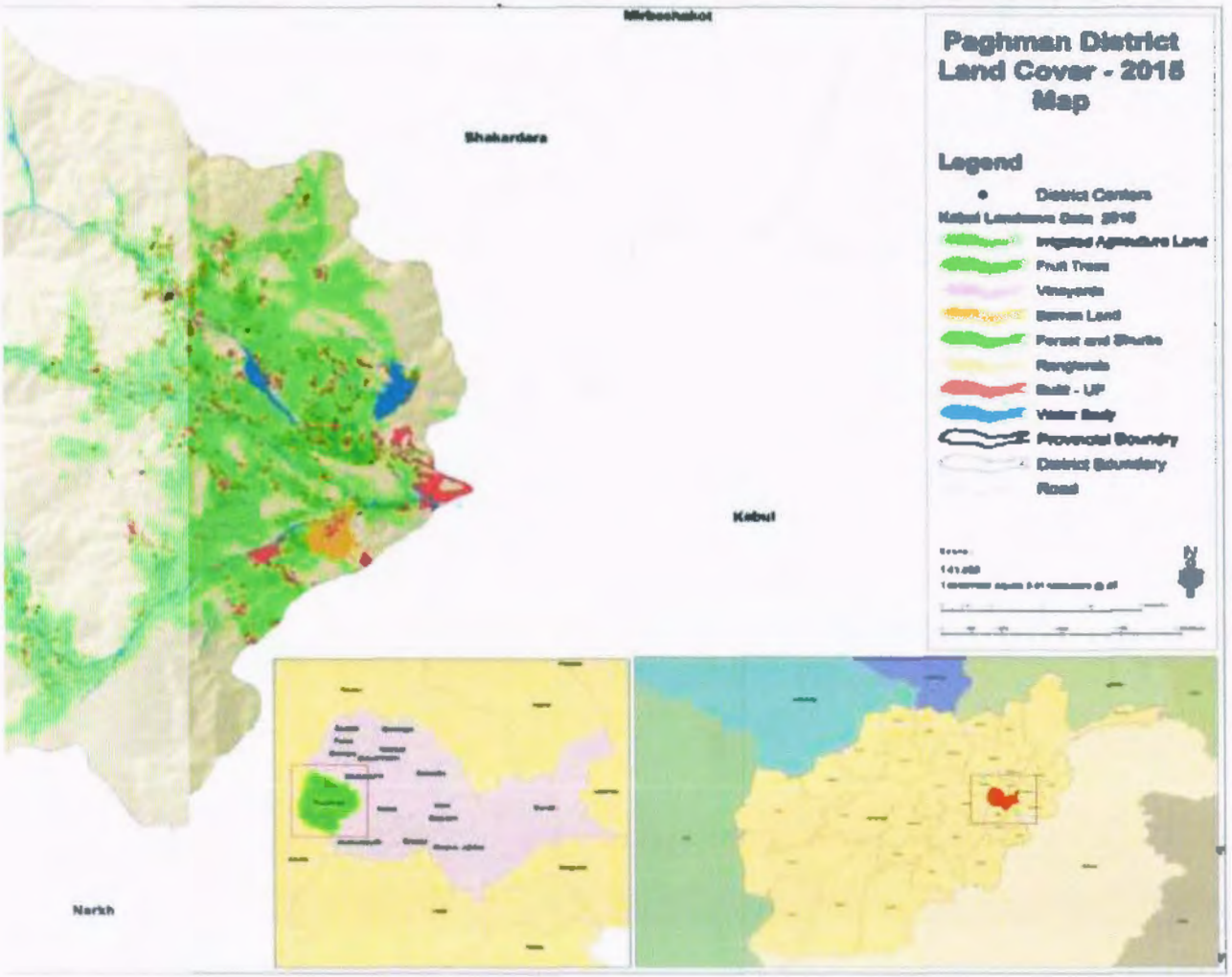


Figure-13: 2015 land cover of Kabul province

4.3 Current Adaptive Capacity of Paghman District to Climate Variability

Recent climatic variability, alterations in precipitation pattern and seasonal variations experienced in Paghman district have been affected the environment and natural resources i.e. water resources, agricultural activities, rangelands and biodiversity, and social well-being of the residents i.e. livelihood and health, so far these climate change induced impacts adversely affected both environmental and social arrangements, yet the intensity and magnitude of the impacts are moderate and not at high risk, however due to the dependency of local people on agricultural and water resources, it increases the rate of vulnerability, in the meantime, the results indicate high vulnerability condition of water and agriculture sectors to climate variability and change, in fact these situations and results only represent the district.

Adaptive capacity of the district has assessed with the help of following factors, as assessment of adaptive capacity of a place or region generally needs natural, physical and financial factors.

4.3.1. Environment and Natural Resource of Paghman District

Paghman district has abundance of natural resources especially water resources as the district is a valley thus surrounded by mountains and most of the mountains usually covered by snow during winter season, however due to recent climate variability and past droughts natural resource especially surface water bodies have been affected negatively, although with the abundance of natural resources as the magnitude of change is small and predictable therefore the adaptation can take place easily.

4.3.2. Socio-Economic Condition of Local Communities

In general term residents of Paghman district has good economic condition due to suitable conditions for agricultural activities and livestock husbandry, in the meantime the district is commercially well developed and it is the picnic place for large numbers of families.

Although implementation of climate change adaptation and mitigation measures will be difficult for the residents of the district in both financial and technical, without support of government they cannot implement and initiate climate change adaptation and mitigation measures.

4.3.3. Contribution of Local Communities

Local Communities of Paghman district have been started some basic community based climate change adaptation measures in there localities i.e. Kareez irrigation system, cold-storage rooms, rain water collection places and check dams, this indicates contribution of local communities and their willingness in adoption and implementation of climate variability and change adaptation and mitigation measures, however, there is less knowledge and awareness about climate variability and change, beside that they are practicing their local knowledge and methods to mitigate, reduce or prevent water scarcity, pests and diseases.

4.3.4 Ongoing Climate Change Adaptation Measures in Paghman District

Government has started some initiative and some important projects funded by United Nations Development Program (UNDP) and World Bank (WB) are being implemented in Paghman district as well in other parts of the country, it seems to be a fundamental and essential step toward climate change adaptation and mitigation in the country as well it points out the government attention and anticipation towards climate change adaptation and mitigation.

Followings are precise information about existing projects being implementing in Paghman district, Kabul province and all over Afghanistan.

- UNDP's funded project is Climate Change Adaptation Project (CCAP) works on awareness dissemination and capacity building on climate change, introduction of climate change adaptation measures and community based natural resources management promotion, the project covers 4 provinces including Kabul province;
- Kabul Green Belt Project (KGBP) initiated by government with the financial and technical support of WB, KGBP's objective is to plant trees, for reducing air pollution and combating climate change and build a green belt in the surrounding of Kabul city and some parts of Paghman district is in the project coverage.
- The first WB funded project is On Farm Water Management Project (OFWMP) covers sustainable agricultural growth water resource management

and its security aspects in the district, the project covers 16 provinces including Kabul province; and

- The second WB funded project is National Horticulture and Livestock Program (NHLP) covers sustainable food and agricultural security, healthy Livestock rearing and dairy products improvement, the project covers almost all provinces including Kabul province.

In addition, some other international donors and NGOs are working on modern agricultural extension and community based natural resources management in the district, therefore these initiatives indicate as well signify the existing adaptive capacity of the district toward climate change adaptation and mitigation.

Below figure represents adaptive capacity to climate change of the district, based on all aspect required for the assessment of adaptive capacity to climate change like natural, physical and financial aspects.

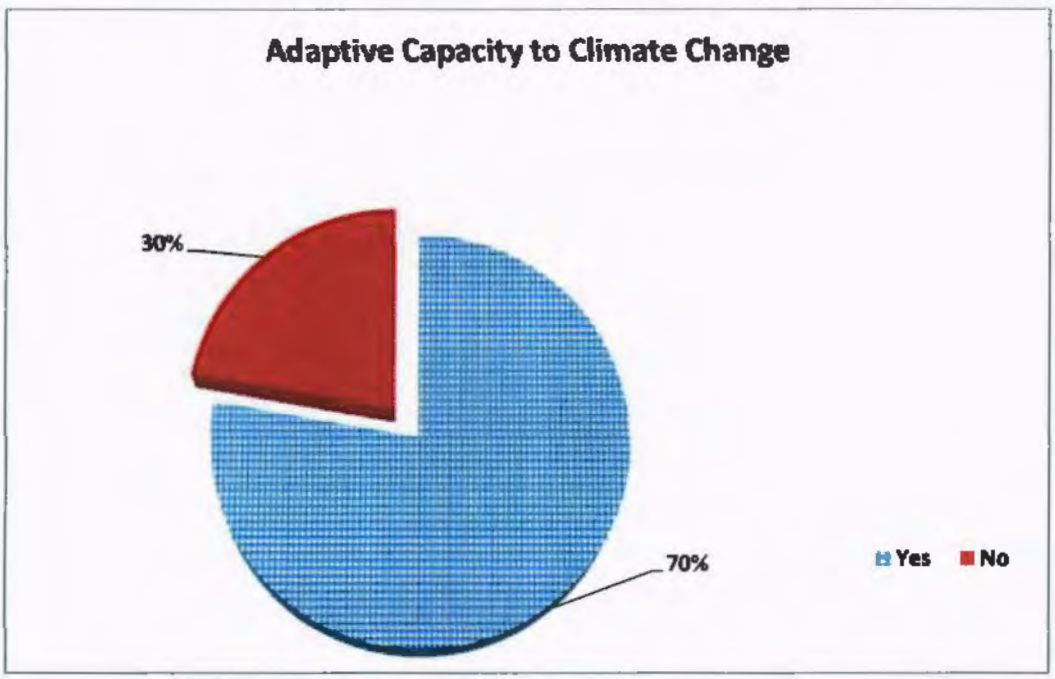


Figure-14: Adaptive capacity of Paghman district to climate change

4.4 Future Climate Change Condition

4.4.1. Future Climate Change Projections

Future climate change projections for Afghanistan have performed based on IPCC 4th assessment report (AR4 2007), emission scenarios A2[1], A1B and B1 under General Circulation Model (GCM) climatic modeling method, by UNDP, future climate change projection and forecasted models are established based on past climatic (19970s-1999) data restored by Department for International Development (DFID), PEACE project and Stockholm Environment Institute (SEI).

However these future climatic projects and models are not realistic, actually they are alternatives, though the projections represent or indicate the changes in comparison of technological advancement and innovations, economic growth and population growth.

Future climate change models and projection point out nearly 1.4 °C raise in temperature and little decrease in rainfall up to 2030, although the overall climatic projection (till 2099) represents about 2 to 6 °C raise in temperature, in the meantime a decline of 10 to 40 mm in precipitation is forecasted, along with rainless situations in southern parts of the country.

Meanwhile, AIB and A2 climate change projection scenarios project decrease in precipitation and increase in temperature, while B1 climate change projection scenarios projects increase in precipitation and very little change in temperature, actually these figures are only for the time series of 2030 as well future climate change projection have made based on three months or seasons wised.

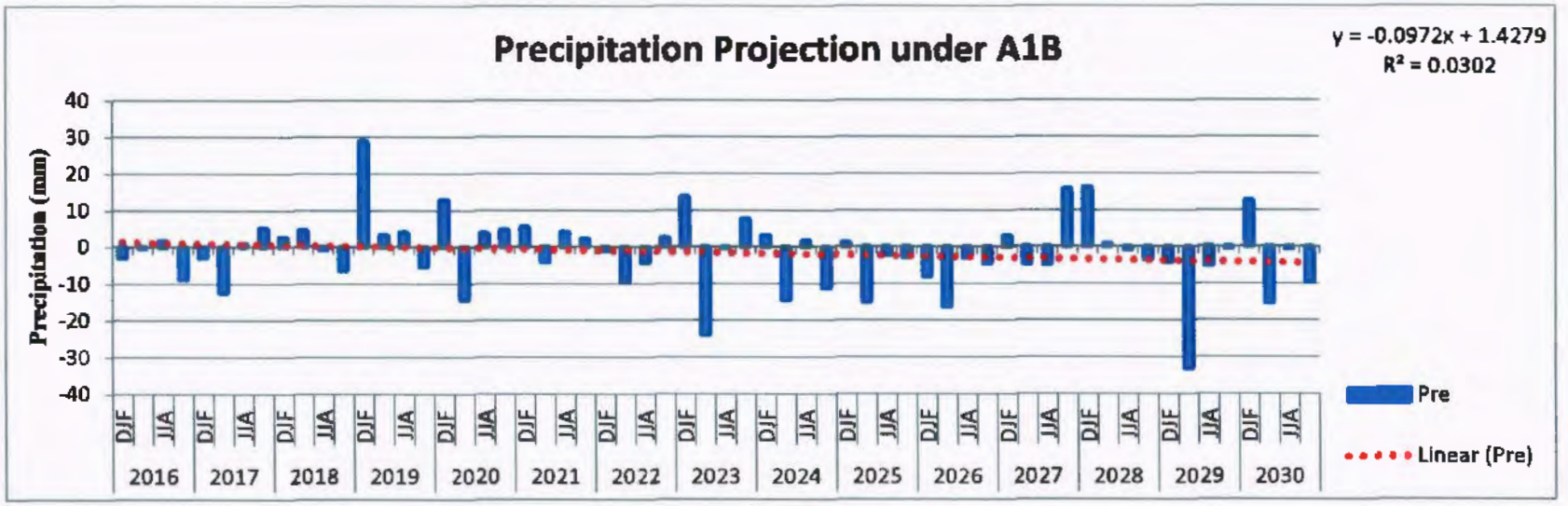
In addition, climatic variability (both precipitation and temperature) analysis of Paghman district also indicates a change in the climatic conditions of the district, as in recent years decline in snowfall and a little rise in temperature has observed, in the

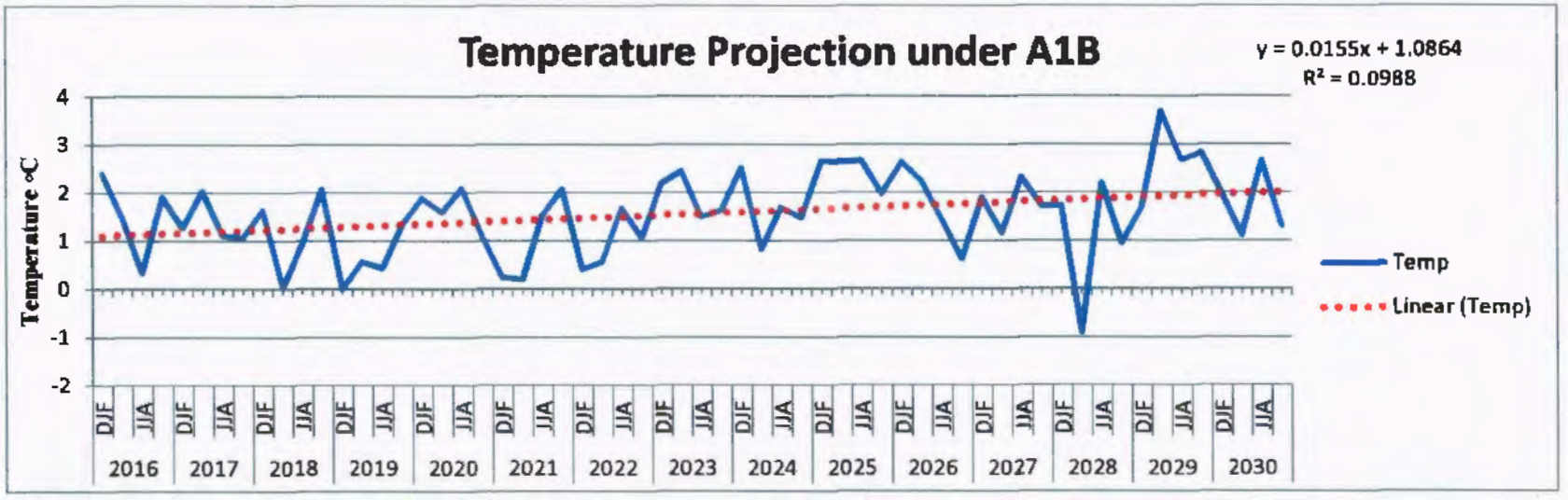
[1]A1B: Is based on Rapid Economic Growth as well scenario represents Future Climate Projection on the assumption, of fast economic development, little population growth, and speedy technological advancement, thus it represent a balance world.

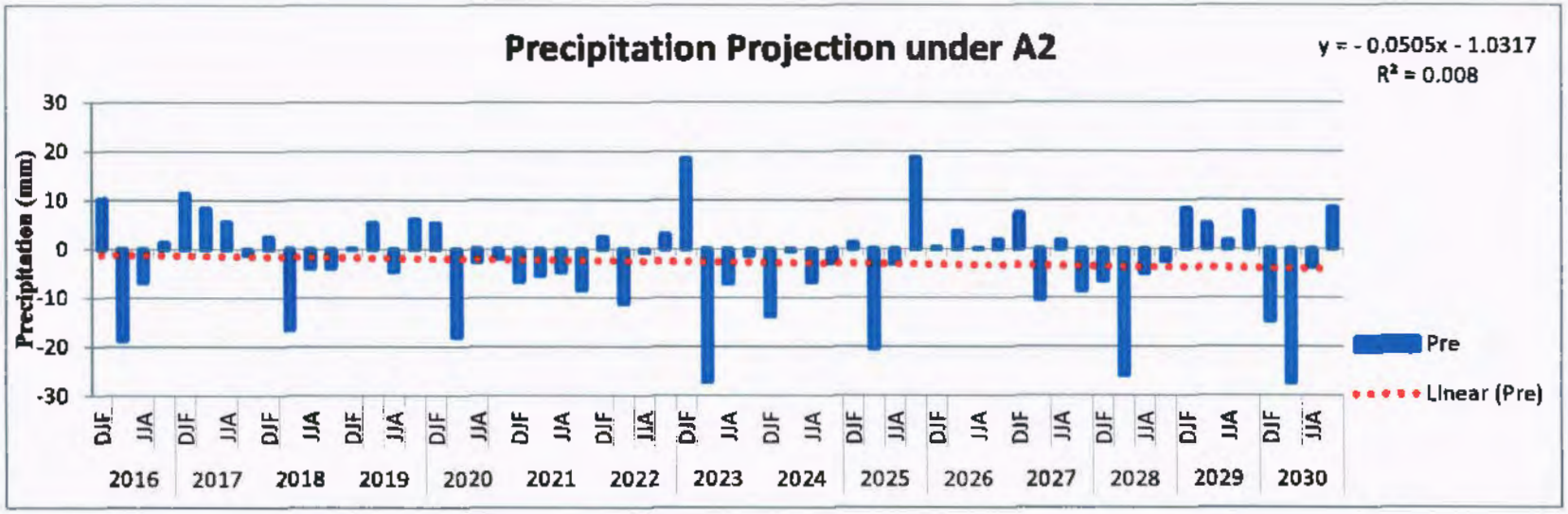
A2: Is based on Regionally Oriented Economic Development as well scenario represents Future Climate Projection on the assumption, of independence to use, conservation of national resource.

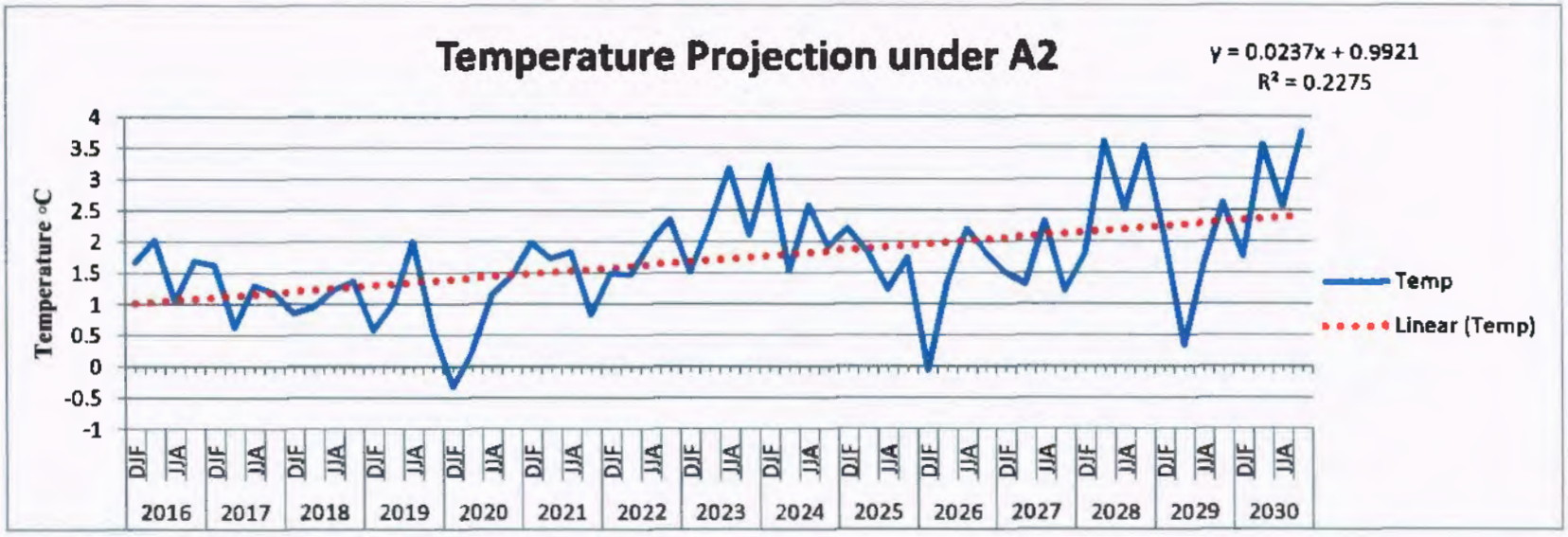
B1: Is based on Global Environmental Sustainability as well scenario represents Future Climate Projection on the assumption, of little population growth, fast economic development and with speedy technological advancement, thus it represent a homogenous world.

meantime climatic variability shows alterations in precipitation pattern, as in previous years the district usually experienced precipitation especially snowfall in late December and early January months, although snowfall has declined in last four years, which caused various social and environmental damages to the social and economic wellbeing of the district residents especially to farmers, and to environmental system and services at all.


Precipitation Projection under A1B
y = -0.0972x + 1.4279
R² = 0.0302
Precipitation (mm)
40
30
20
10
0
-10
-20
-30
-40
DJF
JJA
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Pre
Linear (Pre)


Temperature Projection under A1B
y = 0.0155x + 1.0864
R² = 0.0988
Temperature °C
4
3
2
1
0
-1
-2
DJF
JJA
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Temp
Linear (Temp)


Precipitation Projection under A2
y = - 0.0505x - 1.0317
R² = 0.008
Precipitation (mm)
30
20
10
0
-10
-20
-30
DJF
JJA
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Pre
Linear (Pre)


Temperature Projection under A2
y = 0.0237x + 0.9921
R² = 0.2275
Temperature °C
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
DJF
JJA
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Temp
Linear (Temp)

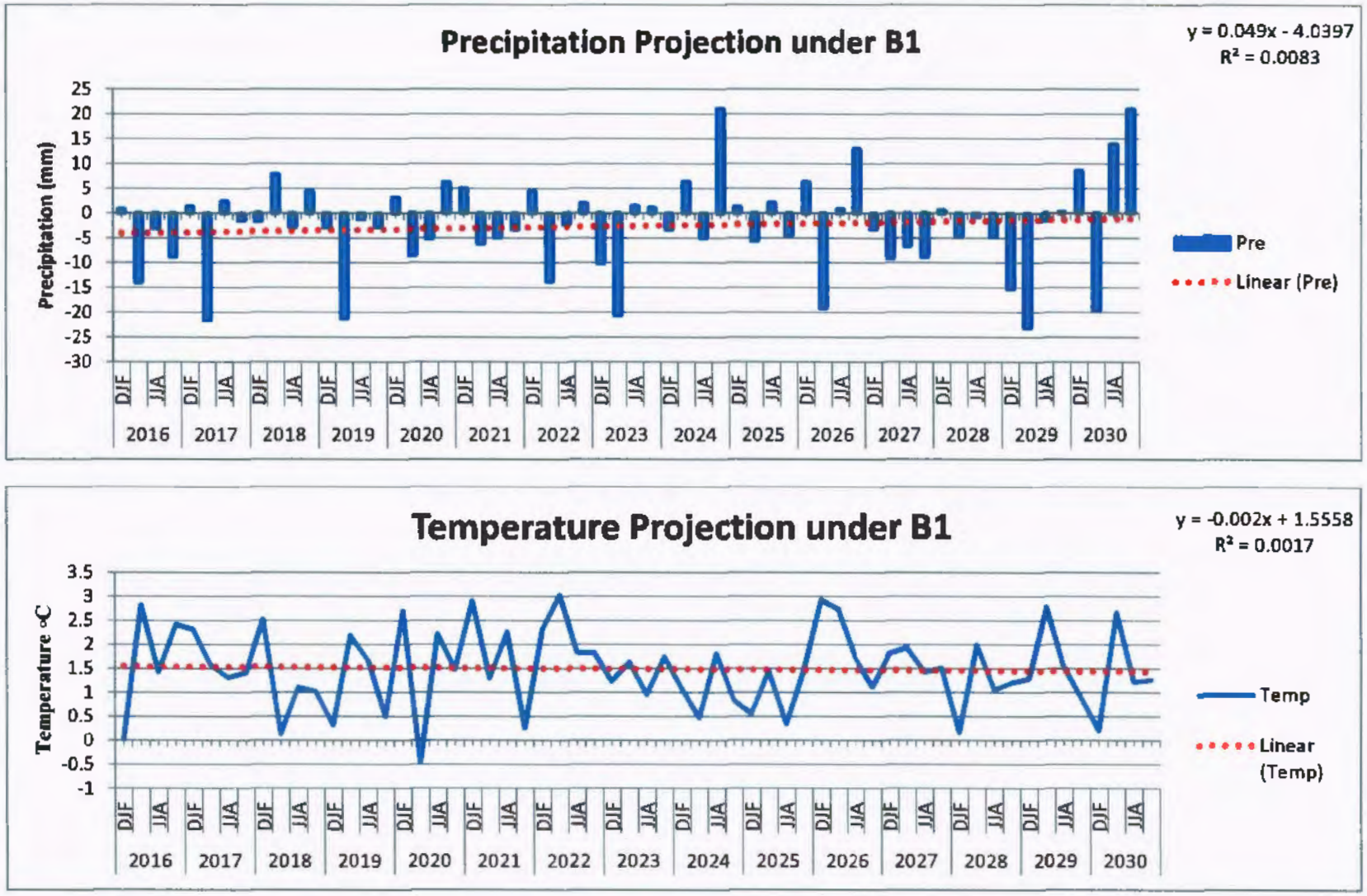


Figure-15: Future climate change projection for Afghanistan model means annual precipitation under A2, A1B and B1

4.5 Future Adaptive Capacity of Paghman District to Climate Variability and Change

4.5.1 Institutional and Governance Processes

Government Republic Islamic of Afghanistan (GRIoA) has developed Afghanistan National Development Strategy (ANDS) in 2008, the main objective of the strategy is to ensure and promote sustainable development in the country and recover environmental, social and economic losses and degradations of three decades of war, in compliance with ANDS as well knowing the importance and value of natural resources and the challenges encounter i.e. climate variability, change and droughts, fortunately NEPA, MAIL, MEW and other inline institutions developed long and short term strategies and policies, to some extent most of them directly and indirectly support and contribute to climate change adaptation and mitigation. Followings are names of specific strategies and policies:

- Renewable Energy Policy
- Natural Resources Management Strategy
- Biodiversity Strategy
- Environmental Strategy
- Nation Adaptation Program of Action for Climate Change
- Climate Change Adaptation Strategy (Draft)
- Integrated Water Resource Management Strategy
- Disaster Risk Reduction Programs

All the above mentioned policies, strategies and programs show the contribution, support and willingness of GRIoA in adoption and implementation of climate change adaptation and mitigation measures, in the meantime, with the help of these institutional and governance programs give a green light in the application of climate change adaptation and mitigation measures towards future climate change.

4.5.2 Long term Contribution of Local Communities

Local Communities of Paghman district have been started some basic community based climate change adaptation measures in there localities i.e. Kareez irrigation system, cold-

storage rooms, rain water collection places and check dams, this indicates long term contribution of local communities and their willingness in adoption and implementation of climate variability and change adaptation and mitigation measures, as local communities suffer a lot and receive huge negative environmental, social and economic losses due to their dependency on agriculture activities and natural resource especially on water resources where both sector are vulnerable to climate variability, change and its associated induced impacts, therefore in this case local communities should promote community based climate change adaptation and mitigation measure as well they must welcome each and every activities initiate by government.

4.5.3 Effectiveness of Ongoing Climate Change Adaptation and Mitigation Measures against Future Climate Variability and Change

As described in previous sections that Paghman district has suitable and very good adaptive capacity in adaptation and mitigation to climate variability, change and its associated impacts, in the meantime the ongoing climate change adaptation measures will be resulting long-term positive impact against future projected climate change and promoting community based natural resource management, removing barriers to sustainable development and laying the groundwork for climate change adaptation mitigation in Afghanistan.

A1B and A2 scenario based future climate change of Afghanistan up to 2030 times rise projected decrease in precipitation and increase in temperature, while B1 scenario based future climate change projected increase in precipitation and little decrease in temperature, keeping all the scenario based future climate change projection there will be climate variability however the rate of variability will be less, therefore till 2030 to some extent the district might not experience major climate variability, beside that adoption and implementation of climate change adaptation and mitigation measures is highly needed as Afghanistan has unstable climate condition therefore it will be better to take proactive climate change adaptation and mitigation measures in anticipation.

Meanwhile present institutional and governance processes point out the government attention and anticipation towards climate change adaptation and mitigation, below figure

represents future adaptive capacity of the district against future projected climate variability and change, which is assessed based on present institutional and governance processes, future projected climate variability and change and long term contribution of local communities in the adoption and implementation of climate change adaptation and mitigation measures.

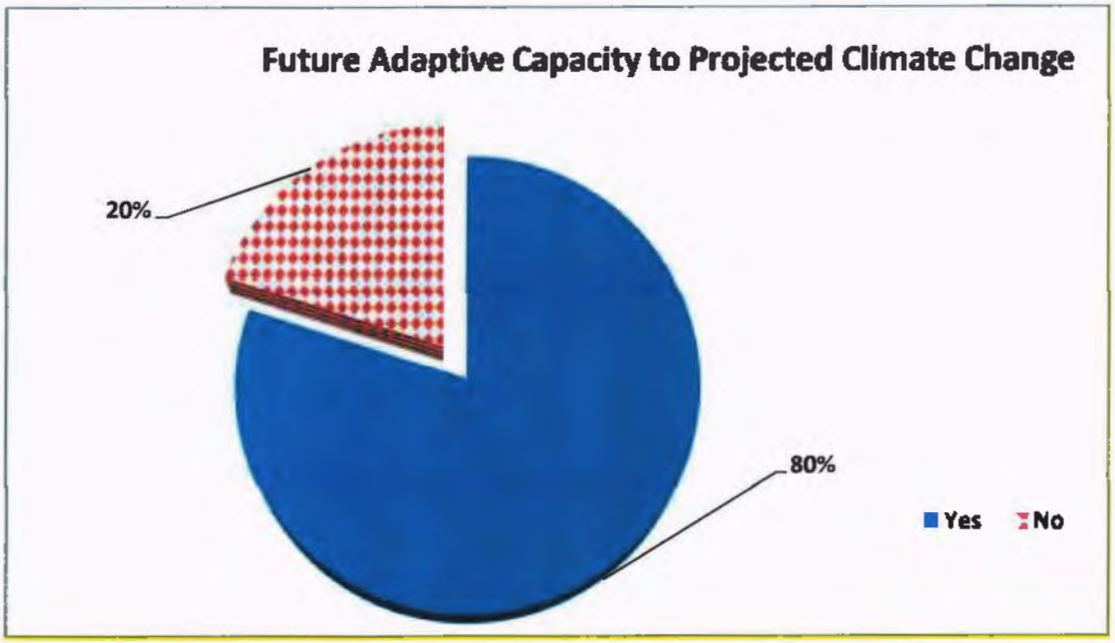


Figure-16: Future adaptive capacity of Paghman district to climate change

4.6 Socio-environmental Impacts Resulted from Climate Variability in Paghman District

Recent climate variability for example decline in precipitation, seasonal and precipitation alterations, have adversely affected the water resources, agricultural activities, harvest and cultivation seasons, ecosystem services, infrastructural facilities and livelihood of the entire rural communities in Paghman district, rural areas and in the country at all. The intensity and magnitude of climate variability induced impacts, are due to fragile infrastructural facilities, lack of proper anticipated adaptation and preparedness mechanisms measures to climate change, in the district.

Due to the dependency of local communities on agricultural activities livestock rearing and natural resources local communities have been affected adversely however the rate of vulnerability is low.

Interviews and meetings with local communities in the district as well questionnaires based results indicate that recent climatic variability resulted various adverse impacts on both human and natural systems in the district, although the magnitude and intensity of theses impacts are not sever, still, proper proactive adaptation preparedness and mitigation measures need to be taken into account for the prevention, mitigation and reduction the intensity, magnitude of these impacts.

Meanwhile, due to seasonal alterations and decline in annual precipitation amount, water resources especially surface water bodies and agricultural practices have been affected drastically, in the meantime various farmers complained about climate variability and alterations in precipitation pattern observed in past ten years as a result these variability affected their periods of cultivation and harvests, furthermore the district has cold weather and sufficient water for irrigation, thus it has suitable conditions for fruit trees, i.e. Apple, Cherry and wall nuts, however in previous years the district experienced snowless and short-term winter seasons.

In addition, land use changes have and urban growth have been affected the environmental and social systems of the district as large pieces of agriculture and range lands shifted to residential areas, which also affected adversely natural resources and livelihoods of local communities in the district.

Followings are sector-wise representation of impacts resulted from climatic variability in the district:

4.6.1 Water Sector

Climatic variability i.e. seasonal variation, have surprisingly appeared in past 10 years, to some extent these variability and alterations have worsen and worsening water sector in Paghman district, although climate variability induced impacts varies across the country, as southern and northern parts of the country experienced more impacts and suffered a

lot, though on the average basis, shrinkage in surface water bodies have pointed out all over the district, due to the dependency of local communities on agricultural activities, livestock husbandry, and natural resources many them have suffered and experienced economic losses.

Observed impacts are decline in snowfall in winter seasons and early snow-melt or snow-thaw in spring seasons, although the district is familiar in its greenery, enormous amount of water and cherry and apple orchards, though the amount of surface water has reduced and various farmers are using tube wells in summer seasons for irrigation purposes.

Droughts of 1990s and recent climatic variability i.e. rise in temperature and decline in precipitation (snowfall) adversely affected water resources especially surface water resources as various wetlands and natural ponds have disappeared or in unsecure condition i.e. Kol-e-Hashmat Khan wetland in Kabul province in many others in different parts of the country, many villagers and farmers in the district stated that several small and large springs have disappeared since 2006.

On the average basis the district receives 450-500 mm precipitation of annual basis, hence mountains of the district receive enormous snowfall during winter seasons, in the meantime it's considered the main contributor to Kabul River and groundwater recharger of Kabul city, even though in recent years due to snowless winters, rise in temperature and early thaw have reduced the capacity and availability of surface and ground water bodies, in addition, Paghman River has shrunken and became smaller due to recent climatic variability experienced in past 10 years. Local villagers in the district stated that in the past due to heavy snowfall during winter season we could not easily travel in the village even though haul roads between some villages in the district could not accessible due to blockage, furthermore they added that since 2006 we experienced surprisingly snowless and warm winters which yielded negative impacts on their livelihood, well beings and environment.

In addition, vulnerability index and scores of water sector is high among the other sectors vulnerable to climate change, vulnerability ranking is obtained from the analysis and

assessment of observed impacts, metrology data and from the interviews and meetings with local communities and relevant governmental officials.

4.6.2 Agriculture Sector

Agriculture sector is the major and most profitable sector in the economy of Afghanistan, more than 75 percent population of the country is engaged (both directly and indirectly) and performing agricultural activities, statistics represents more 12 million people perform agricultural activities thus they engage in that sector on the average basis more than 50 percent of Afghanistan's GDP is generated from agricultural activities, same is the case in Paghman district, more than 75 percent of its population depend on agricultural activities and livestock husbandry, on the average basis each farmer gains about two thousands US dollars from agricultural activities on annual basis.

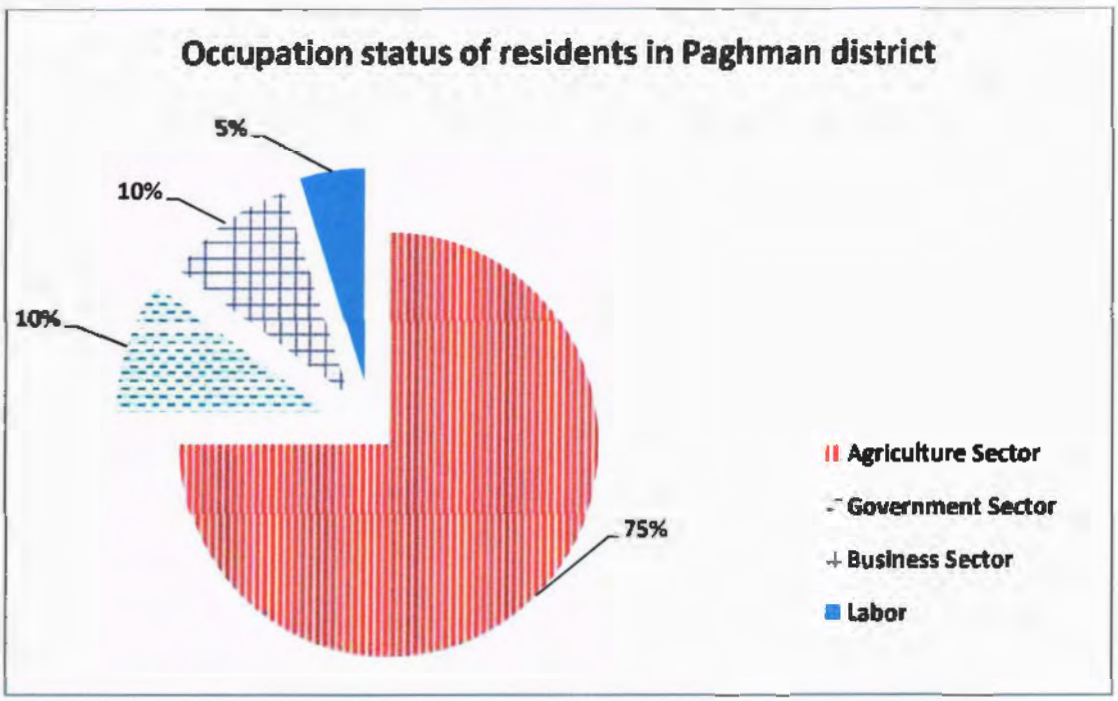


Figure-17: Occupation status of residents in Paghman district

Apart from mountains, entire land of Paghman district is suitable for cultivation and carrying out agricultural practices, so far major parts of the district is covered by orchards and fruit trees as the district has pleasant weather condition and sufficient water for

irrigation, in addition some pieces of the land is being cultivated (on rain-fed irrigation basis) for major and minor crops. In the meantime due to prevailing climatic variability, temperature rise and seasonal variations, since last 10 years some rain-fed arable land did not cultivate, thus various farmers adversely affected, on the average basis each farmer received 300-500 US dollar loss, those pieces of land completely dependent on seasonal precipitation, as well due to seasonal variations, alterations in precipitation pattern and temperature rise many fruit trees i.e. apricot and apple trees are sensitive to atmospheric conditions, due to warm winters in recent years unusually fruit trees blossom in late winter seasons, although the usual season for blossoming is in mid or late spring seasons, in addition sleet-fall (freezing rain) occurred on blossoming time which damaged fruit productivity and resulted insufficient or less harvest, observations from interviews and meetings with farmers pointed out a loss of 500-800 US dollar received by each farmer from orchards in the district.

In addition, vulnerability index and scores of agriculture sector is also high due to its dependency on water.

4.6.3 Biodiversity Sector

Biodiversity sector has direct linkage with climatic variability, changes and natural conditions, as the climate plays a vital part in maintaining the smooth functions of natural systems, provision of ecosystem services and continuity of interrelationships among flora and fauna with nature, though all over the planet earth history climate has changed actually on natural routine basis, however due to anthropogenic activities and recent human induced climate alterations and changes drastically affected biodiversity and natural system's balance, as various plant and animal species have extinct or in the state of danger all over the world as well in Afghanistan.

Paghman district is a mountainous area it has rich biodiversity especially wildlife (both birds and animals) and reptiles, the most famous wild animals of the district are wolf, fox, wild rooster and wild cats, there are very little information available about the wildlife of the district therefore full details are not available about wildlife of the district, these information and names are provided by the residents of the district.

Biodiversity especially wildlife has affected a lot due to recent climatic variability, temperature rise and snowless winters, affected the presence of wild animals in the district, during meetings with local villagers in the district they said that, "in the past time, during late autumn and winter seasons (before 2000s) we could not travel individually due to the presence and danger of wolfs and other wild animals in the village, even though wolfs often came to the sub-urban (near to Kabul city) parts of the district, although at the present time, due to warm and snowless winter seasons we have not seen any wolf in the village since long time", in the meantime some villagers said that due to climatic changes and temperature rise various migratory birds have disappeared.

In addition, similar to water sector, agriculture sectors, biodiversity sector is also highly vulnerable to climatic variability, wildlife is the most affected part of the biodiversity affected by climate variability, temperature rise and seasonal variations observed in the district.

4.6.4 Rangeland Sector

Paghman district is a suitable and secure place for nomads for grazing as the district has various pastures and rangelands, they are located in hilly and lower valley parts of the district (see land cover of the district); usually nomads come to the district in mid spring season (in late April month) from eastern parts (Lghman and Negrahar provinces) and leave the district in early autumn season (in mid-September month) to eastern parts of the country, due to recent climactic changes, temperature rise and seasonal alterations, at the present time movements of nomads have changed and shifted during last 10 years as they now come to the district in late winter or early spring seasons (late February and early March months) and leave the district on mid-autumn (in late October month).

To some extent rangelands and pastures are positively affected, however the situation might be different across the country as various southern and northern parts of the country lost their pastures and rangelands due to deforestation, recurrent floods, landslides, soil erosion and urban growth.

In the meantime, rapid urban expansion and growth observed in the district in recent years have vanished some rangelands as the most development has done in hilly areas, and in case of its continuity pastures and rangelands will be drastically affected.

Information and data obtained from the villagers and farmers during interviews and meetings about nomads past coming and departure time to the district, along with their present coming and departure time to district, showed that, on the average basis nomads stayed for five months in the district in the past (before 2006), although in present time they stay for more than six months in the district.

Additionally, unlike to water sector, agriculture and biodiversity sectors, rangelands and pastures are sensitive to climatic variability and seasonal variation in the district, as the sector has affected positively.

4.6.5 Health Sector

Health sector is the most important and representative of every society and community of an area, health sector is consider to be the most vulnerable and sensitive sector to weather and climatic changes, temperature rise, droughts, natural disasters and other associated climate induced impacts, the sector could be affected by several climatic influences, due temperature rise and seasonal changes various people especially children suffered from Malaria, Pneumonia and other viral diseases in Paghman district and all over the country.

In the meantime due to population growth and urban expansion (without master planning) the production of solid and liquid wastes in the district has been increased, thus due to absence of proper canalization, poor waste collection practices (absolutely not collection of wastes in sub-urban rural parts on Kabul province) and sanitation measures various people affected and suffered from Malaria disease.

Survey and interview results with residents of the district indicated that due to recent climatic variabilit and temperature rise mosquitoes have seen during summer seasons in the district since last five year, due to mosquitoes presence various people affected by Malaria disease, although in the past mosquitoes were not appear or exist all over the year in district. Furthermore due to unusual seasonal changes various and lack of basic

knowledge about child health various children in the district suffered from Pneumonia disease, even some of them died.

In addition, similar to water, agriculture and biodiversity sectors, health sector is also highly vulnerable to climate variability and other associated climate change induced influences, temperature rise is the most unfavorable and dangerous climatic factor to health sector as it is suitable and pleasant condition for several disease causing parasites and vectors.

4.6.6 Livelihood

Likewise other rural communities in the country has low economic situations, same is the case in Paghman district as many families has low economic situations, most of them make their food and butter from agricultural activities and livestock rearing, due to recent climate variability, rain-fed arable land remained from cultivation, as a result several farmers and their families adversely affected, on the average basis each farmer received 300-500 US dollar loss, those pieces of land completely dependent on seasonal precipitation, as well due to these climate induced impacts, many fruit trees i.e. apricot and apple trees are sensitive to atmospheric conditions, due to warm winters in recent years unusually fruit trees blossom in late winter seasons, although the usual season for blossoming is in mid or late spring seasons, in addition sleet-fall (freezing rain) occurred on blossoming time which ruin fruit productivity and resulted insufficient or less harvest, observations from interviews and meetings with farmers indicate a loss of 500-800 US dollar received by each farmer in Paghman district.

In general terms, livelihoods of the most residents of the district is directly depend on agricultural activities and agriculture sectors is directly linked with water resources, due to recent climate variability, seasonal variations and decline in precipitation water resources and agriculture activities have been affected negatively by recent climate variability, so the livelihoods of local communities.

Below table shows the vulnerability index and scores of each sector along with their vulnerability status:

Sectors	Climate Variability and Change Induced Factors						
	Drought	Seasonal Variations	Alterations in Precipitation Pattern	Natural Disasters	Temperature Raise	Total Average Score (out of 100)	Vulnerability Status
Water Sector	95	85	85	75	80	*84*	*Very High*
Agriculture Sector	90	80	85	75	75	*81*	*Very High*
Biodiversity Sector	90	75	75	70	70	*76*	*High*
Rangeland Sector	90	70	65	80	65	*74*	*High*
Livelihood Sector	85	70	70	75	60	*72*	*High*
Health Sector	80	75	55	50	60	*64*	*Moderate*

Table-1:- Vulnerability status of Sectors vulnerable to climate induced factors.

Note: Vulnerability scores have developed from vulnerability survey form, questionnaires, interviews and meetings with local communities in Paghman district as well with government officials in various relevant departments and ministries, on the average basis more than 100 people were interviewed. In the meantime vulnerability form (available in annexes) filled by all respondents during interviews and meetings.

Very High: 80-100

High: 70-80

Moderate: 60-70

Low: 50-60

Very low: less than 50

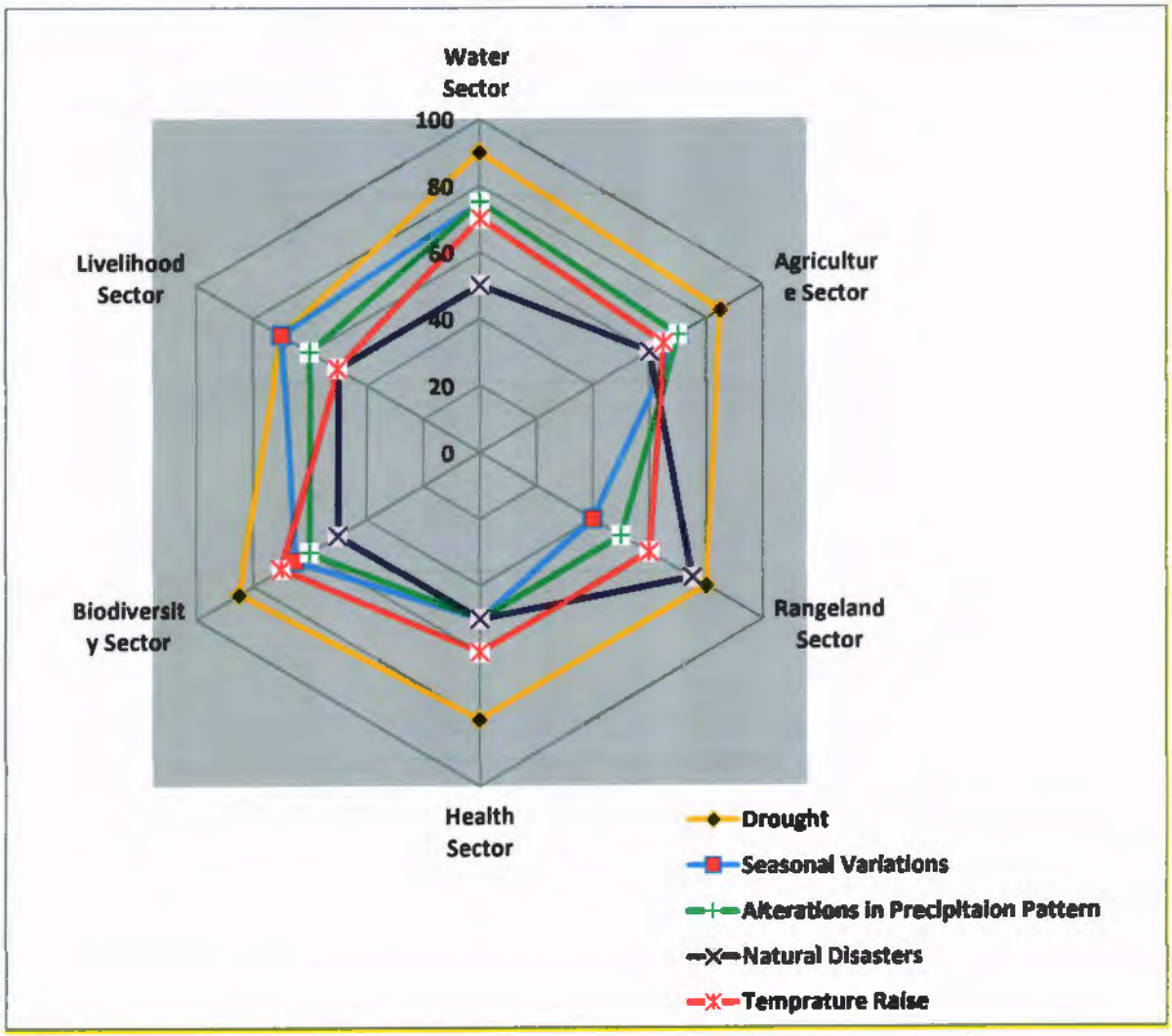


Figure-18: Vulnerability status of Sectors vulnerable to climate induced factors.

4.7 Recommended Climate Change Adaptation Measures

Adaptation to climate variability and change or climate change adaptation means that local communities and societies prepare or take proper proactive and alternatives measures to adapt their social and environmental systems to prevailing climate variability and change induced impacts, as well change risks into opportunities, adaptation could be refer and range from starting a minor activity i.e. tree plantation up to major activities i.e. flood control and dams establishment. To some extent climate change adaptation is a response and precautionary measures to reduce and decrease the vulnerability of social

and environmental system, and recommend offsets or alternatives which are resistant and friendly to climate change in a given area i.e. Paghman district.

Recent climatic variability and seasonal variations have affected social and environmental systems in the district, in addition future climate change projections indicate that these prevailing climate changes will boost up the vulnerability and the situation may become worsen if proper proactive climate change adaptation measures are not taken into account.

Adaptation and climate variability and change have direct relationship, the degree of adaptation grows with increase in the intensity and magnitude of climate change, therefore Adaptation to climate change is precautionary and preparatory measures to reduce and decrease the vulnerability of social and environmental system at the present time and decrease the associated risks for the future.

Followings are community based climate change adaptation measures recommended for local communities in Paghman district:

4.7.1 Water Resource Management and Ground water recharge through Check Dams Construction

Check dams are small and temporary structures usually established and constructed in mountainous and sloppy areas to reduce water flow speed, prevent soil erosion and mitigate flood risks and hazards, check dams are very old method practiced long ago all over the world, presently in various developing countries and rural areas (valleys and mountainous regions) check dams are being constructed, therefore it considered an essential and important as well recognized community based climate change adaptation strategy, similarly, Paghman district is valley and mountainous area, hence it has suitable and applicable conditions for the construction of check dams.

Establishment and construction of check dam is a very suitable, applicable and cost effective climate change adaptation strategy in the district, due to recent climate variability, seasonal variations and temperature rise caused early snow melt and thaw as well these variations enhanced water flow velocity in the district, therefore establishment

of check dams would be a great climate change adaptation strategy in the district, advance check dam construction structures and its associated activities will be expensive and local communities would not be able to bear the costs, so without government financial support it will not be applicable, however local communities in the district can build check dams by using local materials, simple and local designs and collective and volunteer work.

In addition, check dams play a crucial part in recharging ground water resources in the district, due to population growth and early thaw shrunken surface water bodies thus this increased the demand for ground water for irrigation and domestic usages during summer season in the district, in the meantime check dams may prevent or reduce and mitigate flooding risks and hazards in the district.

4.7.2 Rehabilitation and Construction of Irrigation Canals

Water and agriculture have direct relationship with each other, without water agricultural activities cannot be performed, due to recent seasonal variations, decline in snowfall and temperature rise have shrunken surface water bodies and caused early snow-melt and thaw, therefore water shortages and deficiencies for irrigation purposes have been occurred in recent years, which has increased the demand of ground water for irrigation and domestic usages during summer season in the district. On the other hand due to poor irrigation infrastructure, huge amount of water is being lost during irrigation and due to absence of water reservoirs many farmers confront with water shortages and deficiencies during summer season.

Statistics of socioeconomic conditions indicate (disused in detail in previous sections) that more than 75 % of the population depends on agriculture sector and more than 70 % is irrigation based agriculture, however recent climatic variability adversely affected several farmers, therefore necessity and need is felt for preventing these impacts in the future.

Beside other recommended climate change adaptation measures, another very suitable and community based climate change adaptation strategy for combating all the above

mentioned climate variability and change associated impacts is the rehabilitation and construction of irrigation canals and infrastructure, this will reduce water losses and fulfill water requirement for irrigation purposes as will this will enhance agricultural production in the district. By undertaking this strategy present and future climate change risks will be reduced and mitigated.

This climate change adaption measure is a cost effective, effective and community based climate change adaptation strategy, however, at present time government has initiated some project for the rehabilitation and constructing irrigation infrastructure in the district.

4.7.3 Adjusting Agricultural Activities to seasonal variations

Climate variability and seasonal variations drastically affected usual cropping and cultivation seasons in Paghman district and all over the country, therefore, at the present time these changes are considered as threats to sustainable agricultural practices in the district, local communities especially farmers must adjust and adapt their agricultural activities to prevailing climate induced impacts in the district.

Site visits, climate variability data analysis and interview results, found and observed changes in cropping calendar (roughly 20 days change has observed between winter and spring seasons the change has conceptualized and developed through snowfall and snow thaw, blossoming (flowering) of fruit trees and cereal and other minor crops cultivation periods), due to lack of knowledge among farmers regarding climate change as well absence of precautionary measures for adjusting their agricultural activities, they followed their usual farming practices, in conclusion they received economic losses.

Professional agricultural and farming extension assistance to the farmers (these service should be provided from government side via professional agriculture extension workers), is the best option for adjusting agricultural and farming activities and planning cropping calendar to seasonal variations and climate change, however there are some other options available for adjusting agricultural activities to seasonal variations i.e. provision of climatic data to farmers for their self-study, but due illiterateness farmers would not be able to handle it, therefore vocational agricultural extension trainings and

assistance are the only suitable option for adjusting agricultural activities to climate change and seasonal variations. To some extent this climate change adaptation measure seems difficult, although it's very important in reducing and mitigating future climate change risks.

4.8 Recommended Climate Change Mitigation Measures

Mitigation to climate change or climate change mitigation refer to the actions and measures or management efforts for the prevention, mitigation and reduction the intensity of climate change induced impacts i.e. global warming and temperature raise, in general terms mitigation to climate change refers to the prevention or mitigation in man-made activities contributing to climate change i.e. Carbon Dioxide (CO2) emissions through different activities and practices, therefore climate change mitigation can be achieved by afforestation, uses of renewable sources of energy, adopting new technologies (environmental friendly), effective and efficient use of natural resources especially fossil fuels and enhancing carbon sinks.

Recent climatic variability and seasonal variations have affected social and environmental systems in Paghman district, in addition future climate change projections indicate that these prevailing climate changes will boost up the vulnerability and the situation may become worsen if proper climate change mitigation measures are not taken into account.

However, climate change mitigation practices are costly, therefore it will be difficult for local communities in the district to implement and apply these strategies and measures, although some basic and community based mitigation measures have recommended below, actually the sole purpose is to bring changes in their lifestyle, disseminate and increase climate change knowledge among the local villagers in the district.

4.8.1 Enhancing Carbon Sinks and Reducing Temperature Rise through Afforestation

Paghman district is a greener area compared to other parts of Kabul province, having sufficient water and suitable conditions for afforestation.

Knowing the value and significance of forests in mitigating climate change risk and induced impacts as well for reducing air pollution, government has initiated a project by the name of Kabul Green Belt Project (KGBP) (discussed in previous section), through which millions of tress will be planted in Kabul province especially in the district.

Furthermore afforestation and value of forests in mitigating climate change is highly emphasized by United Nation Framework Convention on Climate Change (UNFCCC) in various international and regional climate change conferences and negotiations, in the meantime the value of afforestation was one of the Afghanistan priority for climate change mitigation in its Intended Nationally Determined Contribution (INDC) to climate change report submittal to UNFCCC's Conference Of Parties 21st century (COP 21).

Studies and analysis indicate that, temperature rise was one of the main climate change induced factor which severally affected various agricultural and framing practices in the district, therefore afforestation and in-suite forest conservation and preservation will be an easy and possible option as well cost effective and community based climate change mitigation practice for enhancing CO_2 sinks and moderating temperature in the district, although the recommended climate change mitigation strategy highly needs government financial and technical assistance.

4.8.2 Use of Sustainable Biomass Energy Systems and Renewable Sources of Energy

Sustainable biomass energy systems (fuel efficient cook stoves, biogas plants and etc.) and renewable sources of energy (hydro, solar, wind and others) are considered clean sources of energy as well the best climate change mitigation strategy, they play a vital part in mitigating greenhouse gases, air pollution, diseases and health risks, socioeconomic development and cost effective than nonrenewable and unsustainable sources of energy, IPPC strongly endorsed the strategic importance of renewable source energy in mitigating climate change as well it highlighted and estimated the available renewable energy generation capacity present at the universal scale for climate change mitigation.

Afghanistan has suitable and favorable conditions for hydropower, solar and wind energy generation, on the average basis the country has the potential of generation more than 20,000 MW electricity from renewable sources of energy, although in the present time about 300 MW all over the country.

Interview results indicate that almost all families use wood and animal wastes for fueling and heating purpose in unsustainable manner in Paghman district; however all families have cattle and can easily established biogas plant/system, in the meantime, the district has favorable condition for small scale hydro and solar power generation, as the district has steep slopes and about 320 sunny days all over the year, therefore usage renewable sources of energy and usage of biomass in sustainable manner can reduce the dependency on forest and woods as well ensure high energy efficiency.

4.9 Observations and Knowledge of Villagers about Climate Change

Local communities of Paghman district have been experiencing and observing the recent climatic variabilit, seasonal variations and all other climate change induced factors, during the interviews and meetings with local villagers in the district, almost all the respondents expressed their understanding and knowledge about climate change as most of the villagers were farmers and their agricultural and farming practices were drastically affected due to recent seasonal variations, change in precipitation patterns and temperature rise, however the respondents were only aware in their traditional knowledge as most of them were uneducated as well due to absence of information sharing culture and lack of extension services from the governmental side about climate variability, change and its associated impacts, most of the farmers received economic losses due to recent climatic variability experienced in the district.

Furthermore, local villagers did not have knowledge about climate variability and change adaptation and mitigation during my all site visits and collective meetings with the residents of the district I frequently briefed them verbally about climate change adaptation measures to be practiced by the community, in the meantime I tried my best to recommend cost-effective, applicable and effective community based climate change adaptation measures and strategies (discussed in detail in previous sections), on the other

hand, in regard to climate change mitigation measures I briefed them about effective and efficient use of natural resources, afforestation, use of renewable sources of energy and sustainable use of biomass.

In addition, the need of disseminating information regarding climate change and its associated induced impacts through social media and agricultural extension services is highly needed.

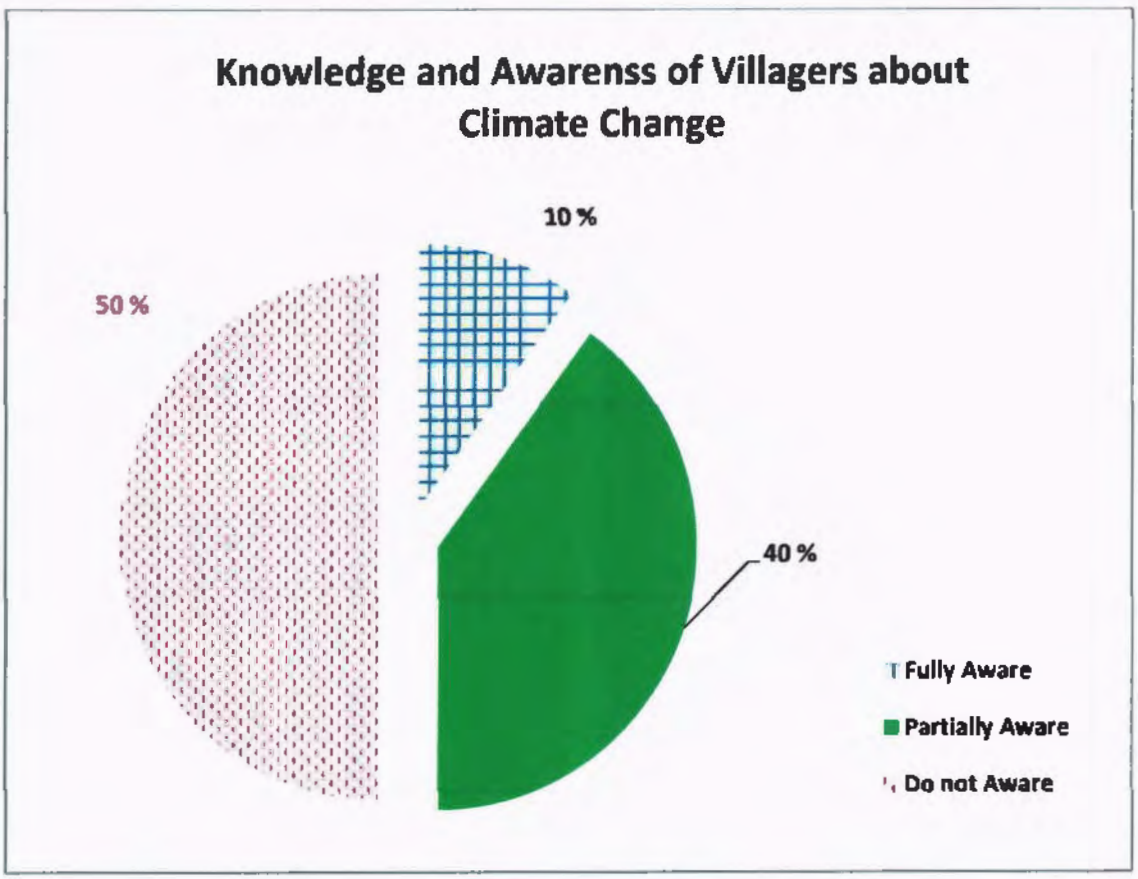


Figure-19: Knowledge and Awareness of Villagers about Climate Change in Paghman District.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Climatic variability analysis of Paghman district from 2006 till 2015 indicates negative change or decrease in precipitation, which is "- 0.1806 mm", and positive change or increase in temperature, which is "0.0183 °C", changes in the climatic conditions of the district, as a result, decline in snowfall and a little rise in temperature has observed in recent years. In the meantime climatic variability shows alterations in precipitation pattern, as in previous years the district usually received precipitation especially snowfall in late December and January months, but now it has been shifted to late January and February months, although snowfall has declined in last four years, which yielded various social and environmental damages to the socio-economic wellbeing of residents especially to farmers, and to environmental system and services at all. On the other hand, future climate change projection of Afghanistan, point out, nearly 1.4 °C raise in temperature and little or no decrease in rainfall up to 2030, specifically, AIB and A2 climate change projection scenarios project decrease in precipitation and increase in temperature, while B1 climate change projection scenarios projects increase in precipitation and very little change in temperature, actually these figures are only for the time series of 2030, although the overall climatic projection (till 2099) represents about 2 to 6 °C raise in temperature, in the meantime a decline of 10 to 40 mm in precipitation is forecasted, along with rainless situations in southern parts of the country.

Furthermore, analysis and measurements obtained from land covers (1993, 2010 and 2015) point out 800 ha increase in settlements or residential area in the district.

In a nutshell, this research study concluded that both, social and environmental systems have been affected due to recent climate variability, additionally, the overall results shows that water and agriculture sectors in the district have been affected adversely from recent climatic variability experienced in the area, in the meantime these sectors are at high risk and the most vulnerable sectors to climate variability and change, luckily the

district has good adaptive capacity and suitable conditions for the implementation of climate change adaptation and mitigation measures, in the meantime local communities are willing and contributing to adopt and implement long term and strategic climate change adaptation and mitigation measures, so far some climate change adaptation initiative and important projects are being implemented in the district for water and food security purposes.

In addition, due to lack of knowledge and awareness of local communities about climate change, the need for disseminating information regarding climate change and its associated induced impacts through social media and agricultural extension services is highly needed.

5.2 Recommendations

In reference to the research study, bellow recommendations have given:

1) Government should give the priority to water management and irrigation infrastructure rehabilitation and development in Paghman district and all over the country.

2) Government should support (both financially and technically) local communities in the implementation of climate change adaptation and mitigations measures and strategies in the district and all over the country.

3) All concern governmental departments especially NEPA, MAIL and Police should stop illegal forest cutting and poaching all over the country and initiate reforestation and afforestation in deforested areas.

4) All concern governmental departments especially NEPA and MEW should promote and facilitate use of sustainable biomass energy usage and systems as well renewable sources of energy.

5) MAIL should promote smart and climate compatible agricultural practices and new methods like land laser leveling and green house based agriculture activities.

6) MAIL should provide agricultural extension services regarding crop water requirement and on farm water management to the local communities especially farmers in the district and all over the country.

7) Metrology department and MAIL should inform and support local communities especially farmers about climate variability and seasonal variation during cropping and farming seasons.

8) MEW and MAIL should introduce community based and cost effective, climate change adaptation and mitigation measures and strategies in the district and all over the country.

9) MEW and MAIL should initiate and give the priority to integrated water resource management especially to watershed management.

10) MAIL should provide agricultural extension services and technical assistance regarding climate change and its associated induced impacts encountered to agriculture sector in the district and all over the country.

11) MAIL, MEW, MRRD and NEPA should disseminate information and awareness rising programs regarding climate change and its associated induced impacts through social media.

12) ANDMA and meteorology department should aware local communities through extension workers or other effective communication means, about anticipated natural disasters occurrence.

13) ANDMA should introduce community based and cost effective disaster risk reduction and management measures and strategies in the natural disaster prone areas.

14) MAIL and MEW should introduce drought resistant trees and plants in water scarce areas especially in southern parts of the country.

15) MAIL should rehabilitate and develop strategic grain storage stores or silos all over the country, to avoid delay and constrains in food supply during emergency situations.

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ANNEXES

Annex-1: Precipitation and Temperature Data

Precipitation data of Paghman district			Temperature data of Paghman district			
Month	**Precipitation (mm)**	**Trend**	**Month**		**Temperature °C**	**Trend**
Jan-06	111	52.2011	Jan-06	Max	-2	8.991217
Feb-06	89	52.02055		Min	-10	9.009561
Mar-06	101	51.84	Feb-06	Max	3	9.027905
Apr-06	59	51.65945		Min	-7	9.046249
May-06	0	51.4789	Mar-06	Max	7	9.064593
Jun-06	0	51.29835		Min	-1	9.082937
Jul-06	2	51.1178	Apr-06	Max	11	9.101282
Aug-06	13	50.93725		Min	5	9.119626
Sep-06	6	50.7567	May-06	Max	19	9.13797
Oct-06	8	50.57615		Min	8	9.156314
Nov-06	111	50.39559	Jun-06	Max	23	9.174658
Dec-06	138	50.21504		Min	12	9.193002
Jan-07	21	50.03449	Jul-06	Max	28	9.211346

Feb-07	99	49.85394		Min	15	9.22969
Mar-07	183	49.67339	Aug-06	Max	29	9.248034
Apr-07	0	49.49284		Min	14	9.266378
May-07	15	49.31229	Sep-06	Max	24	9.284722
Jun-07	54	49.13174		Min	10	9.303066
Jul-07	0	48.95119	Oct-06	Max	20	9.32141
Aug-07	20	48.77064		Min	4	9.339754
Sep-07	0	48.59009	Nov-06	Max	10	9.358099
Oct-07	0	48.40954		Min	-1	9.376443
Nov-07	4	48.22899	Dec-06	Max	6	9.394787
Dec-07	41	48.04844		Min	-5	9.413131
Jan-08	82	47.86788	Jan-07	Max	-1	9.431475
Feb-08	39	47.68733		Min	-9	9.449819
Mar-08	8	47.50678	Feb-07	Max	5	9.468163
Apr-08	180	47.32623		Min	-6	9.486507
May-08	28	47.14568	Mar-07	Max	8	9.504851
Jun-08	4	46.96513		Min	2	9.523195
Jul-08	6	46.78458	Apr-07	Max	14	9.541539
Aug-08	46	46.60403		Min	7	9.559883

Sep-08	0	46.42348	May-07	Max	20	9.578227
Oct-08	8	46.24293		Min	9	9.596571
Nov-08	2	46.06238	Jun-07	Max	25	9.614915
Dec-08	9	45.88183		Min	14	9.63326
Jan-09	168	45.70128	Jul-07	Max	29	9.651604
Feb-09	99	45.52072		Min	16	9.669948
Mar-09	122	45.34017	Aug-07	Max	28	9.688292
Apr-09	255	45.15962		Min	15	9.706636
May-09	76	44.97907	Sep-07	Max	26	9.72498
Jun-09	23	44.79852		Min	11	9.743324
Jul-09	0	44.61797	Oct-07	Max	22	9.761668
Aug-09	11	44.43742		Min	5	9.780012
Sep-09	8	44.25687	Nov-07	Max	12	9.798356
Oct-09	6	44.07632		Min	3	9.8167
Nov-09	55	43.89577	Dec-07	Max	7	9.835044
Dec-09	23	43.71522		Min	-2	9.853388
Jan-10	80	43.53467	Jan-08	Max	-2	9.871732
Feb-10	138	43.35412		Min	-8	9.890077
Mar-10	26	43.17357	Feb-08	Max	5	9.908421

Apr-10	65	42.99301		Min	-6	9.926765
May-10	56	42.81246	Mar-08	Max	9	9.945109
Jun-10	30	42.63191		Min	3	9.963453
Jul-10	11	42.45136	Apr-08	Max	12	9.981797
Aug-10	36	42.27081		Min	7	10.00014
Sep-10	27	42.09026	May-08	Max	19	10.01848
Oct-10	0	41.90971		Min	10	10.03683
Nov-10	6	41.72916	Jun-08	Max	24	10.05517
Dec-10	0	41.54861		Min	13	10.07352
Jan-11	4	41.36806	Jul-08	Max	30	10.09186
Feb-11	113	41.18751		Min	17	10.11021
Mar-11	28	41.00696	Aug-08	Max	29	10.12855
Apr-11	61	40.82641		Min	16	10.14689
May-11	10	40.64586	Sep-08	Max	27	10.16524
Jun-11	0	40.4653		Min	13	10.18358
Jul-11	0	40.28475	Oct-08	Max	21	10.20193
Aug-11	26	40.1042		Min	6	10.22027
Sep-11	15	39.92365	Nov-08	Max	9	10.23861
Oct-11	54	39.7431		Min	2	10.25696

Nov-11	28	39.56255	Dec-08	Max	8	10.2753
Dec-11	0	39.382		Min	-3	10.29365
Jan-12	40	39.20145	Jan-09	Max	-4	10.31199
Feb-12	78	39.0209		Min	-13	10.33033
Mar-12	48	38.84035	Feb-09	Max	-2	10.34868
Apr-12	119	38.6598		Min	-8	10.36702
May-12	28	38.47925	Mar-09	Max	5	10.38537
Jun-12	0	38.2987		Min	-1	10.40371
Jul-12	2	38.11814	Apr-09	Max	9	10.42205
Aug-12	10	37.93759		Min	4	10.4404
Sep-12	46	37.75704	May-09	Max	16	10.45874
Oct-12	20	37.57649		Min	8	10.47709
Nov-12	20	37.39594	Jun-09	Max	23	10.49543
Dec-12	77	37.21539		Min	13	10.51377
Jan-13	43	37.03484	Jul-09	Max	29	10.53212
Feb-13	166	36.85429		Min	16	10.55046
Mar-13	72	36.67374	Aug-09	Max	28	10.56881
Apr-13	67	36.49319		Min	15	10.58715
May-13	7	36.31264	Sep-09	Max	22	10.6055

Jun-13	15	36.13209		Min	10	10.62384
Jul-13	3	35.95154	Oct-09	Max	18	10.64218
Aug-13	17	35.77099		Min	4	10.66053
Sep-13	3	35.59043	Nov-09	Max	8	10.67887
Oct-13	10	35.40988		Min	1	10.69722
Nov-13	39	35.22933	Dec-09	Max	5	10.71556
Dec-13	27	35.04878		Min	-1	10.7339
Jan-14	3	34.86823	Jan-10	Max	-2	10.75225
Feb-14	76	34.68768		Min	-9	10.77059
Mar-14	130	34.50713	Feb-10	Max	2	10.78894
Apr-14	83	34.32658		Min	-5	10.80728
May-14	87	34.14603	Mar-10	Max	7	10.82562
Jun-14	5	33.96548		Min	3	10.84397
Jul-14	5	33.78493	Apr-10	Max	11	10.86231
Aug-14	10	33.60438		Min	6	10.88066
Sep-14	0	33.42383	May-10	Max	19	10.899
Oct-14	19	33.24327		Min	10	10.91734
Nov-14	66	33.06272	Jun-10	Max	25	10.93569
Dec-14	2	32.88217		Min	14	10.95403

Jan-15	44	32.70162	Jul-10	Max	31	10.97238
Feb-15	83	32.52107		Min	17	10.99072
Mar-15	98	32.34052	Aug-10	Max	30	11.00906
Apr-15	30	32.15997		Min	16	11.02741
May-15	36	31.97942	Sep-10	Max	27	11.04575
Jun-15	0	31.79887		Min	14	11.0641
Jul-15	13	31.61832	Oct-10	Max	19	11.08244
Aug-15	3	31.43777		Min	6	11.10079
Sep-15	7	31.25722	Nov-10	Max	8	11.11913
Oct-15	16	31.07667		Min	3	11.13747
Nov-15	40	30.89612	Dec-10	Max	3	11.15582
Dec-15	15	30.71556		Min	-2	11.17416
			Jan-11	Max	-1	11.19251
				Min	-7	11.21085
			Feb-11	Max	4	11.22919
				Min	-3	11.24754
			Mar-11	Max	10	11.26588
				Min	5	11.28423
			Apr-11	Max	13	11.30257

				Min	8	11.32091
			May-11	Max	21	11.33926
				Min	11	11.3576
			Jun-11	Max	27	11.37595
				Min	16	11.39429
			Jul-11	Max	33	11.41263
				Min	19	11.43098
			Aug-11	Max	31	11.44932
				Min	18	11.46767
			Sep-11	Max	28	11.48601
				Min	15	11.50435
			Oct-11	Max	22	11.5227
				Min	11	11.54104
			Nov-11	Max	9	11.55939
				Min	4	11.57773
			Dec-11	Max	5	11.59607
				Min	1	11.61442
			Jan-12	Max	-1	11.63276
				Min	-6	11.65111

			Feb-12	Max	7	11.66945
				Min	-3	11.6878
			Mar-12	Max	10	11.70614
				Min	4	11.72448
			Apr-12	Max	16	11.74283
				Min	9	11.76117
			May-12	Max	25	11.77952
				Min	13	11.79786
			Jun-12	Max	28	11.8162
				Min	17	11.83455
			Jul-12	Max	32	11.85289
				Min	20	11.87124
			Aug-12	Max	31	11.88958
				Min	19	11.90792
			Sep-12	Max	27	11.92627
				Min	14	11.94461
			Oct-12	Max	20	11.96296
				Min	9	11.9813
			Nov-12	Max	11	11.99964

				Min	5	12.01799
			Dec-12	Max	7	12.03633
				Min	1	12.05468
			Jan-13	Max	-2	12.07302
				Min	-7	12.09136
			Feb-13	Max	4	12.10971
				Min	-3	12.12805
			Mar-13	Max	8	12.1464
				Min	3	12.16474
			Apr-13	Max	14	12.18309
				Min	9	12.20143
			May-13	Max	24	12.21977
				Min	11	12.23812
			Jun-13	Max	26	12.25646
				Min	16	12.27481
			Jul-13	Max	33	12.29315
				Min	20	12.31149
			Aug-13	Max	30	12.32984
				Min	19	12.34818

			Sep-13	Max	27	12.36653
				Min	14	12.38487
			Oct-13	Max	21	12.40321
				Min	9	12.42156
			Nov-13	Max	9	12.4399
				Min	5	12.45825
			Dec-13	Max	6	12.47659
				Min	-2	12.49493
			Jan-14	Max	-2	12.51328
				Min	-8	12.53162
			Feb-14	Max	5	12.54997
				Min	-5	12.56831
			Mar-14	Max	7	12.58665
				Min	2	12.605
			Apr-14	Max	15	12.62334
				Min	8	12.64169
			May-14	Max	22	12.66003
				Min	9	12.67837
			Jun-14	Max	24	12.69672

				Min	15	12.71506
			Jul-14	Max	32	12.73341
				Min	18	12.75175
			Aug-14	Max	31	12.7701
				Min	17	12.78844
			Sep-14	Max	28	12.80678
				Min	13	12.82513
			Oct-14	Max	19	12.84347
				Min	8	12.86182
			Nov-14	Max	10	12.88016
				Min	4	12.8985
			Dec-14	Max	6	12.91685
				Min	-2	12.93519
			Jan-15	Max	-2	12.95354
				Min	-8	12.97188
			Feb-15	Max	5	12.99022
				Min	-2	13.00857
			Mar-15	Max	9	13.02691
				Min	5	13.04526

			Apr-15	Max	12	13.0636
				Min	7	13.08194
			May-15	Max	20	13.10029
				Min	10	13.11863
			Jun-15	Max	26	13.13698
				Min	15	13.15532
			Jul-15	Max	32	13.17366
				Min	20	13.19201
			Aug-15	Max	31	13.21035
				Min	19	13.2287
			Sep-15	Max	28	13.24704
				Min	14	13.26539
			Oct-15	Max	22	13.28373
				Min	12	13.30207
			Nov-15	Max	10	13.32042
				Min	5	13.33876
			Dec-15	Max	6	13.35711
				Min	2	13.37545

Annex-2: Vulnerability survey form

Sectors	Climate Change Induced Factors				
	Drought	**Seasonal Variations**	**Alterations in Precipitation Pattern**	**Natural Disasters**	**Temperature Raise**
Water Sector					
Agriculture Sector					
Biodiversity Sector					
Rangeland Sector					
Livelihood Sector					
Health Sector					

1 = Very Low 2 = Low 3 = Moderate 4 = High 5=Very High

Annex-3: Paghman District Land Covers

Paghman District Land Cover 1993	Area/Ha
Intensively Cultivated (1 or 2 crops / year), wheat followed by other crops	6369
Occasionally Cultivated (every 2 or 3 years), generally wheat	3368
Low shrubs / grassland and forbs (open to closed cover)	26067
Cultivation in flat-laying areas	32
Bare soil / rock outcrop, or sparsely vegetated areas	111
Lakes, reservoirs, etc.	95
Settlements and associated non-agricultural lands	80
Total	**36122**

Paghman District Land Cover 2010	Area/Ha
Irrigated Agriculture Land	8603
Fruit Trees	2026
Vineyards	14
Barren Land	14
Forest and Shurb	46
Rangeland	24443
Built-Up	589
Water	386
Total	**36121**

Paghman District Land Cover 2015	Area/Ha
Irrigated Agriculture Land	8152
Fruit Trees	1388
Vineyards	31
Barren Land	184
Forest and Shurb	59
Rangeland	24882
Built-Up	886
Water	537
Total	**36119**

Annex-4: Questionnaire form

Questionnaire form for Community Based Venerability Assessment of Socio Environmental Impacts of Climate Change on Paghman District, Kabul province, Afghanistan

Date.....

Name .....

Age.....

Sex (male/female) .....

Status (married/single) .....

Address.....

1. Demographic

- What is your present source of livelihood/Occupation?
  a) Agriculture
  b) Laborer
  c) Public servant
  d) Business
  e) Animal husbandry
  f) Any other.....
- What is your literacy level?
  a) Up to Primary school
  b) Up to Secondary school
  c) Under graduate
  d) Post graduate
  e) Illiterate

- How many members are in your family?
  Males.....
  Females.....
- What is your monthly income?----------

- Do you have private property like land, car, shop, livestock.....or any other specific?-

---

- What kinds of cattle you have in your house?
  a) Sheep
  b) Goat
  c) Cows
  d) Camel
  e) Horse
  f) Donkey
- Do you carry out Agricultural activities?

- Do you have irrigation facility?

- Do you have access to clean drinking water in your home?

- What is the main source of water for drinking purpose?
  a) Surface water
  b) Ground water
- Do you have sewerage system in your village?

- Do you have electricity facility in your village?

- What is the main source of household fuel?
  a) Natural Gas
  b) Fuel
  c) Wood
  d) Coal
  e) Animal manure
- Do you have any health center (clinic) in the village or in the nearby area?

- Do you have school in your village or in the nearby area?

- What is your personal observation about climate change?.....

2. Climate change

- Have you noticed a change in annual climatic pattern in the past few years?
  Yes_____No_____
  If yes, what sort of change?
  Describe.....
  .....
- Have you experienced dry periods and periods of drought in 10 years?
  Yes_____No_____
  If yes, please describe the
  changes.....
  .....
- In case your personal observation, how do you compare today with past 10 years, have precipitation patterns changed?
  Yes_____No_____
  If yes, please describe the
  changes.....
  .....
- What do you think these climatic changes are useful or harmful?
  Useful_____ Harmful_____
  Please describe the reasons for your
  answer.....
  .....
- What kinds of problems are being created by the prevailing climatic changes?.....
  .....

3. Drinking water

- Is your source of water today the same as before past 10 years?
  Yes_____No_____
  If no, describe how it has
  changed.....
  .....

- If you compare today with before the 10 years, how has the quantity of available water (both surface and ground) have changed?
  More_____Same_____Less_____
- If you have a well for drinking water, how many meters did it have before 10 years, and how many meters depth does it have now?
  Meters before _____
  Meters now _____

4. Crops

- If you compare today with before 10 years, how has the production of irrigated crops changed?
  Less_____Same_____More_____
- If you compare before 10 years and now, how has production of rain-fed crops changed?
  Less_____Same_____More_____
- Has vegetation cover/land use changed since 10 years?

5. Water for agriculture and livestock

- What are your sources of water for agriculture?
  Shallow well _____
  Deep well_____
  Spring (Kareze) _____
  River _____
- If you have a well for agriculture, how many meters did it have before 10 years and how many meters depth does it have now?
  Meters before _____
  Meters now _____
- If you compare before 10 years and now, has the amount of water available for agriculture changed, especially surface water?
  Yes _____No _____
  If yes, what are the reasons for the changes.....
  .....

6. Rangelands

- Have you noticed any changes in the production capacity of rangelands since the past few years and now?
  Yes _____No _____

If yes, please describe.....
.....

- Have there been changes in grazing practices from before 10 years and now?
  Yes _____No _____
  If yes, please describe,
  .....
  .....
- Have you noticed that there are more people using the same rangelands since before 10 years?
  Yes _____No _____
  If yes, please describe where the new people came from.....
  .....

7. Livelihood

- Does your framing practices, especially horticulture sector affected from recent climatic changes i.e. seasonal variations, alterations in precipitation pattern and temperature rise in the district?
  Yes _____No _____
  If yes, please describe,.....
  .....
- Does rain-fed framing practices affected from recent climatic changes i.e. seasonal variations, alterations in precipitation pattern and temperature rise in the district?
  Yes _____No _____
  If yes, please describe,
  .....
  .....
- Have you affected from recent climatic changes experienced in the district (economically and socially)?
  Yes _____No _____

  If yes, please describe.....
  .....

Annex-5: List of Interviews

List of Interviews Conducted with different Relevant Governmental Departments

S.N	Name	Designation	Department	Date
1	Dr. Hasseb Payab	Director of Irrigation Directorate	MAIL	05-12-2016
2	Mr. Noorullah Stankizai	Director of Statistics and GIS Directorate	MAIL	11-03-2017
3	Mr. Shahedullah Ghaznawi	General Manager of Natural Resources General Directorate	MAIL	17-01-2017
4	Eng. Haroon Mashal	Metrology Specialist	Metrology Department	23-10-2016
5	Qari Habibullah Waziri	Climate Modeling Specialist	Metrology Department	23-10-2016
6	Mr. Haneef Atal	MIS Specialist	Metrology Department	23-10-2016
7	Mr. Ibrahim Hashimi	Water Resource Management Specialist	MEW	26-10-2016
8	Eng. Khalid Jafari	Renewable Energy Specialist	MEW	26-10-2016
9	Eng. Tawheed Khaliqyar	Head of Supreme Council of Land and Water	MEW	26-10-2016
10	Miss. Arya	Head of Climate Change and GHGs Unit	NEPA	29-11-2016
11	Miss. Shakela	Head of Sustainable Development Unit	NEPA	29-11-2016
12	Dr. Noor Ahmad Akhundzadah	Dean of Environmental Science Faculty	Kabul University	22-11-2016

List of Interviews Conducted with UNDP, UNEP, UNFAO and WB

S.N	Department	Date
1	UNDP	05-12-2016
2	UNEP	15-02-2017
3	UNFAO	17-10-2016
4	WB	20-12-2016

List of Interviews Conducted with Community Development Council (CDC) Members

S.N	Name	Occupation	Date
1	Mr. Haji Zmrai	Head of Paghman CDC	14-09-2016
2	Mr. Hashmat Gul	Member of Paghman CDC	14-09-2016
3	Mr. Nabi Jan	Member of Paghman CDC	14-09-2016
4	Mr. Gul Ahmad	Member of Paghman CDC	14-09-2016
5	Mr. Aslam Khan	Member of Paghman CDC	14-09-2016

List of Interviews Conducted with Villagers

S.N	Name	Occupation	Date
1	Mr. Mula Hashim	Farmer and community elder	21-09-2016
2	Mr. Haji Manan	Community elder	21-09-2016
3	Mr. Najam-ud-din	Farmer	21-09-2016
4	Mr. Ghuas-ud-din	Farmer	21-09-2016
5	Mr. Naseem Jan	Farmer	21-09-2016
6	Mr. Ajab Gul	Farmer	21-09-2016
7	Mr. Dawood	Farmer	21-09-2016
8	Mr. Haji Arab	Community elder	28-09-2016
9	Mr. Kaka Ayoub	Farmer and community elder	28-09-2016
10	Mr. Sayad Noor	School Teacher	28-09-2016
11	Mr. Naqeebullah	Farmer	28-09-2016
12	Mr. Aslam Alamyar	Community elder	28-09-2016
13	Mr. Dil Agha	Farmer	28-09-2016
14	Mr. Ashugullah	Farmer	28-09-2016
15	Mr. Saleem	Farmer	28-09-2016

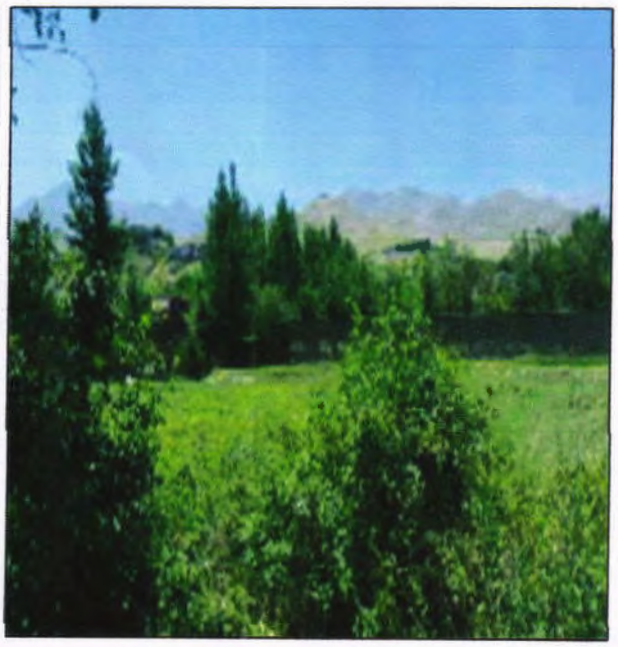
Annex-6: Focus Group Meetings (FGMs) Agenda

FGMs Agenda, Venue, Date and Contact Person/Department

S.N	Agenda	Contact Person/Department	Venue	Date
1	▪ To introduce the purpose of research, awareness about climate change and its adaptation and mitigation, importance of community based natural, sustainable development; and ▪ To obtain information about the existing social norms and ethics in Paghman district's communities and the villagers in particular.	Paghman District Community Development Council	Haji Zmari House, Paghman District, Kabul, Afghanistan	14-09-2016
2	▪ To deliver a presentation regarding climate change, vulnerability of Afghanistan to climate change, future consequences and adaptation and mitigation measures to taken for combating the prevailing climatic changes; ▪ To introduce the purpose and importance of the search; ▪ To obtain necessary data and facilitation during the research; and ▪ To obtain information about, previous work and existing projects and initiatives about climate change and sustainable development by NEPA.	Climate Change and Sustainable Development units	NEPA Central office, Kabul, Afghanistan	05-12-2016
3	▪ To discuss and deliver a presentation regarding the findings and results of the research study, highlight the necessary and immediate actions for combating climate change; ▪ To suggest role and importance of the community in alleviating climate change through CBNRM; ▪ To recommend site specific and community based climate change adaptation and mitigation measures for existing or upcoming projects and initiatives of the relevant departments, which were recommended for Paghman district, in this research study.	Supreme Council of Land and Water	Ministry of Energy and Water (MEW), Kabul, Afghanistan	24-04-2017

Annex-7: Photographs

View of Paghman District



Focus group meetings, interviews and filling out Questionnaire