CLIMATE CHANGE AND MANAGEMENT OF WATER RESOURCES IN SKARDU

By

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NATIONAL UNIVERSITY OF MODERN LANGUAGES

ISLAMABAD

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The undersigned certify that they have read the following thesis, examined the defense, are satisfied with the overall exam performance, and recommend the thesis to the Faculty of Social Sciences for acceptance:

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Candidate of **Master in Philosophy** at the National University of Modern Languages do hereby declare that the thesis **"Climate Change and Management of Water Resources in Skardu"** submitted by me in partial fulfillment of MPhil degree, is my original work, and has not been submitted or published earlier. I also solemnly declare that it shall not, in future, be submitted by me for obtaining any other degree from this or any other university or institution.

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ABSTRACT

After the 19th century industrial revolution, the emission of carbon dioxide caused amplification in air pollution and the world has been introduced with the term climate change. Consequently there is 1.5 ^{o}C increase in overall earth temperature due to the disruption in greenhouse gases. Additionally, notable defrosting in the glaciers of north and south poles has been seen. The glaciers of Karakoram and Hindu Kush are also not immune to the effects of climate change. According to Pakistan Metrological Department, Intergovernmental Penal on Climate Change (IPCC), and German watch report America, Canada, and China are the top listed countries responsible for the excessive emission of greenhouse gases. However, Pakistan is included in the least responsible countries. Under the supervision of United Nations the establishment of IPCC came into being. Similar to other countries of the world Pakistan has also become a member of IPCC in 2005 under Paris Agreement. Pakistan has also established ministry of climate change but the need to spread awareness on public level is inevitable. Moreover, in 2017 under the said ministry, Environmental Protection Agency has also been established in Gilgit-Baltistan under the supervision of legislative council of Gilgit-Baltistan. Although this agency has created a policy document in which recommendations have been suggested in the light of UNSDG but have been facing lack of practicality due to insufficient public awareness. District Skardu that is also a capital of Baltistan division is a world popular city. On 17th December 2021 Prime Minister of Pakistan inaugurated international terminal of Skardu Airport.

Sad Para Lake is the only source to fulfill its water requirements. In 2010 WAPDA built a multipurpose dam on it that is still incomplete because of “Shadung Nala” that had to be conjoined with Sad Para Lake. This project has been left incomplete by the alliance of Executive agency and contractor and now neither water nor electricity requirements are being fulfilled.

Subsistence farming was only done for a short period of six months in Gilgit Baltistan. Water is insufficient for domestic use, cattle and drinking. Keeping in view these facts, it is the need of the hour to start Mega Water Management. Present “Kuhuls” (water channels) should be made, so that the far end of the fields can be irrigated. As far as the research gap is concerned, no research has been done on water management although research on drinking water in Gilgit has been done.

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M.Phil. (**Pakistan Studies**)

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INTRODUCTION

Industrial Revolution in the early 19th century and the human social and economic development have changed people's lifestyle significantly. The need for energy and consumption of fossil fuels like coal, oil and natural gas have resulted in increased emission of carbon dioxide and other greenhouse gases into the atmosphere. These emissions have changed the energy balance of the earth and its atmosphere. Global population growth has caused land use change, deforestation, increased agricultural and livestock activities and increased solid and liquid waste production, resulting in many environmental problems including climate change. Atmospheric models predict that the earth temperature will increase from 1 to 3.5°C by the year 2100, which is more than temperature changes during the past 10,000 years. Emission of greenhouse gases, production of aerosols in the atmosphere, changes in the earth's reflection index and thermal pollution are the factors affecting climate change. Among these factors, the effect of greenhouse gases is well known and is the most important one. The earth absorbs most of solar radiations that reach the earth through its atmosphere and, after getting warm, reflects the thermal waves back to space. Portion of this infrared radiation passes through the atmosphere and a fraction of it is absorbed by greenhouse gases and reflected back to the earth surface which results in an energy balance between the earth and space. This so called greenhouse effect is a natural phenomenon, which has created the normal temperatures ranges in the atmosphere. Indeed, if the greenhouse effect did not exist, the earth's average temperature would have been about 15.5 degrees lower than the temperature that it has now and another ice age would occur. However, the concentration of greenhouse gases in the atmosphere has exceeded the normal level by as much as 30%, resulting in global warming.

Temperature variations are commonly used to detect and quantify possible climate change. Another means is to analyses trends and variability in precipitation data. Some investigators have reported that there is an enhanced hydrologic cycle over the last two decades, especially for some parts of the Northern Hemisphere. Although, much emphasis has recently been placed to quantify climate change over different parts of the globe.

Climate change is not just a future scenario. Increased exposure to droughts, floods and storms is already destroying opportunity and reinforcing inequality Meanwhile, there is now overwhelming scientific evidence that we are getting closer to an irreversible ecological catastrophe. This could lead to an unprecedented reversal in human development in our lifetime and acute risks for our children and their grandchildren Climate change is

affecting the Earth's ecosystems. We depend on these ecosystems for a range of services and resources - from water to agriculture to livelihoods and many others. Therefore, climate change poses a serious threat to our ability to meet the eight Millennium Development Goals. The fact that the poor are already seeing its impacts only underscores the worsening situation significant efforts to stop climate change are not taken. The Human Development Report 2007/2008: Fighting climate change: Human solidarity in a divided world "seeks to understand the implications of climate change on the opportunities the world has at present and its implications for the future of human development. One of its distinctive features. Is the work done for the understanding how climate events impact on the poor. Climate change is the defining human development challenge of the 21st Century. Failure to respond to that challenge will stall and then reverse international efforts to reduce poverty. The poorest countries and populations will suffer the earliest and most damaging setbacks, even though they have contributed least to the problem. Looking to the future, no country-however wealthy or powerful-will be immune to the impact of climate change. The poor are suffering and will suffer more with climate change. Given that 40 percent of the world's population live in poverty and are unable to meet their daily basic needs, these 2. 6 billion people are at risk to face first-hand the impacts of dangerous climate change and human development reversals. The Report makes case for the urgency with which climate change needs to be addressed. Time matters for all of us. Today we are living with what we did yesterday; tomorrow we will all live with what we do today. We need to take action now. It has been estimated that if all of the world's people generated greenhouse gases at the same rate as some developed countries (i.e., Canada and the United States), we would need nine planets (to absorb the GHGs and avoid dangerous climate change). With 15% of the world's population, rich countries account for almost half of (annual, global) emissions of CO_2. It is estimated that avoiding dangerous climate change will require rich nations to cut emissions by at least 80% by 2050, with cuts of 30% by 2020. Emissions from developing countries will peak around 2020, with cuts of 20% by 2050. Some 262 million people were affected by climate disasters annually from 2000 to 2004, over 98% of them in the developing world. Global temperature increases of 3-4 C could result in 330 million people being permanently or temporarily displaced through flooding. Over 70 million people in Bangladesh, 6 million in Lower Egypt and 22 million in Vietnam could be affected. With 3 ° C of warming, 20-30% of land species could face extinction. An additional 220-400 million people could be exposed to malaria a disease that already claims around 1 million lives annually.

RATIONALE:

Climate change has the potential to shift the dynamics of water security nexus. Extreme weather conditions and shift in water supply pattern could add more pressure to each of the anticipated security concerns, highlighting the need for a comprehensive water management strategy, because Gilgit-Baltistan is a predominantly agricultural economy, and decrease in yield will affect not only livelihood but also food security both in urban and rural populations. Such insecurity runs the risk of aggravating existing social inequalities in water use and availability and intensifying the socio-political factors.

Water and sanitation are at the core of sustainable development, and the range of services they provide underpin poverty reduction, economic growth and environmental sustainability. However, in recent decade's overexploitation, pollution, and climate change have led to severe water stress in locales across the world.

STATEMENT OF THE PROBLEM:

The impact of climatic change on hydrological characteristics are likely to have significant repercussions not only on Gilgit-Baltistan but also mainland population that depend heavily on mountain water resources for domestic, agricultural, energy and industrial purposes. Seasonal shift in precipitation and increasing temperatures may alter the agriculture calendar.

Glaciers and snow deposits are vulnerable to the impacts of climate change. The melted water from glaciers and snow enters streams, which subsequently feed man-made channels that bring water into the settlement for agriculture use, domestic requirements, and livestock. Conventionally rural areas depend mainly on the irrigation channels for the supply of water for domestic purposes and livestock usage. Water from the dug pits generally reserved for drinking and cooking purposes. Water availability during winter is minimum, due to reduced snow and glacier-melt, which affect the quality of stored water. In summers, the water is replenished more frequently.

Skardu is facing severe water shortage due to dependence upon only water source Sad Para Lake. There is needed to take immediate steps to cope with the situation. Short term and long-term measures are required as considering the crisis. Economically direct detrimental impacts of climate change will be across diverse sectors including water, energy, food and agriculture, forest, and fisheries. The most serious risks of climate change relate to food, water, and energy security. Water security has crucial importance for the

economy as it is bound to have impacts on all economic sectors. Future increase in population and the need for economic development is likely to increase the demand for water substantially. Currently, the biggest user of water in Gilgit-Baltistan is agriculture sector, where demand for water is likely to increase much faster due to enhanced evapotranspiration because of elevated temperatures in the wake of climate change. In terms of supply, both main sources the Glaciers of Hindu Kush- Karakorum- Himalayas (HKH) and precipitation will be affected due to melting glaciers (first increasing the water and then decreasing) and erratic rainfall, respectively. Hence, the efficiency of water use will need improvement/management in all the sectors of economy, particularly agriculture, where average water delivery efficiency due to age, overuse, misuse, and poor maintenance of water channels (kohl's) and consequent seepage has reduced substantially from the channels (kuhuls) head to the root zone.

SIGNIFICANCE OF THE STUDY:

Water and water management are among the main challenges Pakistan has been struggling with since 1947. In this regard this research is highly significant. Along with this the significance of this research is set around the challenges in the wake of growing concerns for dealing with the impacts of global phenomena- climate change. Typical of a highly mountainous region, the environmental system of Gilgit-Baltistan is highly exposed to hazards resulting from rising temperature, melting glaciers and unpredictable variations in precipitation levels.

OBJECTIVES:

1. To identify the water resources in Skardu for better water resources management.
2. To observe the climate change on water resources, agriculture, livestock, and population of Skardu.
3. To suggest the way forward to overcome the water shortage and resilience against climate change.

RESEARCH QUESTIONS:

1. What are the ways to identify the water resources in Skardu for better Water Resource Management?
2. How to observe the climate change on water resources, agriculture, livestock, and population of Skardu?

3. How to suggest the way forward to overcome the water shortage and resilience against climate change?

THEORETICAL FRAMEWORK

Hardly any country in the world adopts "rational "management of water resources; instead, water problems are routinely ignored until they reach crisis proportions. Officials responsible for governing water uses and quality often embrace policy instruments, such as underpricing of water and command and control regulations that are highly inferior to best practices.

In nearly all countries, freshwater resources are under increasing stress. According to theory there is tremendous technical potential for reducing energy and other industrial impacts on water resources, actually realizing those potentials will hinge on governance. In one vision of governance, societies identify water stress in advance and respond with policy incentives that give firms and other users of water resources the flexibility to adjust and find the least cost means of controlling their impacts. That model which author refers as "Model 1"- is a lovely vision that rarely exists in the real world. Instead, an alternative "Model 2" is what usually prevails. In this alternative vision, water resource stresses are ignored until they became acute. Policy instruments are prescriptive and not flexible.

Second, theorist has suggested that the biggest inefficiencies in Model 2- the tendency for societies to ignore water stresses until they become acute and the strong bias in favor of "command and control" regulations over more flexible markets- are deeply rooted in human cognition and political economy. They will be very hard to fix. Third, author has suggested that there is tremendous promise in popular new ideas for water governance – notably integrated water resources management (IWRM). However, the optimism about IWRM must be tempered by realities about how integration across many different industries and political systems might actually be achieved. IWRM-and other basin-wide management schemes-is likely to be layered on top of existing governance systems rather than replace them. Without politically difficult efforts to remove existing system of governance while implementing new IWRM schemes, the result is likely to be more fragmented governance.

Fourth, these political challenges for efficient governance are significant where governors focus on water quantities; the problems are likely to be even greater as more jurisdictions focus on water quality such as temperature, pollution loads, seasonal flows

and complex interactions between the uses of fresh water for human and natural purposes. These new missions are difficult to manage because they necessarily work across multiple government agencies, each with their own objective.

Together these four arguments suggest that "governance" factors are likely to explain why real world outcomes in fresh water management could be radically different from the economically optimal potential.

LITERATURE REVIEW:

This research is based on the literature that is helpful in understanding the climate change and water management in Skardu. For collecting data, the researcher finds out the following literature to ascertain the facts and figures relevant to the research topic.

Pakistan is one of the most vulnerable countries facing the risk of climate change, despite contributing very little to the global greenhouse gases (GHG) emissions. The 2010 Global Climate Risk Index of German watch ranked it first among some 180 nations of the world. The country's vulnerabilities are high due to heavy dependence of its economy on agriculture, which is highly climate sensitive; water supply of its rivers from the Hindu Kush-Karakoram-Himalayan glaciers, which are reported to be receding due to global warming.

Developing countries are the hottest spot for disaster events. It is developing nations where disaster represents a major source of risk for the poor and can potentially destroy development gains and accumulated wealth.

The areas worst affected which will face severe water shortages comprises the entire Mediterranean region, Northwest and South of Indian Sub-continent, Mongolia, Northern China, most of Sub-Sahara Africa, major regions of North and South America, especially Western United States.

Water resources are inextricably linked with Climate Change; this is why the projected Climate Change has serious implications for Pakistan's water resources.

Fresh water resources in Pakistan are based on snow and glaciers melt and monsoon rains, both highly sensitive to Climate Change.
Increase in the formation and outburst of Glacial Lakes (GLOF).

Higher frequency and intensity of extreme climate events coupled with irregular monsoon rains causing frequent floods and drought; and greater demand on water due to higher evapotranspiration rates at elevated temperatures.

Water Resources are inextricably linked with Climate and impending Climate Change scenario has serious implications for Pakistan Water Resources.

With rapid growing population, Pakistan is heading towards a situation of Water shortage and by corollary, a threat of food insecurity.

Per capita surface water availability of has declined from 5,260 cubic meter/year in 1951 to around 1,000 cubic meter in 2016.

This quantity is likely to further drop to about 860 cubic meter by 2025 marking our transition from a "water stressed" to "water scarce".

Pakistan is an agricultural country. Therefore water is an essential resource for sustained economic growth as well as human survival. Water, which is one of the most important national resource is increasingly becoming a scarce natural resource.

Climate Change sometimes is not perceived as a fundamental Water challenge, but it definitely exacerbate existing Water Management practices. In order to adapt to these Climate Change Impacts, it is even more essential to revisit existing Water Management practices across all relevant sectors.

A phenomena through which the GHGs (carbon-dioxide, methane and nitrous oxide) together with water vapor trap radiation from the sun, preventing it from dissipating back into space. The GHG effect keep the Earth's average surface temperature at 15 ^{o}C. Without it the average temperature of earth would slash down to an inhospitable -18 ^{o}C. Global Warming is attributed to the high concentration of these GHG's in the atmosphere. Climate data from the year 1880 to 2012 show a successive increase of 0.65 ^{o}C to 1.06 ^{o}C in global temperatures. (IPCC, 2014)

The IPCC Fourth Assessment Report suggest that climate change is likely to accelerate the intensity, duration and frequency of floods, storms, heat waves, draught etc. the IPCC (2007) has identified impacts of climate change including significant increase in heavy precipitation, increase in tropical cyclones and longer drought periods. Similarly, during 2013 in the list of most affected countries. Pakistan was ranked at fifth position, whereas German Watch ranged Pakistan at third amongst most affected nations.

The region is one of the highly glaciated areas in the world and extremely sensitive to climate change. The volume of ice in a glacier, its surface area, thickness, and its length are determined by the balance between input (snow and ice) and outputs (melting and calving). These factors are regulated by temperature, humidity, wind speed and slope.

As climate change occurs, this balance may deteriorate, resulting in change in thickness and the advance or retreat of the glaciers. Glaciers in several regions of Asia have been retreating since 1950, including the mountain glaciers of Gilgit-Baltistan. Empirical evidence indicates that 30% to 50% of existing mountain glacier mass could disappear by

2100, if global warming scenarios in the range of 2-4 °C occurs. For every 1°C increase in temperature, the snowline on mountains shrinks by about 150 m.

The smaller the glacier, the faster it will respond to changes in the climate. Shrinking glacial mass will lead to drastic changes in hydrology of mountain regions – as glaciers melt rapidly, they provide enhanced runoff, but as the ice mass diminishes, the total runoff/water flow will reduce to minimum. This occurrence will result in severe consequences to the highlanders in terms of vegetation, pastures, agriculture, hydropower energy and biodiversity including mountain communities of Gilgit-Baltistan.

The Karakorum, Himalaya and Hindu-Kush are hosted by numerous large and small glaciers. In Pakistan, glaciers have covered around 17,000 km*areas. It is second biggest mass of glacier outside the north and south poles. All the glaciers are the water towers and reservoirs for supplying fresh water. It feeds more than 50 small and large rivers in Pakistan. The perennial supply of water from these glaciers is lifeline for the people and economy of Pakistan. As the country is agro- based and heavily dependent on perennial supply of irrigation for agriculture, industrial use, hydro-power generation and the most important is domestic utilization. Without these glaciers, the country would have been an uncongenial arid land to support the growing population. Due to climate change phenomenon, glaciers are retreating in northern Pakistan. Because of glacier melting, it would have significant impacts on the agricultural production, hydro-power generation, industrial establishments, and eco-biodiversity in the vast Indus plains of Pakistan. Besides this, these glaciers also attract large-scale tourists, trackers, and scientists from all over the world.

Water resources increased from 2,961 m^3 per capita in 2000. A more recent study indicates an available supply of water of little more than 1,000 m^3 per person, which puts Pakistan in the category of a high stress country. According to the United Nations' "UN World Water Development Report", the total actual renewable Using data from the Pakistani federal government's Planning and Development Division, the overall water availability has decreased from 1,299 m^3 per capita in 1996-97 to 1,101 m^3 per capita in 2004-05. In view of growing population, urbanization and increased industrialization, the situation is likely to get worse. Nevertheless, excessive mining of groundwater goes on. Despite a lowering water table, the annual growth rate of electric tube wells has been indicated to 6.7% and for diesel tube wells to about 7.4%. In addition, increasing pollution and saltwater intrusion threaten the country's water resources. About 36% of

the groundwater is classified as highly saline. Contrary to this, Pakistan is vulnerable to wide range of hazards including earthquakes, landslides, floods, extreme weather phenomenon. Glacial Lake Outburst Floods (GLOF), snow avalanches etc. The country's extreme vulnerability to climate change is a feature of its geographic location, elevation as well as demographic. Pakistan lies on a steep incline, dropping sharply from almost 8,500 m down to sea level within an aerial distance of less than 2,000 km.

The situation is augmented by the presence of huge glacial reserves in the north. Through a consistent process of ablation in summer and accumulation in winter, it contributes more than 70% water to river discharge. This frozen "blue gold" is the country's most precious resource and sustain the agro-based economy aided by the unpredictable summer monsoon rain. Now more than ever the world needs to transform the way it manages its water resources and delivers water and sanitation services for billions of people. Urgent action is needed to overcome this global crisis, as it is affecting all countries around the world, socially, economically and environmentally. The climate change has increased the frequency and intensity of hydro-meteorological events and enhanced the unpredictability of the monsoon and posed a major threat to food, water, and energy security in the country (Government of Pakistan, *state of the environment report, 2005)*. In addition to this, environment, agriculture and livestock sector, forests and biodiversity and health are other areas that will be seriously affected as the climate induced melting of glaciers, heat waves, cyclonic, diseases/epidemics, floods, intense precipitation, droughts, and variable monsoons have been turned into an inevitable future reality for Pakistan.

Pakistan is one of the most vulnerable countries facing the risk of climate change, despite contributing very little to the global greenhouse gas emissions. The 2010 Global Climate Risk Index of German watch ranked it first among some 180 nations of the world. The country's vulnerabilities are high due to heavy dependence on its economy on agriculture, which is highly climate sensitive; water supply of its rivers from the Hindu Kush-Karakorum-Himalaya glaciers, which are reported to be receding due to global warming; and increased risks to its coastal areas. Compounding the problems are the extreme weather events, which have enhanced in their frequency and intensity in the country. An analysis of data from 52 meteorological stations in Pakistan over a 40 -years period (1961-2000) shows that the frequency of highest daily temperature and heaviest rainfall events have increased by the passing decades. Moreover, all the turn of the century, the country experienced the worst drought of its history and in the first decade of the

twenty-first century saw several extreme weather events including the history's worst flood in 2010. In terms of risks, climate change poses a major threat to all dimensions of sustainable development, economic, social as well as environmental. It is likely to have widespread impacts across various sectors and ecosystems such as food, water**,** and energy; forests and biodiversity; coastal and marine environment; as well as on the occurrence and intensity of climate related hazards such as floods and droughts.

RESEARCH METHODOLOGY

The methodological plan of the examination assumes a huge part in appearing the center goals of the investigation. Dependability and legitimacy of the examination's results are dependent on the methods applied by the specialists. The principle intend to introduce this work is to explain the ideas of the peruse identifying with every one of the techniques utilized by the researcher while executing the examination. "By approach we mean the way of thinking of the exploration cycle. This incorporates the suspicions and qualities that fill in as a reasoning for research and the guidelines or measures the specialist utilizes for deciphering information and arriving at resolutions.

Exploration procedures are significant in the investigation of any issue. This examination is exploratory and done by utilizing subjective information. This examination is to clarify the effect of environmental change upon the administration of water assets in Skardu. In this manner the exploration comprises of various components. The analyst would utilize optional information like magazines, papers, books, distributed papers, articles and sites.

Examination configuration is the primary defense of how exploration questions and exploration objectives are connected to the information being assembled. Examination plot is the essential thought of partner every one of the systems into an explained way so that testing extent, inspecting strategy, cycle of information assortment and examination of the examination orchestrated and in line. Spellbinding examination configuration is embraced when a scientist is portraying the components in regards to an individual, gathering or circumstance. Hence, the spellbinding exploration just attempts to clarify the attributes of any examination populace and doesn't legitimize building up any huge connections. Same is the situation with the current examination as the specialist attempts to expound specific Water Management in Skardu. Keeping in see the objectives of the momentum research is applying unmistakable analytical plan to meet the expectations of the examination. The

investigation will feature and clarify the impacts of environmental change on water the board in Skardu.

ORGANIZATION OF THE STUDY

The study is classified into the following chapters.

The initial pages are about the introduction, in which the researcher tries to explain the phenomena of climate, climate change. Theoretical framework is about the theory of water management like "Political Theory of Water Governance". Literature Review, Significance, is discussed.

Chapter 01 is about the area profile of Skardu in which researchers with the help of books and articles defined the history, caste system, area, and location, in detail for the convenience of the reader.

Chapter 02 is about the impacts of Climate Change, globally, Regional (Pakistan) and Local (Gilgit-Baltistan).

Chapter 03 covers Management, Resource Management, Water Resources Management, and Watershed Management.

Chapter 04 is about the utilization of water resources in Gilgit-Baltistan, i.e. agriculture sector, power sector, water for drinking and its management.
While the last findings and conclusion along with policy recommendations are discussed.

AIMS OF THE STUDY

The aim of the study is to assess the reasons of shortage of water in Skardu with a view to suggest some viable options to deal with the situation through water management.

CHAPTER-01: HISTORY, AREA AND PROFILE OF SKARDU

1.1. EARLY HISTORY

The Skardu region was part of the cultural sphere of Buddhist Tibet since the founding of the Tibetan Empire under Songster Gimp in the mid-7th-century CE.[1].
Tibetan tantric scriptures were found all over Baltistan until about the 9th century, given the region's close proximity to Central Asia. Skardu remained in contact with tribes near Kashgar, in what is now China's western most province of Xinjiang. Following the dissolution of Tibetan suzerainty over Baltistan around the 9th-10th century CE, Baltistan came under control of the local Maqpoon Dynasty, a dynasty of Turkic extraction, which according to local tradition, is said to have been founded after a migrant from Kashmir named Ibrahim Shah married a local princess.[2]

1.2. ORIGIN OF BALTI'S

Vigne is of the view that Balti's seem to be a race of Tartar origin and their physiognomy partakes of an admixture of the Mongolian or Tartar, and the more noble features of the Indian or Persian races which originally met from the north and the south upon the banks of the Indus.[3] It is generally said that Tibetans from the Ladakh side came to Khaplu via Nobra and Mongolians from Yarkand came to Khaplu via Kondus valley. Cunningham places the Bhotis of Ladakh as an off-shoot of the Great Mongolians.

1.3. EARLY CONDITIONS IN BALTISTAN

The initial conditions in Baltistan are shrouded in darkness due to the lack of education and the lack of efforts of the people. In the second century AD, no traces of the Baltistan have been found. More information is not available. Col. Muhammad Akhtar Malik DIG, NLI, northern areas. According to page 23 of the "History of Northern Light Infantry", Baltistan was a state in the seventh century AD. At that time Baltistan was called Bolar Kalan and Gilgit and Chitral Bolar Khurd. At that time the people of Baltistan were in the form of small tribes. There was a chief of each tribe. During the eighth century, Aldan invaded Gilgit-Baltistan and Chitral, a single state. Later, the chief dynasty of China

[1] Dani, Ahmad Hassan (2001). *History of Northern Areas of Pakistan up to 2000 A.D.* Sang-e-meel Publication, Lahore.
[2] Ibid.
[3] Ibid.

forcibly annexed these areas to their empire. Soon the Muslims of Central Asia defeated the Chen dynasty. Gradually, the declaration of chiefs and tribes came to an end and a government of kings was formed. [4]

1.4. RELIGION

In Baltistan, the majority of the population professes Shiaism. Next in number come Noor-Bukshi, then Ahl-e-Hadith and lastly Sunnis.[5]

The influence of Buddhist religion is reflected in the architecture of some of the Khanqas and mosques constructed in this region after the conversion of the people to Islam. The mosque at Thagas (Khaplu valley) is stated to be the first one constructed in this region and dates back to 1012 A.H. The Khanqah at Gamba Skardu, dates back to 1130 A.H. The date of Shigar Khanqah could not be ascertained. One version is that Khanqah was constructed by Raja Azam Khan (1755-1785) while another version is that it was constructed by Raja Hussain Khan (1785-1815). It is said that it was constructed later than the one at Gamba Skardu. The foundation of the Chaqchan mosque at Khaplu is said to have been laid by Syed Mohammad Noor Buksh who visited this area between 840 and 850 A.H. The mosque does not bear any date. The Khanqah at Keris bears the date of 1118 A.H.[6]

1.5. CASTE SYSTEM

In the recent past, the society of Baltistan has been a nightmare due to living with Hindus for centuries. This persisted even in the time of the kings.[7]

The biggest caste was of the Rajas and Syed's. Which were combined with a little current and the kings had the upper hand.[8]

In second place were the Turkuchus, Mini-Minister, Adviser and the Pachos (Bar and Family Affairs) who were direct friends of the Rajas. Each Raja had twelve or fourteen advisors. The Rajas did not want all the administrative matters. The same people were to be invited along with the procession of the marriage of daughters of the Rajas, which was a great honor.

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[4] Endreson, R. T. (1998). *History, Folklore and Culture of Gilgit Baltistan.* Oxford University Press, London.
[5] Qalbi. Wazir Ali*. Qadam Baltistan,* Sode Publications 2002, Skardu.
[6] Dani, Ahmad Hassan (2001). *History of Northern Areas of Pakistan upto 2000 A.D*. Sang-e-meel Publication, Lahore.
[7] Qalbi. Wazir Ali *Qadam Baltistan*, Sode Publications 2002, Skardu.
[8] Qalbi. Wazir Ali *Qadam Baltistan*, Sode Publications 2002, Skardu.

1.6. MAQPOON DYNASTY

Skardu was founded around the year 1500 along the Indus River where it enters a broad valley at its confluence with the Shigar River.[9] Around the year 1500, *Maqpon Bokha* was crowned ruler, and founded the city of Skardu as his capital.[10] The Skardu Fort was established around during his reign; King *Maqpon Bokha* imported craftsmen to Skardu from Kashmir and Chilas to help develop the area's economy. While nearby Gilgit fell out of the orbit of Tibetan influence, Skardu's Baltistan region remained connected due to its close proximity to Ladakh, the region which Skardu and neighboring Khaplu routinely fought against. Sikhs traditionally believe that Guru Nanak, the founder of Sikhism, visited Skardu during his second *udasi* journey between 1510 and 1515 .[11]

1.7. MUGHAL TIME

In the early 1500s, Sultan Said Khan of the Timurid *Yarkent* Khanate, based in what is now Xinjiang province of China raided Skardu and Baltistan. Given the threat illustrated by the Sultan Said's invasion, Mughal attention was roused, prompting the 1586 conquest of Baltistan by the Mughal Emperor Akbar. The local Maqpon rulers pledged allegiance, and from that point onwards beginning with Ali Sher Khan Anchan, the kings of Skardu were mentioned as rulers of Little Tibet in the historiography of the Mughal Empire.[12] Mughal forces again incurred into the region during the reign of Shah Jahan in 1634-36 under the forces of Zafar Khan, in order to settle a dispute to Skardu's throne between Adam Khan, and his elder brother Abdul Khan. It was only after this point, during the rule of Shah Jahan and Aurangzeb that Skardu's ruling family was firmly under Mughal control.[13] The ability of the Mughal crown to fund expeditions to territories of marginal value, such as Baltistan, emphasizes the wealth of the Mughal coffers.[14]

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[9] Dani, Ahmad Hassan (2001). *History of Northern Areas of Pakistan upto 2000 A.D.* Sang-e-meel Publication, Lahore.
[10] ibid
[11] Ali, Manzoom (2004, June 12). *Archaeology of Dardistan*. The News, Lahore.
[12] Dani, Ahmad Hassan (2001). *History of Northern Areas of Pakistan upto 2000 A.D*. Sang-e-meel Publication,
[13] Dani, Ahmad Hassan (2001). *History of Northern Areas of Pakistan upto 2000 A.D*. Sang-e-meel Publication, Lahore.
[14] ibid

1.8. DOGRA RULE

In 1839, Dogra commander Zorawar Singh Kahluria defeated Balti forces in battles at Wanko Pass and Thano Kun plains, clearing his path for invasion of the Skardu valley. He seized Skardu Fort on behalf of the Dogra Kingdom based in Jammu. Singh's forces massacred many the garrisons' defenders, and publicly tortured Kahlon Rahim Khan of Chigtan in front of a crowd of local Balti's and their chiefs. Dogra forces failed in their 1841 attempt to conquer Tibet. Following their defeat, Ladakhis rose in rebellion against Dogra rule. Balti's under the leadership of Raja Ahmed Shah soon also rose in rebellion against the Dogras, and so Maharaja Gulab Singh dispatched his commander Wazir Lakhpat to recapture Skardu. His forces were able to convince a guard to betray the garrison by leaving a gate unlocked, thereby allowing Dogra forces to recapture the fort and massacre its Balti defenders. The Raja of the Balti's was forced to pay an annual tribute to the Dogra Maharaja in Jammu, while the fort's provisions were provided for by the Balti Raja.

Following the Dogra victory, Muhammad Shah was crowned Raja of Skardu in return for his loyalty to the Jammu crown during the rebellion and was able to exercise some power under Dogra administration. Military commanders held real governing power in the area until 1851 when Kedaru Thanedar was installed as a civilian administrator of Baltistan. During this time, Skardu and Kargil were governed as a single district. Ladakh would later be joined to the district, while Skardu would serve as the district's winter capital, with Leh as the summer capital, up until 1947.[15]

Under the administration of Mehta Mangal between 1875 and 1885, Skardu's *Ranbirgarh* was built as his headquarters and residence. A cantonment and various other government buildings were built in Skardu during this period. Sikhs from Punjab were also encouraged to migrate to Skardu to set up commercial enterprises during this period. The Sikh population prospered and continued to grow - eventually also settling in nearby Shigar and Khaplu.[16]

[15] ibid

[16] Dani, Ahmad Hassan (2001*). History of Northern Areas of Pakistan up to 2000 A.D.* Sang-e-meel Publication, Lahore

1.9. 1947-48 KASHMIR WAR

After the Partition of British India, on 22 October 1947, Pakistan launched a tribal invasion of Kashmir by Pashtuns leading to the Maharaja Hari Singh acceding to India[17]. The Gilgit Scouts, under the leadership of Major William Brown, mutinied on 1st November 1948, bringing the Gilgit Agency under the control of Pakistan.[18] Major Aslam Khan took over the command of the Gilgit Scouts, organized a force of some 600 men from the rebels and local recruits, and launched attacks on the remaining parts of the State under Indian control. Skardu was an important target because Aslam Khan felt that Gilgit could be threatened from there. The Skardu garrison defended by a contingent of 6th Jammu and Kashmir Infantry under the command of Col. Sher Jung Thapa. The initial attack was repulsed, but the city fell into the rebel hands. After holding the garrison for 6 months and 3 days, Thapa and his forces surrendered on 14 August 1948, Pakistan's Independence Day.[19]

1.10. LANGUAGE

Figure 1: LANGUAGE

[17] Afridi, B.G. (1987). "*Baltistan in History*".Emjay books international Peshawar Pakistan.
[18] Malik, Iftikhar (2008). *Arz-e-Shumal Ka Manzar Nama*. Habib Publishers, Gilgit
[19]Ibid.

The Balti Language is based on Tibetan and had its own alphabets, which in course of time, became extinct due to the conversion of Baltistan to Islam and spread of Persian script in the land subsequently. The change of religion went a long way in introducing some changes in the language. In this connection Vinge's account may be reproduced usefully. He says, "The language of Little Tibet differs considerably from that of Ladak. Arabic letters are often used in their names, and more Arabic words than Persian; but not much of either, and still less of Turki; and I was told that a Ladaki and a Balti, meeting from the distant verge of their respective countries, would have some little difficulty in understanding each other. In the language of Tibet, generally, there are thirty simple letters, out of which fifteen different sets are formed, which may be used with a prefix of some other letter, as the aspirate, for instance, is a prefix to any vowel. The word RGylfo, already mentioned, has a prefix of the letter R, which is rapidly sounded as if it were part of the G. In this manner are formed two hundred and nine combinations of letters.[20]

1.11. TRADITIONS TO CELEBRATE BALTI WEDDINGS

The Balti's are very conservative in the observance of their long established customs. These customs are so deep rooted by continuous observance that these now have the force of law. Any digression or deviation from any of these customs is looked down upon and condemned by the society. Sometimes the breach of any rule of customs by any member of the community is followed by social boycott and his expulsion from the society.[21]

Customs in respect of celebrating marriages are also very rigid and inflexible. It has been noticed that on many occasions the parents of the bride / bridegroom sold their immovable property in order to fulfil some customs involving heavy expenditure. (Afridi, 1984).

Different tribes and families follow their own matrimonial customs and marriage customs differ from one family to another. The entire population being Muslim, marriage contracts are governed by Muslim personal law but the celebration of marriages is regulated by different customary rules followed by different classes of people: -

a) The Rajas / Jagird ars of Baltistan

b) The Wazirs and Trukchus

[20] Afridi, B.G. (1987*). "Baltistan In History"*.Emjay books international Peshawar Pakistan
[21] Ibid.

c) The Kashmiri's.

d) The common Balti's. (Afridi, 1984)

1.12. GEOLOGY

Skardu is located along the Kohistan-Ladakh terrane, formed as a magmatic arch over a Tethyan subduction zone that was later accreted onto the Eurasian Plate.[22] The region has low seismic activity compared to surrounding regions, suggesting that Skardu is located in a passive structural element of the Himalayan thrust. The stone in the Skardu region is Katzara schist, with a radiometric age of 37 to 105 million years. Numerous complex granitic pegmatites and a few alpine. Cleft metamorphic deposits are found in the Shigar Valley and its tributaries Shigar Valley contains the Main Karokoram Thrust separating the metasediments (chlorite to amphibolite grade) on the Asian plate from the southern volcanoclastic rocks of the Kohistan-Ladakh Island arc.[23]

1.13. LOCATION STATUS

Skardu's Airport is situated at an elevation of 2,230 meters (7,320 feet) above sea level, though the mountain peaks surrounding Skardu reach elevations of 4,500–5,800 meters (14,800–19,000 feet).[24] Upstream from Skardu are some of the largest glaciers in the world, including the Baltoro-Glacier, Biafo-Glacier, and Chogo Lungma-Glacier. Some of the surrounding glaciers are surrounded by some of the world's tallest mountains, including K2, the world's second tallest mountain at 8,611 meters (28,251 feet), Gasherbrum at 8,068 meters (26,470 feet), and Masherbrum at 7,821 meters (25,659 feet)[25]. The Deosai National Park, the world's second highest alpine plain, is located upstream of Skardu as well. Downstream from Skardu is located the Nanga Parbat mountain at 8,126 meters (26,660 feet).[26]

1.14. SKARDU CLIMATE

Skardu features a cold semi-arid climate (Köppen climate classification *BSK*). The climate of Skardu during the summer is moderated by its mountain setting; the intense heat

[22] Khan. Et al., (2012) "*People Perception about Climate Change and Adaptation in the Arid Region of Pakistan".* Peshawar: Institute of Geography, Urban and Regional Planning University of Peshawar KPK, Pakistan.

[23] ibid

[24] S. B. Cheema, G. Rasul, & D. H. Kazmi, *Evaluation of Projected Minimum Temperatures for Northern Pakistan.* Pakistan Journal of Meteorology, (2011) 63-70.

[25] Dani, Ahmad Hassan (2001). *History of Northern Areas of Pakistan up to 2000 A.D.* Sang-e-meel Publication, Lahore.

[26] ibid

of lowland Pakistan does not reach it. (Skardu climate data, 2014). The mountains block out the summer monsoon, and summer rainfall is thus quite low. However, these mountains result in very severe winter weather. During the April-to-October tourist season, temperatures vary between a maximum of 27 °C (81 °F) and a minimum (in October) 8 °C (46 °F). (Skardu climate data, 2014). Temperatures can drop to below −10 °C (14 °F) in the December-to-January midwinter period. The lowest recorded temperature was −24.1 °C (−11 °F) on 7 January 1995. (Skardu climate data 2014).

Climate data of Skardu													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Record high c (F)	13.9 (57.0)	16.7 (62.1)	24.0 (75.2)	29.6 (85.3)	34.4 (93.9)	40.0 (105.8)	41.0 (105.8)	41.0 (105.8)	38.2 (100.8)	31.2 (88.2)	22.9 (73.2)	16.2 (61.2)	41.0 (105.8)
Average high *c (F)	3.2 (37.8)	6.1 (43.0)	12.4 (54.3)	18.8 (65.8)	23.4 (74.10)	28.7 (983.70)	31.6 (88.90)	31.2 (88.2)	27.2 (81)	20.4 (68.7)	13.2 (55.8)	6.5 (43.7)	14.9 (588)
Average Low*c (F)	-8.0 (17.6)	-4.4 (34.1)	1.5 (34.7)	6.6 (43.9)	9.7 (49.5)	13.4 (56.1)	16.4 (61.5)	16.0 (60.8)	11.4 (52.5)	4.3 (39.7)	-1.9 (28.6)	-5.6 (21.9)	4.1 (39.4)
Record Low *c (F)	-24.1 (-11.4)	-20.0 (-4.0)	-13.5 (7.7)	-1.1 (30.0)	0.4 (32.7)	4.0 (39.2)	7.5 (45.5)	7 (44.6)	2.6 (36.7)	-4.2 (24.4)	-9.5 (14.9)	-17.2 (1.0)	-24.1 (-11.4)
Average rainfall mm (inches)	27.5 (1.08)	25.9 (1.02)	36.9 (1.45)	31.3 (1.23)	25.3 (1)	9 (0.35)	9.8 (0.39)	12.2 (0.48)	9.3 (0.37)	7.3 (0.29)	5.6 (0.22)	16.3 (0.64)	172.7 (6.80)
Average relative humidity (%) (at 17:00 PST)	**64.3**	**52**	**34.9**	**25.6**	**24.6**	**22.3**	**27.3**	**30.7**	**29.9**	**31.2**	**36.6**	**56.2**	**29.6**

***Table 1:* CLIMATE DATA OF SKARDU**

Temperatures can fall below -10 ° C (14 ° F) all through the winter months of December- January.

1.15. SATPARA DAM

Satpara Dam is a medium-size multi-purpose concrete-faced earth-filled dam located downstream from Satpara Lake on the Satpara Stream approximately 4 km from the town of Skardu in Gilgit-Baltistan.[27] Total area of Satpara Lake is (93000AF), having installed capacity of 17.36 MW of hydroelectricity, supplies power to approximately 30,000 households in the Skardu Valley, irrigates 15,536 acres (62.87 km2) of land and supplies 3.1 million gallons per day (13 cusecs) of drinking water to Skardu city. Main source of water is melting ice of the Deosai plains during the summer seasons.[28] To increase the storage capacity of the main dam, diversion of Shatung Nullah was also included in the original scope of the project. Complete irrigation system and power houses were designed as per original scope having Shatung Nullah one of the main components. Dams provide a range of economic, environmental, and social benefits, including recreation, flood control, water supply, hydroelectric power, waste management, river navigation and wildlife habitat.

The Satpara Dam development project on the Satpara Lake was inaugurated in 2003. It was completed in December 2013. It is 6 km (4 mi) south of Skardu city and is at an elevation of 2,700 meters (8,900 ft.) from mean sea level.[29] The main source of water is melting ice of the Deosai plains during the summer season. Now Satpara Dam provides drinking water to the whole city of Skardu and agricultural water to major areas of Skardu, for example, Gayoul, Newrangha, Khlangranga, Shigari Khurd. It is a multipurpose project, which will produce 17.36 megawatts hydro generation, irrigate 15,000 acres (61 km^2) of land and provide 13 cusecs drinking water daily to Skardu city.

1.16. SKARDU REGION

Skardu is one of 14 Pakistani controlled territories in Gilgit-Baltistan. Skardu district is encircled to the east by Ghanche District, to the south by Kharmang District, to the west by Astore District, to the north by Rondu District, and to the north by Shigar District. The central command is the town of the Skardu, which is a section-level camp.

[27] WAPDA, 2010.Sadpara Dam project, Pakistan water and power development authority.
[28] ibid
[29] WAPDA, 2010.Sadpara Dam project, Pakistan water and power development authority.

1.17. EDUCATION

According to Alif Ailaan Pakistan Constituency Education Rankings 2015, Skardu District positions in fourteen of the 148 districts up to the level of teaching. In terms of office and structure, the region is graded 89th out of 148.[30]

1.18. MAJOR CITIES

The most important cities in the Skardu area are: Mehdiabad, Hussain Abad Skardu, Parkutta, Satpara, Rondu Valley, Sermik valley, and Skardu.[31]

1.19. CENSUS

The people of the Skardu region dominate the majority of the Shia Muslim community, 98% of who are Shia, 2% belong to the Norbakshi church, and 2% belong to the Sunni sect.[32]

1.20. FRUITS

Dry Fruits and nuts are extensively grown through the region, together with cherries, mulberries apples, apricots, pears, plums, grapes, almonds and walnuts.[33]

1.21. VEGETABLES

Like tomatoes, peas, beans, carrots, onions, capsicum, turnips, potatoes, spinach are also created.

1.22. CASH CROP CEREALS AND CORN CROPS:

Money crops such as potatoes, peas and sorghum have been used and exported. Exports of new managed products and minor repairs have increased over time since a government official worked with.

[30] Malik, Iftikhar (2008). Arz-e-Shumal Ka Manzar Nama. Habib Publishers, Gilgit
[31] Qalbi. Wazir Ali *Qadam Baltistan,* Sode Publications 2002,
[32] Endreson, R. T. (1998). *History, Folklore and Culture of Gilgit Baltistan*. Oxford University Press, London.
[33] Dani, Ahmad Hassan (2001). *History of Northern Areas of Pakistan upto 2000 A.D.* Sang-e-meel Publication, Lahore.

CHAPTER-02: CLIMATE CHANGE-GLOBAL, REGIONAL AND LOCAL

2.1. CLIMATE (DEFINITION)

1. Climate is the normal climate in a given region throughout a more drawn out timeframe. A depiction of an environment remembers data for, e.g., the normal temperature in various seasons, precipitation, and daylight. Likewise, a depiction of the (possibility of) limits is frequently included. Environment, states of the air at a specific area throughout an extensive stretch of time; it is the drawn out summation of the barometrical component (and their varieties) that, throughout brief time frame periods, comprise climate. These components are sun powered radiation, temperature, dampness, precipitation (type, recurrence, and sum), air pressing factor, and wind (speed and direction).[34]

2. Climate is the drawn out normal of climate, regularly arrived at the midpoint of over a time of 30 years. All the more thoroughly, it is the mean and inconstancy of meteorological factors over a period traversing from months to a long period of time[35] A portion of the meteorological factors that are normally estimated are temperature, stickiness, climatic pressing factor, wind, and precipitation. From a more extensive perspective, environment is the condition of the segments of the environment framework, which remembers the sea and ice for Earth. The environment of an area is influenced by its scope, territory, and height, just as close by water bodies and their flows.[36]

    1. Climate: the state of a nation or spot about temperature, dampness.

2.2. ENVIRONMENTAL CHANGE (DEFINITIONS)

1. Climate change is the variety in worldwide or local environments over the long run. It reflects changes in the inconstancy or normal condition of the air over the long haul scales going from a very long time to a long period of time. These progressions can be brought about by measures inward to the Earth, outside powers (e.g., varieties in daylight force) or, all the more as of late, human exercises. In

[34] Rasul. G., (2012). *"Climate Data and Modelling Analysis of the Indus Eco region".* WWF – Pakistan.
[35] *Khan. Et al., (2012) "People Perception about Climate Change and Adaptation in the Arid Region of Pakistan".* Peshawar: Institute of Geography, Urban and Regional Planning University of Peshawar KPK, Pakistan
[36] Rasul. G., (2012). "*Climate Data and Modelling Analysis of the Indus Eco region*". WWF – Pakistan.

ongoing use, particularly with regards to ecological strategy, the expression "environmental change" frequently alludes just to changes in present day environment, remembering the ascent for normal surface temperature known as a dangerous atmospheric devation. Sometimes, the term is likewise utilized with an assumption of human causation, as in the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC employments "environment fluctuation" for non-human caused varieties.[37]

2. Earth has gone through intermittent environment shifts before, including four majors' ice ages. These comprise of frosty periods where conditions are colder than ordinary, isolated by interglacial periods. The aggregation of snow and ice during a cold period expands the surface albedo, reflecting a greater amount of the Sun's energy into space and keeping a lower air temperature. Expansion in ozone harming substances, for example, by volcanic movement, can expand the worldwide temperature and produce an interglacial period. Proposed reasons for ice age periods remember the places of the mainland's varieties for the Earth's circle, changes in the sun powered yield, and volcanism.[38]

3. Climate change has arisen as another worldwide test and postures exceptional dangers to the social and normal frameworks across the globe. It is described by long haul shifts in climate designs because of varieties in temperature and precipitation levels. These progressions step by step sway the equilibrium of normal and human frameworks prompting more continuous disastrous occasions including floods, dry spells, ascend in ocean level, ice sheet dissolving, and change in precipitation designs. Logical proof tells that environmental change is being driven more by human instigated ozone depleting substances produced into the climate, especially after the mechanical transformation. With ascend in temperatures; dissolving of icy masses is probably going to be additionally sped up, bringing about expanded progression of water in streams and, ultimately, lack of freshwater accessibility over the long haul. The underlying flood in stream water will wind up in oceans, bringing about ocean levels by 18 – 36 cm for low outflow situations and 26 – 59 cm for high discharge situations. In corresponding with the

[37] IPCC (2001) *Special Report on Emissions Scenarios, IPCC Working Group III,* Intergovernmental Panel on Climate Change.
[38] Ibid.

ascent in progression of water, the precipitation is probably going to increment from mid of the century with incessant and serious precipitation occasions. Industrialized and agricultural nations the same are hoping to be influenced from the aftermaths of rising temperatures and a dangerous atmospheric deviation.[39] Nations across the world are consequently meaning to devise methodologies and make fundamental moves towards environmental change transformation and moderation for a free from any danger future. It is around the world perceived that mountain biological systems are among the most powerless against environmental change. These weaknesses are probably going to be strengthened because of lopsided warming in mountain regions; and especially so in Gilgit-Baltistan that is one of the profoundly sloping and glaciated areas of the world external the Polar Regions. [40]

2.3. GLOBAL CLIMATE CHANGES

Fifth Intergovernmental Panel on Climate Change Panel Report (IPCC, 2013) showed that the worldwide mean surface temperature has expanded by 0.84°C since 1880. This has prompted a worldwide danger, for example environmental change, bringing about significant financial and biological effects, particularly in the mountain area. The world's mountains are focal points of biodiversity and give climatically unique life zones across short rise distances. [41]Around 10% of the total populace straightforwardly relies upon mountain assets for their vocation and prosperity the precipitous districts have considerable.

The land use change acquires various changes climatic example. In addition to high-level deforestation promotes declining rainfall and global warming on a global scale, hence it changes the global climate model. The size of this change is very large and not very pleasant so it is strongly associated with the management of the ecosystem and all networks that use common assets. Biodiversity is currently considered to be a major global change (Sala et al., 2000). Since the principal "Intergovernmental Panel on Climate Change" (IPCC) it has been seen that earth worldwide temperature has been expanding a direct result of environmental change, which is more perilous for overall biodiversity. The altitudinal

[39] N. Nikolaishvili, and L. Matchanariani, (2011) *Impacts of Climate Change on Georgia's Mountain Ecosystems. Climate Change Impacts on High-Altitude Ecosystems*. Springer International Publishing, 245-274.
[40] Din, K., Tariq, S., Mahmoud, M. and Rasul, G. (2014), "*Temperature and precipitation: GLOF triggering indicators in Gilgit-Baltistan Pakistan",* Pakistan Journal of Meteorology, Vol.10No.20, pp.39-56.
[41] Corner, C. (2004), "*Mountain Biodiversity, its causes and function*", Ambo, Vol.13, pp.11-17.

appropriation of vegetation is required to move to higher height and a few animal varieties with climatic reaches restricted to mountain ridges perhaps will become terminated in light of vanishing of their natural surroundings or decreased relocation potential. Mountain Regions are considered as delicate environment. Environmental Change addresses significant dangers to the biological systems trustworthiness and worldwide biodiversity. The outcomes of these climatic changes contrarily affect the quantity of untamed life and other regular environments Mountains have the most delicate environment on the planet.[42] Change in the worldwide temperature and nearby precipitation may altogether change the altitudinal scope.[43]Of some cornerstone species existing in the various scopes of sloping regions and make more weights on the delicate biological system of bumpy regions. It is hard to appraise the specific impact of environmental change on rocky regions in light of the questions related with the environment situation and furthermore the presence of nonlinear criticism and the information hole between the effects.[44] Many examinations show that mountain environments are more powerless against environmental change. Environmental change in rugged biological systems is generally observable in the spaces like a Boundary Ecosystems ("Eco cline") or at Eco tones, where two biological systems are meeting. Species can react either by moving or however transformation.

Over the past several decades, the catastrophic destruction of the earth has led to the formation of contracts far beyond the vast expanse of the cryosphere, with severe damage from ice sheets and ice sheets, decreased ice cover and Arctic Sea degree and size, and increased permafrost temperatures.

The weaknesses of different areas to environmental change have been featured and proper transformation activities explained. These cover activities to resolve issues in different areas like water, horticulture, ranger service, seaside regions, biodiversity, wellbeing and other weak environments. Despite the way that Pakistan's commitment to worldwide ozone depleting substance (GHG) emanations is tiny, its job as a mindful individual from the worldwide local area in fighting environmental change has been

[42] Becker, A. and Bugmann, H. (eds.), 1997*: Predicting Global Change Impacts on Mountain Hydrology and Ecology: Integrated Catchment Hydrology/*Altitudinal Gradient Studies. IGBP Report 43, Stockholm
[43] Schild, A. (2008), *"ICIMOD's position on climate change and Mountain System"* Mountain Research and Development,Vol.28Nos3/4,pp.328-331.
[44] Becker, A. and Bugmann, H. (eds.), 1997: *Predicting Global Change Impacts on Mountain Hydrology and Ecology: Integrated Catchment Hydrology*/Altitudinal Gradient Studies. IGBP Report 43, Stockholm

featured by giving due significance to relief endeavors in areas like energy, ranger service, transport, businesses, metropolitan arranging, agribusiness and domesticated animals.[45]

It is for all intents and purposes sure that the worldwide sea has warmed unabated since 1970 and has taken up over 90% of the overabundance heat in the environment framework. Since 1993, the pace of sea warming has dramatically increased. Marine warmth waves have likely multiplied in recurrence since 1982 and are expanding in power. By retaining more CO2, the sea has gone through expanding surface fermentation. A deficiency of oxygen has happened from the surface to 1000 meters. Worldwide mean ocean level (GMSL) is ascending, with speed increase in late a very long time because of expanding paces of ice misfortune from the Greenland and Antarctic ice sheets, just as proceeded with glacial mass misfortune and sea warm extension. Expansions in hurricane winds and precipitation, and expansions in outrageous waves, joined with relative ocean level ascent, intensify outrageous ocean level occasions and beach front risks.[46]The Cryosphere and hydrological-related changes have affected landscapes and freshwater and mountainous terrain and Polar Regions with the discovery of freshly covered ice, changes in ice cover, and ice fragmentation. These advances add to the change in the occasional exercise, quantity, and distribution of plant and animal species that are important for environmental, social and economic, non-disruptive environmental influences, and a viable ecosystem.

Since about 1950 many marine species in various circles have undergone changes in landing and occasional exercise due to ocean temperatures, sea ice changes and biogeochemical changes, such as oxygen depletion, to their natural habitat. This has led to changes in biodiversity, abundance, and the formation of biomass in areas, from the equator to mines. Modified interactions between species affect nature and function. Other marine species are affected by both the effects of fishing and environmental changes.[47]

Beach front biological systems are influenced by sea warming, including strengthened marine warmth waves, fermentation, loss of oxygen, saltiness interruption and ocean level ascent, in mix with unfriendly impacts from human exercises on sea and land. Effects are

[45] Becker, A. and Bugmann, H. (eds.), 1997*: Predicting Global Change Impacts on Mountain Hydrology and Ecology: Integrated Catchment Hydrology*/Altitudinal Gradient Studies. IGBP Report 43, Stockholm
[46] B, M., Diaz, H. F., and Bradley, Reniston. S., 1997*: Climatic change at high elevation sites; a review.* Climatic Change, 36, 233 – 251.
[47] Harmeling S (2014) *Global climate risk index*, 2012, Germanwatch. Retrieved http://germanwatch.org/klima/cri.pdf

as of now saw on territory region and biodiversity, just as environment working and administrations.[48]

Since the mid-twentieth century, the contracting cryosphere in the Arctic and high mountain regions adversely affects food security, water assets, water quality, livelihoods, wellbeing and prosperity, foundation, transportation, the travel industry, and amusement, just as culture of human social orders, especially for Indigenous people groups. Expenses and advantages have been inconsistent circulated across populaces and areas. Variation endeavors have profited with the consideration of Indigenous information and neighborhood information. Changes in the sea have affected marine environments and biological system administrations with provincially different results, testing their administration. Both positive and adverse consequences result for food security through fisheries, neighborhood societies and livelihoods, and the travel industry and diversion. The effects on environment administrations have adverse ramifications for wellbeing and prosperity, and for Indigenous people groups and neighborhood networks.[49]

Waterfront people group are presented to different environment related risks, including typhoons, outrageous ocean levels and flooding, marine warmth waves, ocean ice misfortune, and permafrost defrost. A variety of reactions has been executed around the world, generally after outrageous occasions, yet in addition some fully expecting future ocean level ascent, e.g., on account of enormous framework.[50]

2.3.1. CLIMATE CHANGE IN AFGHANISTAN

One of the utmost susceptible countries in the world to change in climate, and one of the smallest prepared to grip what's coming is Afghanistan. Specialists speak avalanches, tremendous weather, flood, displacement of mass, drought, difference, landslides, and teenager marriages - all of which by now outbreak Afghanistan-are place to deteriorate.[51] There is comparatively small care paid to Change in climate in Afghanistan, where mainstream of Afghans are agriculturalists or get income through agriculture, where the United Nation Environment Program estimations 80 % of skirmish is about water,

[48] GCISC (2009a) Sheikh MM, Manzoor N, Adnan M, Ashraf J, Khan AM., *Climate profile and past climate changes in Pakistan.* Research report no.GCISC-RR-01. Global Change Impact Studies Centre, Islamabad
[49] A. Markham, (1996) *Potential impacts of climate change on ecosystems: a review of implications for policymakers and conservation biologists.* Climate Research, 6 (1996).
[50] Rasul, G. (2010*). An analysis of knowledge gaps in climate change research.* Pakistan Journal of Meteorology, 7(13).
[51] 2007. Decision 1/CP.13 *Bali Action Plan, United Nations Framework Convention on Climate Change* UNESCO, (2012) UN World Water Development Report (New York: United Nations, 2012), p. 823

resources and land. And support help Afghanis survive with the effect of change in climate and drought -associated hardship is frequently too short term or does not take into consideration the genuine wants of Afghanis on the floor, critic say. Temperatures might rise by 50 F by 2100, conferring to Afghan National Environmental Protection Agency and UN Environment, except actions are taken to bound greenhouse gases discharges. Whilst Afghanistan's precipitation level is expected to continue comparatively constant through the termination of 21st century, warmer temperatures will lead to additional evaporation, jeopardizing life-sustaining water assets.[52]

In July 2018 a massif glacier melts too promptly, affecting a natural dam adjoining a glacial lake to rupture. Hundreds of thousand cubic meters of water run down the mountains, causing a landslides that smashed, numbers of homes, olive trees ,schools and fields producing potatoes, wheat and beans.

Summers and spring snow melting of glaciers retains total community living with their cool, fresh water. Except excessively snow melting is lethal, raising the risk of summer drought and springtime's flooding.

Glaciers volume in stretched Himalaya, Hindu- Kush- area is expected for waning by up to 90 % by 2100, rendering to International Center for the Integrated Mountains Development. Summer and the spring snow melting of glaciers keep whole people alive with their fresh, cold water. However too much snowmelt is lethal, raising the risk of summer drought and springtime flooding.[53]

However yet in Kabul, the best established Afghanistan's city, home for hundreds of consulates and forces centers, lots of city inhabitants look their individual struggle for existence. Kabul population has overfed in current years, employing even more stress on possessions, similar to the water. In spite of Afghanistan plenty of rushing rivers and snowy mountains and clean water is an indulgence for various Afghanis, mainly because of war, extensive water mismanagement and corruption. The change in climate forecasts for Afghanistan divulges an increase in temperature that will have intense impacts.[54]

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[52]IPCC (2001*) Special Report on Emissions Scenarios, IPCC Working Group III,* Intergovernmental Panel on Climate Change.

[53]IPCC. (2001) "Climate Change, *the Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change*" Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 881

[54] IPCC (2016) *Special Report on Emissions Scenarios, IPCC Working Group III,* Intergovernmental Panel on Climate Change.

Afghanistan has a distinctive geography and intricate topography, including the glaciated peaks of Hindu Kush mountain ranges and the dry deserts in the south. It has a range of elevations from 250 meters above sea level (as) to over 7,000 meters above sea level (as). Afghanistan's climate ranges from arid to semi-arid, with great temperature differences between the cold and warm seasons, and thru the different elevations. It is a generally dry and distinguishing continental climate, with the Indian subcontinent monsoon carrying some moist oceanic air from the southeast in the summer. The majority of the country practices hot summers and cold winters. Precipitation is inadequate generally to the months between October-May. The scorched deserts receive less than 100 millimeters precipitation in a year and the highlands receive significant precipitation above 1,000 meters, with most of it dropping as snow during the winter. Savannah, shrub land and grassland cover close to 73 percent of the Afghan terrain, and barren or sparse vegetation, ice and snow, 15 percent of the land. This delicate natural environment has been exposed to impacts by public and their cattle for thousands of years. Today there are no parts of the country, apart from high alpine areas, that have not been affected by people. The equilibrium between precipitation and prime production is unwarranted. Poor land administration, together with insecurity, conflict, drought, migration and poverty, has left Afghanistan highly susceptible to land dilapidation and desertification on the country's agricultural yield, food security and water availability.[55]

2.3.1.1. TRENDS

Afghanistan is ranked eighth out of 170 countries for its vulnerability to change in climate over the next 30 years, with 59 percent of the population affected by climate shocks (compared to 19 percent suffering from security related shocks). Overall, Afghanistan mean annual temperature has risen by 1.8C° since 1950, with significant regional variation. In the southern region, the mean yearly temperature has risen by 2.4C°. In the Hindu Kush region, the warming has been around 1C°, and in the eastern region, 0.6C°. Precipitation does not appear to have changed significantly when considered for the whole of Afghanistan.[56] However, spring precipitation has decreased by almost a third, which is significant in a country where the majority of households rely on the rain fed agriculture

[55] Bergström, S., Carlsson, B., Gardelin, M., Lindström, G., Pettersson, A. and Rummukainen, M., 2001*: Climate change impacts on runoff in Sweden - assessments by global climate models, dynamical downscaling and hydrological modelling*. Climate Research 16, 101-112

[56] Beniston, M., Diaz, H. F., and Bradley, R. S., 1997*: Climatic change at high elevation sites; a review.* Climatic Change, 36, 233 - 251

for their living. The primary agricultural production regions in the Central Highlands, East and North are most affected by the decrease in spring precipitation. The decrease was almost 40 percent in the Central Highlands between 1950 – 2010.[57] Winter precipitation has increased in most parts of the country. Afghanistan's National Environmental Protection Authority (NEPA), together with the UN Environment Program (UNEP), used the CORDEX framework and data for its change in climate projections. For the country, which were published in 2016. According to both the optimistic and pessimistic scenarios, the mean temperature increase in Afghanistan will be significant. The optimistic scenario projects a warming of 1.4 C until 2050 and 2.6C until 2100. The pessimistic scenario projects an increase in temperature of around 2" C until 2050 and of 6.3C until 2100. Under both scenarios, the warming will be most severe in the Central Highlands and the Hindu Kush region. A compilation of the key messages for South Asia, taken from the Inter-governmental Panel on climate change 5th Assessment Report, states that the districts in South Asia with poor structure and rapid population growth are areas of full susceptibility, with "extreme events expected to be more catastrophic in nature for the people living in such districts". The Assessment Report categorizes flood damage structure, settlements, livelihoods and water and food deficiencies; and heat-related death as the key climate-related risks for South Asia.

2.3.1.2. IMPACTS

The consequences of warming projected in both the optimistic and pessimistic scenarios developed by NEPA and UNEP will be drastic. A mean warming of 1.5 °C until 2050 will harshly affect energy production, water resources, ecosystems, agriculture, food security and health.[58] The more extreme warming projected by the pessimistic scenario will likely completely change the environment and current ecosystems. The current agricultural system would not be able to adapt to such temperature increases, which would devastate the economy and the food security of the rural majority.[59] Uncertainty for precipitation is higher in comparison to temperature in climate modeling. However, in comparison to the overall annual precipitation for Afghanistan, the decrease in precipitation during the spring months from March to May is statistically significant. The areas most affected by decreased

[57] Ibid.
[58] UNESCO, (2012) *UN World Water Development Report* (New York: United Nations, 2012), p. 823
[59] Xu, J., Grumbine, R.E., Shrestha, A., Eriksson, M., Yang, X., Wang, Y. and Wilkes, A. (2009), "*The melting Himalayas: cascading effects of climate change water*, biodiversity, and livelihoods", Conservation Biology, Vol.23No.3, pp.520-530.

spring precipitation - the North, Central Highlands and the East-are the regions accounting for most of Afghanistan's agricultural production. Combined with increased temperatures, this will have a severe effect on agricultural production.[60]

2.3.2. CLIMATE CHANGE IN IRAN

Islamic republic of Iran lies in the west of Asia. In north it is sea side to the sea of Caspian and boundaries Turkmenistan and Azerbaijan. It is adjoining Turkey and trig in the West. In the country's south is coastal Sea of Oman with Persian Gulf adjoins Afghanistan and Pakistan in the East. Official and principal language is Persian (Farsi). The population in 1994 (the foundation year) was nearly 57 million (now expected at 72 million). Area exposure of different types of climates in Iran is 29 percent is arid, 20 percent semi-arid, 32.5 percent hyper-arid, 10 percent wet (of the cold highlands).[61]

Amongst the Middle Eastern nations, Iran shall practice an upsurge of 2.6 ° C in average temperatures and 35 percent debility in rainfall in the following years. In associate, Iran by entire greenhouse gases (GHG) discharges nearly by 0616,741 millions of ton of CO2 is the initial liable country to climate change in Middle East, and seventh in world. High-level involvement of Iran in discharging of GHG relies upon a noteworthy making of gas, oil, and speedy urbanization constraints for example air temperature of Iran.[62]

The Inter-Governmental Panel on Climate Change evaluations an upsurge in temperature of the Middle East up to 2 ° C in the coming 15- 20 years and above 4 ° C by the end of this century. The datum is combining with deterioration in rainfall by 20 percent Inter-Governmental Panel on Climate Change. Henceforth, the Middle Eastern countries are extremely susceptible to fronting change in climate special effect. Amongst the Middle Eastern republics, Iran shall practice a surge of 2.6 ° C in average temperatures and 35 percent drop in rainfall in the following years. Therefore, the change in climate datum of Iran is starker than the Middle Eastern area.

Numerous scholars have stated that the heat wave will be augmented 30 percent by the conclusion of the century for West Asia and Iran. Consequently, several information perceives a stable fall in yearly rainfall (30 percent). Temporal and spatial tendency of

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[60] IPCC (2016*) Special Report on Emissions Scenarios, IPCC Working Group III,* Intergovernmental Panel on Climate Change.

[61] Schild, A. (2008), "*ICIMOD's position on climate change and Mountain System"* Mountain Research and Development,Vol.28Nos3/4,pp.328-331.

[62] A. Markham, (1996) *Potential impacts of climate change on ecosystems: a review of implications for policymakers and conservation biologists.* Climate Research, 6 (1996) 179-191

rainfall has been broadly considered in Iran by some research fellows. The two tall mountain range of Alborg and Zagros in north and west, respectively, amazingly influence the spatial and temporal patterns of temperature and rainfall.

2.3.3. CLIMATE CHANGE IN INDIA

India is one of the mainly vulnerable country and major greenhouse gas emitter and in the world to predictable change in climate. This country is now suffering with climate change and the effects of climate change, include, drought, severe storms, heat waves, water stress and flooding, allied adverse cost on livelihood and health. With a 01.2 billion but mounting population and reliance upon agriculture, India maybe rigorously impacted with ongoing change in climate. Worldwide climate predictions, known essential suspicions, point out some changes in India's upcoming climate.[63]

Worldwide interpretation of melt glaciers propose that change in climate is well under way in the area, with the glaciers retreating at a usual pace of 10-15 meters per year. If the pace rises, flood is possible in river valley fed by those glaciers, follow by reduced flow, and follow-on in water insufficiency for irrigation and drinking.

All replicas show a tendency of overall warming in average yearly temperature as well as declined range of daily temperature with boosted precipitation upon the Indian sub-continent. A warm of 0.50 C is probable all over India by 2030 (around equal to the heating over the 20th century) and a heating of 02-04 C by the conclusion of the century, with the extreme raise over north India. Augmented warm is probable to lead the upper levels of tropospheric air pollution and ozone pollution in the main cities of India.

2.3.3.1. INCREASED PRECIPITATION

With the monsoon rains-it is possible to come in the shape of rarer rainy time but further time of great rainfall occasions, with growing amount of rain in every episode, primary to important flood. Drizzle-like rainfall that refills soil wetness is likely to decline. Utmost worldwide model recommend that the Indian monsoons will strengthen. Scheduling may be change, producing a drying through growing season in the late summer.[64] Climate models also forecast an before snow melt, which may have an important hostile consequence on agricultural yield. Mounting discharge of sprays from energy manufacture

[63] Hansen-Bristow, K.J., Ives, J.D., and Wilson, J.P., 1988: *Climatic variability and tree response within the forest-alpine tundra ecotone*, Annals of the Association of American Geographers, 78, 505-519.
[64] World Bank (2010a) *Pakistan floods 2010: preliminary damage and needs assessment.* Asian Development Bank/World Bank, Islamabad.

and further sources may quash precipitation, leading to drier circumstances with more smoke and dust from the burning of dry flora, distressing both global and regional agricultural production and hydrological cycles.[65]

Qualms regarding monsoonal variations will distress farmers' choosing which of the crop to plant and the scheduling of plantation, sinking productions. In adding, former seasonal snow melt and diminishing glaciers will decrease river flow required for irrigation. The large section of unfortunate people (including landless agricultural workers and small holder farmers) may be the firmest hit, require government assistance program on a huge scale. Lastly, immigration, particularly from the Bangladesh, maybe stress resources and Bangladesh- India affairs.

The mainly important impact of change in climate will likely contain the following.[66]

2.3.3.1.1. AGRICULTURE

High-output, High-input, agriculture would be negatively affects even as food demand and further agricultural harvest increase because of an growing population and hope for an better standard of livelihood. Thousands of subsistence and small holder peasants will practice hunger and hardship being less able to expect climatic conditions. To a definite extent, trading may reimburse for those deficit.[67]

2.3.3.1.2. WATER

Melting of glaciers may yield more overspill in the short term except less in the long terms and medium terms. More rigorous storms (especially the cyclones) would cause more harm to communications, exacerbate salt water intrusion and livelihoods in storm surge. Changes in the timing of amount and monsoon rains will make the production of foodstuff and other agricultural products more doubtful, still in good-weather time, farmers will be more probable to make decision leading to less yield.

2.3.3.1.3. INEQUALITY EXACERBATION

The wellbeing of those who are affecting by change in climate and who have restricted means to adjust may act as a strength that can throw the governments, foster unrest and

[65] Rasul, G. (2010*). An analysis of knowledge gaps in climate change research.* Pakistan Journal of Meteorology, 7(13).

[66] Khan, B. and Ali, F. (2011), "*Understanding sectoral impacts of climate change on Gilgit Baltistan, regional climate risk reduction project (RCRRP),* UNDP-ECHO initiative, Pakistan".

[67] GCISC (2009a) Sheikh MM, Manzoor N, Adnan M, Ashraf J, Khan AM*., Climate profile and past climate changes in Pakistan. Research report no.GCISC-RR-01*. Global Change Impact Studies Centre, Islamabad

strain communal budgets, nearly one-third of the Indians are tremendously deprived, and the 60 percent rely upon agriculture for their livelihood.[68]

2.3.3.1.4. ENERGY

As India is searching for further ways of energy to meet up growing demands, change in climate alleviation efforts may restrain its use of local and imported oil, coal, and gas, even as expansion of nuclear energy will be sluggish at best and likely to meet opponent. Further non-emitting technology will need technology shift and capability construction.

2.3.3.1.5. MIGRATION

India receive immigrant from a number of countries. Under change in climate conditions, it could be flooded with a lot, mostly from Bangladesh. Such immigration may worsen tension among the two countries as well as putting a sprain on Indian state and central governments. Adaptive capability in India vary by state to state, and socioeconomic status, geographical region studies point to significant factors such as food security, water availability, social and human capital, and the capability of governments (national and state levels) to safeguard its people during harsh times. Where adaptive facility is near to the ground, the prospective is superior for impacts to consequence in displaced community; damage and deaths from, storms heat, floods, and conflicts over assets and natural resources.

2.3.4. CLIMATE CHANGE IN TURKEY

Inter-Governmental Panel on Climate Change, The Fourth Assessment Report indicates that 1 ° C to 2 ° C rise in temperatures of the Mediterranean basin would be detected, that dryness will be sensed in even broader area, and the numbers of incredibly hot days and heat waves would rise in particular in local states. Turkey, on the other side, the usual raise in temperatures is assessed to be about 02.5 ° C to 4 ° C, attainment up to 5 ° C in internal regions and up to 04 ° C in Aegean and Eastern Anatolia. The Inter-Governmental Panel on Climate Change reports and other international and national scientific demonstrating study demonstrate that Turkey in the nearby future will get warmer, more arid and unbalanced in relations of rainfall arrangements[69].

Retreating resources of water, drought, forest fire, ecological degradation and desertification related to these are change in climate impacts that's apparent in Turkey.

[68] India: The Impact of Change in climate to 2030 Commissioned Research Report
[69] UNFCCC (2008) *Report of the conference of the parties thirteenth session, 3–15 December 2007*. Decision 1/CP.13 Bali Action Plan, United Nations Framework Convention on Climate Change

Climate predictions that is conceded out inside the space of the combined Program on Increasing the Capability of Turkey for Adjust to Change in climate, also made alike output to backing other job, representing evident precipitation and temperature increase and a system that can influence all settlements, all monetary zones, climate associated natural calamity risk. The later, in further words, is the modification cycle of the water.[70]

2.3.4.1. RESOURCES OF WATER

Predictions for 2100, proposing that rain shall be pragmatic in its place of snow throughout winter time as a consequence of growing temperature. Similarly, snow shield will melt quicker and adhere superficial overflow. Also, change in the yearly regularity and impact of rainfall arrays will change. Fluctuating rainfall designs from snowfall towards rainfall and quicker melting of snow shields would direct to water deficiencies in high area where agricultural, urban water supply and requirements are synchronized on the base of the snow weight during the course of the year. And this deficiency would hit at times when water claim is at peak.

Such a modification of cycle of water would lead to significant changes in quality and supply of resources of water and effect many climatic-based areas, comprising production of food, wherever water is vibrant. Growing temperature in Turkey as a consequence of change in climate would lead to better summer temperature. Compact precipitation of winter (specifically in the western provinces), more recurrent arid seasons, , loss of surface waters, erosion in marine regions and floods, degradation of soil all of which are straight intimidations to resources of water.[71]

2.3.4.2. AGRICULTURE SECTOR AND FOOD SAFETY

Change in climate will main to changes in temperatures and cycle of water and to recurring changes. This change will inexorably have straight effects on agriculture zone that is straight linked to and measured by the systems. As product of change in precipitation and temperature arrangements, influence region of agriculture pests will increase and quantity of species apprehensive will rise. Change in climate will upset production, sites of production and stock upbringing behavior. The frequency and volume of this ups and downs as well as probability of augmented existence will direct to a greater risk of decline in agricultural return. All of these are straight associated to food security.

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[70] UNESCO, (2012*) UN World Water Development Report* (New York: United Nations, 2012), p. 823

[71] World Bank (2010a*) Pakistan floods 2010: preliminary damage and needs assessment.* Asian Development Bank/World Bank, Islamabad.

A change in climate impact on sector of agriculture is essential for food security as in Turkey agriculture the primacy sector for the socio-economic motives and it where the inhabitant's foodstuff quantity regularly comes after. As a consequence of change in climate impact, quality of water will degrease, quantity of water for agriculture will reduce, ecosystem and biodiversity service will not be protects, pastures will degrade, patterns of sustainable agricultural production will change, stockbreeding actions shall be affected and peasants will find their selves debilitated in conditions of adaptation to change in climate; and all of this will ultimately food safety risk. Change in climate within Turkey is likely to lead to gradually unenthusiastic impacts on soil and resources of water and development of rural area that are vibrant of food safety also food production. For instance, in the Büyük and Gediz the basins of Menderes in the Aegean shoreline, 50 percent fall in the surface water is predictable near the conclusion of this century, foremost to unadorned water deficiencies in settled areas, agriculture, industry. As well, as an outcome of growing temperature and declining resources of water in Mediterranean Area, the tourism sector is probable to be adversely affect. These are long-terms impressions of change in climate. Turkey at present struggling to guard its susceptible water resources and coastal regions and fighting to adjust her agricultural doings to the prevailing climate conditions.[72]

2.3.4.3. BIODIVERSITY, ECOSYSTEM SERVICES AND FORESTRY

In totaling the ever-growing harms in marine ecosystems and terrestrial change in climate will also product in forfeiture of the biodiversity. This shall considerably affect ecosystems, species that are vital for related services and society, ecosystems, wetlands humid soil which store carbon and benthic zones having straight role in variable climate. This is well recognized that dunes and marsh of salt ecosystems give shield against storms. Change in climate, may be with other changes in fertility and along health of forest is now cause variations in geographical dissemination of nearly trees species. Change in climate auxiliary increase the strain on sector such as aqua-production and fishing, and as an outcome of change in climate, there would be further exorbitant impacts and coastal erosions on marine and coastal ecosystem.[73]

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[72] Xu, J., Grumbine, R.E., Shrestha, A., Eriksson, M., Yang, X., Wang, Y. and Wilkes, A. (2009), *"The melting Himalayas: cascading effects of climate change water, biodiversity, and livelihoods",* Conservation Biology, Vol.23No.3, pp.520-530.

[73] A. Markham, (1996) *Potential impacts of climate change on ecosystems: a review of implications for policymakers and conservation biologists.* Climate Research, 6 (1996) 179-191.

2.3.4.4. MANAGEMENT OF NATURAL DISASTER RISK

Magnitude, frequency, countrywide and distribution of natural disasters geographically like drought and floods caused by the changes in cycle of water are likely to amplify. As stated in winter, the growing quantity of water on surface will demand surplus procedures contrary to upgrading of the prevailing infra-structure and floods. Correspondingly, there are areas where the effect of rainfall will rise. Therefore, in urban and rural areas there would be accessible level of risk or flood risks will be high. Rendering to Inter-Governmental Panel on Climate Change, a conceivable climate change in prospect will raise the regularity, length of forests fire and reach in Turkey, subject on the strength and length of the arid and warm seasons. Adjustment activities for forests fire are based on marks converging on mitigation and identification of menaces. Added length of impacts of change in climate is forests fire and these are reflected as year-long perils in Mediterranean, particularly in south. This upsurge is supposed to direct to an extensive of intrusive species, which in reappearance will guide to augmented forests fire influence.[74]

2.3.4.5. PUBLIC HEALTH

Changing climate situations would also have noteworthy influences on human's health. This course has truly ongoing. The further recurrent thrilling climatic occasions become, the further diseases that are related to meteorological conditions would be witnessed and death will rise, for example, a growth in the amount of following extremely hot days will openly influence the acute and elderly health issues in public with persistent cardiovascular diseases. As well, the augmented flood threat as a consequence of change in climate will also upsurge risk of transmissible diseases and have an effect on geographical spreading of such disease. Cumulative human movement through tourism and migration will endorse diseases producing microorganism, vectors with other ailments in new surroundings to where, because of mounting temperatures, they would discover new area to live and different risk will arise. Likewise, change in climate will also lead to grave risk such as infectious diseases transfers by pests.[75]

[74]GCISC (2009a) Sheikh MM, Manzoor N, Adnan M, Ashraf J, Khan AM., *Climate profile and past climate changes in Pakistan. Research report no.GCISC-RR-01.* Global Change Impact Studies Centre, Islamabad

[75] Harmeling S (2014) *Global climate risk index, 2012, Germanwatch*. Retrieved http://germanwatch.org/klima/cri.pdf

2.3.5. CLIMATE CHANGE IN PAKISTAN

South Asia is considered as perhaps the most powerless areas for worldwide environment evolving. In Pakistan there has not been such broad examination completed viewing environmental change and biodiversity when contrasted with different pieces of the world. As Pakistan is a horticultural based country, the nation relies upon the Indus water system framework, as the River Indus is one of the major water transporters in South Asia ascending from the Himalayas and the Tibetan Plateau.[76] The nation is exceptionally helpless against environmental change, consequently enormous floods, dry spell and biodiversity misfortune is normal in future.[77] As per a study directed by Khan et al., nearly 40% of Pakistani people accept that environment is transforming tolerably whilst 60% do accept that it is evolving brutally. Many investigations show that adjustment of environment influences straightforwardly or by implication the entire biodiversity and their territories, prompting their uprooting and in most cruel cases, even elimination. Change in environment additionally influences the seriousness of numerous species by evolving development, demise rates and recovery achievement rates. It is being discovered that adjustment of environment has caused a change in natural surroundings from wet rainstorm woods to savannah.[78] Numerous interesting types of widely varied vegetation are likewise on the edge of elimination because of changing in natural surroundings conditions. Expansions in high temperature and precipitation examples can likewise build woodland creepy crawlies, irritations and weeds which bring about more noteworthy harm to backwoods vegetation, change the species organization and decrease the space of timberland. Internationally the regular biological system has been influenced by current environmental change.[79]

From writing it is discovered that Pakistan is more powerless against environmental change in the coming many years. The greater part of the spaces in Pakistan is showing positive pattern for the period 2011-2050 in temperature and most extreme ascent is normal

[76] Khan, B. and Ali, F. (2011*), "Understanding sectoral impacts of climate change on Gilgit-Baltistan, regional climate risk reduction project (RCRRP),* UNDP-ECHO initiative, Pakistan".

[77] Malik, S.M., Awan, H. and Khan, N. (2012), *"Mapping vulnerability to climate change and its repercussions on", Globalization and Health*, Vol.8No.1, pp.1-10.

[78] Rasul, G. (2010*). An analysis of knowledge gaps in climate change research.* Pakistan Journal of Meteorology, 7(13).

[79] Panhwar MH (1999) *Seepage of water of the river Indus and occurrence of fresh ground water in Sindh. In: Meadows* A, Meadows P (ends) The Indus river biodiversity, resources, humankind. Oxford University Press, Karachi, pp 180–197

in Gilgit-Baltistan likewise, Southern and Central Punjab and lower KPK[80]. The Increase in the pace of temperatures shall expand the warmth wave which is probably going to affect biodiversity and water assets in Pakistan As Pakistan is an agribusiness subordinate country; Change in climate is required to diminish the harvest creation that would greatly affect the occupation of Pakistan.

Concerns about climatic change in Pakistan include the spread of hurricanes, the impact of receding Himalayan waves into the Indus River, declining water levels, declining electricity during the dry season, and adverse events including floods and arid plains. Other potential effects of environmental change include high water pressure; food insecurity due to declining agriculture and livestock; common weeds and weeds; biodiversity decline; blood misfortune; and in the north some biomes flow. Also, high temperatures may affect the organization, circulation and performance of mangroves, and low rainfall may contribute to salt stress.

Pakistan's first international consultation on the United Nations Framework Convention on Change in climate (UNFCCC) provides an account of the environmental standards made using the Greenhouse Climate Temperature Test Model. The State Media has noticed that impact of environmental change upon Pakistanis water supply will probably be important, which will also impact the country power supply; 34 percent of Pakistan energy years depend on hydropower.[81] Environmental changes are probable to have a considerable impact on agricultural sector, with possible consequences as well as exposure to change in crop boundaries, heat stress, and use of water. Environmental change can also affect the caregiver's performance through changes in the wood region, changes in performance, and changes in type and circulation synthesis. Just as the coastal areas of Pakistan, especially the city of Karachi can be affected by sea levels and landslides. Global communication also looks at the potential impact of environmental change on wildlife and biodiversity, as well as the financial implications for social security and food security. [82]

Pakistan is also experiencing a series of major floods and floods due to air and sea temperatures. These times, coupled with rising sea levels, could wipe out maritime urban

[80] Bergström, S., Carlsson, B., Gardelin, M., Lindström, G., Pettersson, A. and Rummukainen, M., 2001*: Climate change impacts on runoff in Sweden - assessments by global climate models, dynamical downscaling and hydrological modelling*. Climate Research 16, 101-112.

[81] GCISC (2009a) Sheikh MM, Manzoor N, Adnan M, Ashraf J, Khan AM., *Climate profile le and past climate changes in Pakistan. Research report no.GCISC-RR-01.* Global Change Impact Studies Centre, Islamabad

[82] IPCC (2016) *Special Report on Emissions Scenarios, IPCC Working Group III,* Intergovernmental Panel on Climate Change

communities such as Badin, Thatta and Karachi. Combined with the reduction of shrinkage and degradation of silk, rising sea level could mean the entry of land into a reservoir within a portion of groundwater. This saltwater disturbance cycle will completely affect the entry of water supplies into the former lakes of Pakistan. Also, the composition of the sea will be mainly affected. Important resources such as Coastal Highway and Gwadar Port may require further insurance. [83]

By addressing these concerns, Pakistan has demonstrated a number of flexible approaches that can be applied to key financial sectors in its Initial National Communication; Additional proposals were developed in 2010 by Task Force's Pakistan on Change in climate. In the international arena, Pakistan has welcomed all submissions by the South Asia Association for Regional Cooperation on environmental change, including the Clamp Announcement of 2010. [84] Also, it is thought that the 2010 floods in Pakistan (far beyond their own experience) have encouraged Pakistani road builders to speed up the process of drafting a social plan and a change in climate plan. Pakistan has successfully expanded its commitment to ensuring its fair contribution of international aid, particularly those achieved through The United Nations. For instance, at the UN General Assembly in the September 2010, Pakistan Minister of Foreign affairs stated, "Environmental change, with all of its seriousness and inequality, has reached 170 million Pakistanis" Weak nations, especially non-industrialized nations" in future UN plans.

Pakistan has experienced catastrophic floods, dry seasons and hurricanes that have killed and destroyed thousands, destroyed jobs and damaged infrastructure. Environmental change suggests that these and other common hazards are likely to increase and worsen in the coming years - clearly that Pakistan is one of the most powerful countries in the fight against the effects of evolution.[85] Change in climate is subject to the worst effects in Pakistan: declining agricultural activity, increased fluctuations in water availability, increased pre-eclampsia attacks and seawater, and increased extreme weather. Addressing these risks requires emphasis on environmental change in community policies and strategies; and intelligent natural interests of structure, organizations, and skills.

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[83] IPCC (2016) *Special Report on Emissions Scenarios, IPCC Working Group III,* Intergovernmental Panel on Climate Change.

[84] Schild, A. (2008), *"ICIMOD's position on climate change and Mountain System"* Mountain Research and Vol.28Nos3/4,pp.328-331.

[85] IPCC. (2001) *"Climate Change, the Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change"* Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 881.

Pakistan is likely to face a major environmental change challenge. The deliberate efforts of public officials and the general public at all levels are needed to prevent these accidents. Over the past 50 years, Pakistan's annual average temperature has risen by 0.5 ° C. The figure of annual warming days has greater than before nearly five times in the last thirty years.[86]Yearly rainfall has exposed high instability but has grown a little over the past fifty years. The sea level beside the Karachi shore has risen by about ten inches recently. Before the ending of the current century, the yearly temperature of Pakistan is likely to rise by 3 °C - 5 °C with a worldwide focus, while worldwide warming could produce an increase of 4 °C - 6 °C.[87]

2.3.6. CLIMATE CHANGE IN GILGIT-BALTISTAN

Nature of the Earth is varying and the effects are feel all over the world. Very small exploration have led to the Himalayas and Karakoram in north of Pakistan in areas of ecological change.[88]Like other hilly areas of the world, ecological change took place in the hilly regions of Pakistan. At Gilgit-Baltistan metrological stations at Gilgit, Skardu, Bunji and Gupis show a total increase in temperatures over the past two decades from 1980 to 2006, and have risen by 0.440 C every several years. Much of the common landscape is unprotected by the Gilgit-Baltistan ecosystem. Gilgit-Baltistan of Pakistan by all accounts is extended by the weather and temperatures show different patterns at different times. It is considered to have more rain than snow. By examining past record points at various GB weather channels, it has been shown that night temperatures are increasing in the North (Gilgit-Baltistan) areas of Pakistan.[89] As shown by a study led by Hussain et al. (, 2005) Extreme temperatures have risen throughout the year, especially in the unequal parts of Pakistan between 1971 and 2000. Change in climate in Gilgit-Baltistan is characterized by low annual rainfall, moderate monthly temperatures, low winter temperatures, and severe signs of coldness in parts of the year. Environmental change is happening in Gilgit-Baltistan. Data taken from various natural channels such as Gilgit, Skardu, Bunji and

[86]Panhwar MH (1999) *Seepage of water of the river Indus and occurrence of fresh ground water in Sindh. In: Meadows A, Meadows P (ends) The Indus river biodiversity, resources, humankind*. Oxford University Press, Karachi, pp 180–197.

[87] GCISC (2009a) Sheikh MM, Manzoor N, Adnan M, Ashraf J, Khan AM., *Climate profile and past climate changes in Pakistan. Research report no.GCISC-RR-01.* Global Change Impact Studies Centre, Islamabad

[88] N. Nikolaishvili, and L. Matchanariani, (2011*) Impacts of Climate Change on Georgia's Mountain Ecosystems. Climate Change Impacts on High-Altitude Ecosystems*. Springer International Publishing, 245-274.

[89] Din, K., Tariq, S., Mahmoud, M. and Rasul, G. (2014), *"Temperature and precipitation: GLOF triggering indicators in Gilgit-Baltistan Pakistan"*, Pakistan Journal of Meteorology, Vol.10No.20, pp.39-56.

Gupisa significant temperature increase was observed during 1980 and 2006 at 0.19 °C every ten years.

Gilgit-Baltistan contains perhaps the most amazing scenes in the world. Three mighty mountains and the world's most powerful Hindu Kush-Karakoram-Himalaya (HKH) at the crossroads. To the west, Gilgit-Baltistan lies the Hindu Kush stands the distance of Karakoram; and the western Himalayas living in the south of Gilgit-Baltistan. Gilgit-Baltistan is located on an area of 72,971 square miles, with about 50% of it comprising mountain peaks, cold cliffs, ponds, and plains. There are fourteen mountain peaks over eight thousand feet (famous as' eight thousand) in the globe, five of which are present in Gilgit-Baltistan.[90]

More than 50 clusters of 7,000 meter live inside a sweep of 500 kilometer in the region. A large cold region stretching more than 15,000 square kilometers contains approximately 5,000 square feet [5,000 sq. m] of land and a layer of snow, including the highest elevation.[91] About 3,000 all kinds and sizes of snow; from which 36-year-old object is dangerous and in a state of chaos in various parts of the world. Although the three main mountains of Gilgit-Baltistan are closely related, one common feature is the difficulty of standing. An important feature of Gilgit-Baltistan is that its biology of mountains and financial structures is among the lowest. Any inequality on each side can put in danger this fragile connection between human and nature. His homeland is one of the glittering regions of the world and is a major factor in change in climate. Cold strength of cold size, surface area, thickness and length means the interaction between the insertion (ice and snow) and the background (melting and reproduction). These components are controlled through temperature, bending, tilt and wind speed. As environmental change occurs, these levels can decrease, bringing about changes in the quantity and function of ice. Ice sheets in many parts of Asia has been declining from 1950, include mountain snow sheets in Gilgit-Baltistan. Evidence suggests that 30% to half of the existing ice sheet is likely to disappear by 2100, if global temperatures rise to a level of 2-4 °C. 150 m. The more moderate the ice size, the faster it will respond to environmental changes. The cold competition will make a big difference in the hydrology of the mountains - as glaciers melt faster, providing

[90] F. Ali, (2010, Dec 2*). Climate change probability in gilgit-baltistan*. Retrieved Feb 1, 2013, from Pamir Times: http://pamirtimes.wordpress.com/tag/climate-change/

[91] Khan. Et al., (2012) "*People Perception about Climate Change and Adaptation in the Arid Region of Pakistan".* Peshawar: Institute of Geography, Urban and Regional Planning University of Peshawar KPK, Pakistan

improved saturation, but as the size of the ice decreases, the total flow / flow of water will decrease. The event will bring critical results to mountain people on crops, agriculture, pastures, biodiversity and hydropower including mountain networks in Gilgit-Baltistan. To have a significant impact on Gilgit-Baltistan and around the world relying deeply on mountainous water resources for housing, energy, agriculture and machinery. Certain changes in climate and temperature can change the farming system. Gilgit-Batista's standard water system, in turn, responds to water shortages across the country. Critical change in climate shall have a significant impact upon the social and financial structures of the nation due to sustainable water prices.[92]

Gilgit-Baltistan unequal networks deal with common assets in the wave area and are relatively weak compared to changes in climate models affecting climate, health, employment and the economy.[93] Common changes in the mountains of Gilgit-Baltistan depends on means horticulture, has a low degree of financial action, and has restricted admittance to social administrations. The aftermaths coming about because of environmental change will intensify its current issues because of its regular settings. [94]

[92] Rasul. G., (2012). *"Climate Data and Modelling Analysis of the Indus Ecoregion"*. WWF – Pakistan.
[93] Hastenrath, S and Greischar, L., 1997. *Glacier recession on Kilimanjaro, East Africa, 1912-89*. Journal of Glaciology 43 (145), 455-459.
[94] Ibid.

CHAPTER-03: WATER RESOURCES MANAGEMENT

3.1. RESOURCE MANAGEMENT

In organizations study, the resources management is effective and efficient progress of organizational resource where necessary. Such resources may include inventory, financial instruments, manufacturing, equipment, or information technology, and natural's resources. In the field of the project management, philosophies, strategies, and process about how to share advanced resources. This includes discussions on effective resource allocation and processes supported by organizations such as Projects Management Institute, through their Project Management Body of Knowledge, approach to projects management. Resources management is a key element in resources evaluation and the human's resource management. Mutually they are important elements of the broad project management system in order to successfully implement and observe the projects. As with major projects management education, there are resources management software tool that simplify the procedure of project resource allocation with portfolio transparency included the provision and need of resources. Purpose of this tool is to ensure that: (1) there are workforce in your organization with particular skills and the required outline of the project, (2) determine the figure of groups and skills fresh employees should employ, and (3) provide staff for many projects. Within consulting organizations and professional services, the efficiency of these processes and tools is often observed by measuring the rate of charged usage.

3.2. PLANNING AND MANAGEMENT OF WATER RESOURCES

"Strategy without tactics is the slowest route to victory; tactics without strategy is the noise before defeat." (Sun Tzu, the Art of War)

The planning and management of water resources is changing. Water management meant enforcing existing rights and adhering to the objectives of the original project.[95] Pakistan is facing a major water crisis. By 2030, experts expect the nation with a mild drought to reduce water pressure into water scarcity. As a result of misuse and overuse, the nation is facing declining water accessibility and quality, rising water pollution and environmental protection in general. Water scarcity is likely to be a major threat to Pakistan's economic performance. [96]

[95] IPCC (2016) *Special Report on Emissions Scenarios, IPCC Working Group III,* Intergovernmental Panel on Climate Change.

[96] Haider G, Prathapar SA, Afzal M, Qureshi AS (1999) *Water for environment in Pakistan. Global water partnership workshop, I*slamabad, Pakistan.

Water is important, be it livelihood, food security, health, or general economic improvement. In Pakistan, as in various other parts of Asia, population expansion, access to social benefits, fast urbanization and changes in consumption and production have put exceptional pressure upon water resources. It is accompanied by institutional failure, inefficiency, and governance that increase the pressure on water use and misuse to create domestic conflicts. Water is often used by communities, nationalities, and regions to express dissatisfaction with management and additional pressure on this important resource. Therefore, understanding water availability, method of distribution, diversity, and demand is crucial in understanding the challenges of water resources management in Pakistan. However, evidence from Gilgit-Baltistan is clear that water shortages and homelessness can lead to ethnic conflicts and lead to political instability that has led to violence. The decline in water quality also lead to almost day by day protests for better services. In a region that is seriously dependent on water for its survival, tackling the problem of water scarcity could increase the serious economic and social risks that have made this region unstable. Proper management of water resources and their use can create a way to build confidence, trust and collaboration between the many water stakeholders. If the level of water was not maintaining the water shortage would be better manage and reduce conflicts.[97]

The emergence of water-related environmental conditions such as floods and drought in the plains and the GLOF in Gilgit-Baltistan, underscores this social divide and highlights change in climate as one of the emerging threats. Domestic water disputes in the country need better understanding in order to develop suitable development strategies. The country is expected to have a water shortage of less than 500 cubic meters / capita / year by 2035.[98] This shocking prediction is based on population growth, procurement management, distribution inequality, and the effect of change in climate.[99]

Water is the foundation of life, livelihood, and productivity, and shortage of access affect not only the human safety but also the social stability. Water availability, like

[97] Khan. Et al., (2012) *"People Perception about Climate Change and Adaptation in the Arid Region of Pakistan".* Peshawar: Institute of Geography, Urban and Regional Planning University of Peshawar KPK, Pakistan.

[98] Din, K., Tariq, S., Mahmoud, M. and Rasul, G. (2014), *"Temperature and precipitation: GLOF triggering indicators in Gilgit-Baltistan Pakistan"*, Pakistan Journal of Meteorology, Vol.10No.20, pp.39-56.

[99] Bhutiyani,M.R.,Kale,V.S.and Pawar,N.J.(2007*),"Long-term trends in maximum, minimum and mean annual air temperatures across the Northwestern Himalaya during the twentieth century",* ClimaticChange,Vol.85No.1-2,pp.159-177.

historically produced conditions, is not just the amount of snow bag or rainfall each year. There is also technology, designed for the public to access services. While the amount of water available is obviously important, community programs designed to access that water have an unequal impact on districts and people who have access to water. The problems of water scarcity are similar to their struggle for poverty and inequality in the distribution of water to regions and between sections of society.

3.2.1. SIGNIFICANCE OF WATER ACCORDING TO THE HOLY QURAN

"We made every living thing from water" (AL Quran)

Water is natural life, and 1 of the consecrations of Allah Almighty. for every capita water obtain ability in Pakistan was 5300 cubic meters at the occasion of independence has condensed to about 1000 cubic meters mostly due to growth in inhabitants. This was the neck and neck where a nation is measured water sparse. In spite for this condition, nation continues consuming the water extravagantly and wasting maximum of it. There was a prerequisite to understand significance of the water and halt for wasting it. The Holy Quran is ample way of life; there are around 63 of verses that totally have words about water. Also, there are quite a lot of Hadiths which intricate the significance of water. Furthermore, the word "Sharia" means sources of water or the mode which lead to the water. In mutually cases, the significance of water is incredibly vibrant.

3.2.2. WATER: THE PRIMARY NEED

The Water is a primary need for each individual. Allah Almighty made the whole thing from water and made all, reliant on water. Our body holds 70 percent of water by weight. We want water for cooking, washing, drinking, and bathing. The least household water requisite / day / capita are about 50 liter (including water for washing, cooking, and drinking). Though, we require much further water to harvest food. For example, on a normal, to produce 1 kg of muesli yields (pulses wheat, rice and many more), it needs about 1,000 liters of water although to produce o1 kilogram of beef, and it needs about 13,500 liters of water.[100]

Correspondingly, a balanced diet /person/ day (including meat, fruit, vegetable) require around 5,400 liters of water and a vegetarian food of the same nutrient value have need of roughly 2,600 liters of water. Consequently, about 70 time further water is utilized to yield

[100] Sharma,E., Molden, D., Rahman, A., Khatiwada, Y.R., Zhang, L.,Singh, S.P.,Yao, T.and Wester, P. (2018), *"Introduction to the Hindu Kush Himalaya assessment",* British Columbia forests. Climatic Change, 34(2), 613-226

food than used for native purposes. Moreover, up to 90 percent of the water used for home purpose comes back in the system in the form of waste-water which can be re-claimed. Nevertheless, 40-90 percent of water use to yield food evaporates which is irreparable failure and could not be improved simply.[101]

3.2.3. GLOBAL TOTAL WATER- FRESH AND SALINE

The total estimated amount of water, on Earth is 11.0x10 MAF (1,360 Mkm3) cover about 70 percent of the earth's surface. About 97.5 percent of this water is saline (97.2 percent contained by oceans and 0.3 percent is ground water) and 2.5 percent or around 35 million km3 is fresh water out of which 31.0 percent comes from ground water. The ground water present in the deep aquifers is static or non-renewable while surface water and ground water present in shallow aquifers is renewable which replenishes annually and is the most important source for human survival. The greater portion of fresh water, about 69 percent is in the form of ice and eternal snow cover in the Antarctica, Arctic and in the mountainous areas. Only about 0.3 percent of the whole amount of fresh water on earth is contained by rivers, lakes, relatively shallow aquifers and soil moisture where it is most easily reachable for economic needs tremendously vital for water ecosystems.

3.2.4. QUANTITY OF WATER

Allah Almighty has gifted amply of water on earth from the time when the establishment of world. This water was stayed at the lowest/depression places on the earth to gather the necessities on the earth up to Day of Doom. This also causes formation of seas and gives existence and dawn to ground water. According to verses of Surah e Hood, the Verse # 07, water is made yet earlier the foundation of earth and reign was also fixed on the water. Imam e Sherani in Kashful- Ghummah said, “Then wind was blown up on the water that created the leather/skin and in this way earth was created”. The position where this skin/leather was created foremost is the place of the Holy Kaaba.[102] Today this water termed as the cycle of water. The water travels in the appearance of vapors and the precipitation banquets it over the snow cover springs, highlands, hills and rivers, in several parts of earth. It is integrated in the composition and creation of several things and lastly returns to its actual source. About totally the old civilizations of the sphere are found adjacent the rivers. Correspondingly, human’s population also remained nearby these rivers

[101]Bandaragoda, D.J.; Rehman, S. Ur. *Warabandi in Pakistan’s Canal Irrigation Systems: Widening Gap between Theory and Practice*; IWMI Books, Reports; International Water Management Institute: Colombo, Sri Lanka, 1995.

[102] Tafseer ul Naeemi, Para # 4, Surah-e- Al-e-Imran, Verse # 96.

and springs. From commencement today, not a single droplet of water has added or condensed in this pool. And we sent down water from the sky in proper measure, then stored it in the earth; and indeed we are able to take it away! So with it we produced gardens of date-palms and grapes for you, in which is abundant fruit for you and you eat there from".[103]

It meaning Allah Almighty gives precipitation according to the procedures which we exercise to water orchards and to drink. The water is refreshed into the soil which forms springs and wells. If Almighty Allah want, not to refresh this into the earth, could take left from men. We produce woods from this water and cultivate countless types of fruit. If there would no rain, we will not get water for drinking and a variety of varieties of fruit.[104] The theory of Aristotle that under-ground networks water spring remains usable for years. Though, contemporary study proved this speculation incorrect. Bertr and Palissy in his famed investigate which was upon the source of the water and artificial/ natural spring, verified that rainfall are the source of the water for spring.

3.2.5. SOURCE OF WATER (RAINFALL)

Bernard Palissy was a foremost that opens "theory of water cycle" in 1580 A.D. Rendering to Palissy, the water evaporates from the sea and transforms into the clouds however cooled and travels reverse to the earth. When condensation takings place in those clouds, its rains. This water all over again reaches to sea while flow via lakes and rivers thus concluding the cycle of water. In the 7thA.DGreek theorist Thales who was from the city of Miletus, gave an idea that wind carries drops of water from sea to earth which bases precipitation. This presumption which was presented in 1580 A.D had already been explained in the Holy Quran in a lot of verses a period ago. Men want to ponder that water we drink from rivers, springs, wells, lakes, from where it derives? It come from rainfall, more or less water drains into rivers, some stowed in reservoirs and maximum of water oozes to the land and makes massive reserve of underground water. We clean it by several ways. In end, rain is a source of water. To whom all sea water belonged? Who has well-ordered the wind to take water vapors into suitable height and finally transforms into water? Who has well-ordered the clouds to befall as rain in a definite mount? Sea water is salty which also has atypical smell and odor. But when rain takes place it is neither odor nor it

[103] Surah Al-Muminoon, Verse 18-19.
[104] Malik, S.M., Awan, H. and Khan, N. (2012), *"Mapping vulnerability to climate change and its repercussions on human health in Pakistan",* Globalization and Health, Vol.8No.1, pp.1-10.

carry saline. It is free from all contaminations. The contaminations in the water because to air pollution or some impurity that come after falling down on earth. Allah has asked to think about water in numerous verses.[105]

3.2.6. SOURCE FOR FOOD – WATER

Men's food requirement depends on the water. If there would not water, there is a not a question about the food. The Holy Quran asks humans being to meditate regarding their foods in this language: "So man must look at his food. That we watered it in abundance. Then we split the earth properly. Thereby we produced grain in it. And grapes and fodder. And olives and date palms. And dense gardens. And fruits and grass. In order to benefit you and your cattle"[106]. Similarly, the foodstuff we obtain is also full-grown by the Allah Almighty. The Allah Almighty shower rain because of which soil get moisture. Growers grow seeds in the soil. Allah grows several crop from the soil. This also comprises each type of fodder for animals and fruit for human. A numeral of verses focus on this topic.

"It is Allah Who created the heavens and the earth, and sent down water from the sky, therefore producing some fruits for you to eat; and subjected the ships for you, that they may sail upon the sea by His command; and subjected the rivers for you. And subjected the sun and the moon for you, which are constantly moving; and has subjected the night and the day for you. And He gave you much of what you seek; and if you enumerate the favors of Allah, you will never be able to count them; indeed man is very unjust, most ungrateful[107]."

3.2.7. BORDER BETWEEN SALINE AND SWEET WATER

Water might be saline and fresh but these stay secluded and do not blend with each other. Nature has employed barrier to distinct them that they could not overlap. This barricade is due to unlike density of water. "And it is He Who caused the two joint seas to flow- one is palatable, very sweet, and the other is salty, very bitter; and kept a veil between them and a preventing barrier".[108]

In Pakistan, other than 90 percent of water for drinking is acquired from underground. This is the water for which Allah Almighty has said that He (Allah) send the

[105] (Zia-ul-Quran Vol. # V
[106] Surah Abbas, Verses 24-32
(Surah Ibrahim, Verses 32-34)[107]
[108] Surah Al-Furan, Verse 53,

water (rain water) into the earth. The ground water of River Indus Basin is saline due to its oceanic geological configuration then this complete area endured part of the sea for millions of year. Presently, the sea withdrew which results in the formation of the Indus plain. The leaching water through canals, rivers, irrigation fields, and water courses has develop a stratum of sweet water upon the saline water. This coating is thick near the rivers and thin when we move away after these rivers.[109]

There is a barricade between saline water and the sweet water termed "saline-freshwater interface". Because of our inefficiency and inability, we distract the saline-freshwater interface and amalgam it by saline water. If this layer of sweet water is pumped out cautiously, we will get sweet water. On the opposing, if the tube well or hand pump is installed below this layer, saline water will be found. In the same way, if the tube well is installing near "saline fresh water interface", primarily we will get freshwater. Nevertheless, later on due to brackish water upcoming, the freshwater in the higher layer will also become salty. We have frequently listened that the water of tube well or hand pump was comparatively fresh in the start but with the passageway of time it became salty. This occurs because of the mingling of yawning salt water into the freshwater. The method of pull out fresh water covering the salty water cautiously is known as "skimming well".[110]

3.2.8. DISADVANTAGES OF OVERUSE AND MISUSE OF WATER

Ground water plays a dynamic role in agriculture centered financial system of Pakistan where above 60 percent of irrigation water necessities are met through it. Also, nearly 100 percent water used in industry and 90 percent drinking water derive from ground-water. The ground-water has played a key role in growing the generally harvesting strength in Pakistan from around 63 percent in 1947 to 120 percent in 2000.[111] Due to inefficient and indiscriminate use of water, there is an excessive pressure on ground-water. The augmented numeral of tube wells and needless use of the water has caused in the debility of ground-water table. As a consequence, not only operational and installation expenditures of these tube wells have augmented enormously but the quality of water has also been worsened. It has been assessed that the ground-water level in various regions of

[109] Haider G, Prathapar SA, Afzal M, Qureshi AS (1999) *Water for environment in Pakistan. Global water partnership* workshop, Islamabad, Pakistan.
[110] Ministry of Water Resources. Pakistan-National Water Policy; Government of Pakistan: Islamabad, Pakistan, 2018. Available online: https://ffc.gov.pk/wp-content/uploads/2018/12/National-Water-Policy-April-2018- FINAL_3.pdf (accessed on 22 January 2020).
[111] IPCC (2016) *Special Report on Emissions Scenarios, IPCC Working Group III,* Intergovernmental Panel on Climate Change.

Baluchistan is decreasing at a rate of greater than three meters/ year. The ground-water in numerous basins in Baluchistan has been pooped completely. Alike situation happens in many areas of Pakistan. Likewise, our future generations have equivalent right on this water. If we remain to waste water in this fashion, our upcoming generations will be destitute of it even for a solo drop of water and surely; they will not recall us in respectable words. Therefore, it is our duty to make effective uses of this valuable water. The effective use of water not only protects water but as well save power.[112]

Allah Almighty says: "Say, what is your opinion - if in the morning all your water was to sink into the earth, then that is such who can bring you water flowing before you?"[113]

Because of inappropriate waste-water organization, the waste-water oozes into the soil along with a lot of heavy metals and chemicals. This similar water we drive for intake which is a core cause of various diseases. Further, this water is correspondingly used in irrigation close the cities devoid of any management. In same way, these metals and chemical pass in into our food chain through crops and soil resulting into numerous diseases such as blindness, urinal and liver cancer, mental stress. Blood pressure and skin cancer.[114]

It is assessed that nearly 40 percent of disease in Pakistan which are produced by intake of contaminated water. We are correspondingly accountable for making water unhygienic. Whereas, Allah Almighty has bless us with the cleanest water as defined in the subsequent verses:

"And it is He Who sent the winds giving glad tidings before His mercy; and we sent down purifying water from the sky. In order that we may revive a dead city with it, and give it to the many beasts and men that we have created, to drink."[115]

Likewise, a lot of surplus water is consumed in industrial unit and waste-water carrying heavy metals and chemicals is drained into waterways, rivers, and canals with no any management. This is not only the waste of water other than also create various environmental glitches. One liter of waste-water contaminates about o8 liters of fresh water and public of other places use this water for drinking purpose – affecting them to hurt from various diseases. At the similar time, the water life is also affected severely.

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[112] Korner, C. (2004*), "Mountain Biodiversity, its causes and function",* Ambio, Vol.13, pp.11-17.
[113] Surah- Al-Mulch, Verse # 30.
[114] *Malik, S.M., Awan, H. and Khan, N. (2012), "Mapping vulnerability to climate change and its repercussions on human health in Pakistan",* Globalization and Health, Vol.8No.1,pp.1-10
[115] Surah Al-Furqan, Verses 48-49.

3.2.9. OUR HOLY PROPHET (PBUH) THOUGHT

"Muslim is whom others is protected from his tongue and hand". "It is not right for Muslim to pollute water. Therefore, he must not urine in it nor pass stool in it. If water is standing he must not take a bath"[116].

He (PBUH) more said: "Never urine in standing water so that you take bath in it".

3.3. WATER MANAGEMENT CONCEPTS AND PROCEDURES

Irrigation is not only a water sector but also a social and political and environmental organization that play a key role in determining economic and social security, food and provide health services to the rural people. Ways to choose the size of the water also depend upon the development objective and the goals of the country. A large area of water can be controlled on the plains or where the development of a forest or pasture is a major goal. In mountainous areas or where major agricultural improvement is planned, the dimension of the wetland is less preferred.[117]

Rain fed agriculture contributes fifty eight percent of the world's food baskets to eighty percent of agricultural countries. Due to global population growth, food production has been increasingly scarce, and this situation continues to worsen with change in climate.[118]Rainfall areas are areas of extreme poverty, malnutrition, the most common land deprivation, poor social and water security and institutions infrastructure.[119] The water expansion program, therefore, is regarded as an efficient tool for address many troubles and is regarded as a locomotive for agricultural development and growth in vulnerable low-lying rain forests.[120] Natural resource management on water scales produces significant benefits in addressing gender issues, protecting the environment, improving health, increasing food production and equality and biological concerns.[121]

3.4. PAKISTAN'S WATER RESOURCES AND CHALLENGES

The overall water situation of Pakistan based on average values, which includes inflow from rainfall, surface water and ground water. The three rivers Indus, Jhelum and

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[116] Saheh-Al-Bukhari

[117] Rasul. G., (2012*). "Climate Data and Modelling Analysis of the Indus Ecoregion*". WWF – Pakistan.

[118] Khan, B. and Ali, F. (2011), *"Understanding sectoral impacts of climate change on Gilgit Baltistan, regional climate risk reduction project (RCRRP),* UNDP-ECHO initiative, Pakistan".

[119] Din, K., Tariq, S., Mahmoud, M. and Rasul, G. (2014), *"Temperature and precipitation: GLOF triggering indicators in Gilgit-Baltistan Pakistan",* Pakistan Journal of Meteorology, Vol.10No.20, pp.39-56.

[120] Rasul. G., (2012). "*Climate Data and Modelling Analysis of the Indus Ecoregion". WWF* – Pakistan.

[121]Rasul, G. (2010). An analysis of knowledge gaps in climate change research. Pakistan Journal of Meteorology, 7(13).

Chenab contribute 137.5 MAF / year, rainfall contribute 6.0 MAF / year and groundwater about 38.1 MAF/year (Ground water contribution has gone up to 50 MAF/year by 2013). But of this volume the water that reaches the agricultural field is 93.3 MAF / year after deducting losses due to evaporation in the open canals and seepage from the unlined canals. Seepage that occurs in the fresh water zone, adds as recharge to the groundwater, which is used for irrigation and is not a loss Almost on the average 32.0 MAF / year is being lost to the Arabian Sea and is a major waste.[122]

Rainfall helps agriculture directly by falling over crop areas, and indirectly by adding its runoff to these rivers and recharge groundwater aquifers. In Pakistan the average annual rainfall ranges from fewer than 4 inches in parts of lower Indus Region to more than 30 inches in the northern foot hills. Seventy-five percent of area in Pakistan receives less than 10 inches, and 20percent less than 5 inches annually, of this rainfall only a small proportion makes any direct contribution to irrigation water supplies; according to one report the figures ranges from 1 to 17 inches / year (on the average about 6 MAF / year). The rest goes away as surface runoff or groundwater recharge.[123]

The main source for the surface water in the dry months for Indus, Jhelum and Chenab is the melting of snow. Snow in the form of glaciers is biggest nature made reservoir since 1 feet of snow hold 1 to 4 inches of water. This surface reservoir is released in summer months staring from mid-March and lasting till mid-July, when monsoon breaks to maintain the river supplies. The rivers carry the melting snow from the northern hills down to the plains where it is used for irrigation. From mid-July to September, the river discharges derive mainly from the rainfall. October to mid-March is the dry season when there is little flow in the rivers, and during this period the reservoirs built on the rivers release their discharge. Reservoir water is essential for the survival of Rabi Crops (November to March) mainly wheat, depends totally on the reservoir storage, like Mangle, Tarbela and Chashma. Diminishing storage volume due to sedimentation is creating severe shortage in surface water supplies and giving rise to disputes between the provinces on the distribution of river waters. The only short and long terms solution is building additional

[122] Bhutiyani,M.R.,Kale,V.S.and Pawar,N.J.(2007*),"Long-term trends in maximum, minimum and mean annual air temperatures across the Northwestern Himalaya during the twentieth century",* ClimaticChange,Vol.85No.1-2,pp.159-177.
[123] Ibid.

dams on these rivers. Building small dams or streams cannot help augment the river supplies in the national canal network.[124]

The farmers, who are suffering from the shortages of canal waters, have turned to ground water which they exploit through tube-wells. However, this is not a healthy sign for water management, since withdrawals have exceeded the recharge, causing mining of water, and serious receding of ground water table. The most important factor is the quality of irrigation water which alone determines whether water is usable or not for crops. While the river water in Pakistan is of excellent quality, all the groundwater found in Pakistan is not usable for irrigation.[125]

It is expected that fresh water demand per capita will increase faster for industry and domestic use. If viable arrangements are not made to capture more water, this share will come from irrigation water; which will further reduce the volume of water needed to produce food for the growing population. Conserving water needs urgent attention to provide operational cushion for water management. We have only a marginal capacity to carry over from the storage of Kharif season to Rabi season when the discharge in the river reduces to a trickle.[126]

Today Pakistan has already reached at the level of Ethiopia and other desert nations of Libya and Algeria; and water shortage is forcing it to become a water scarce nation. Canal diversions have gone down from 106 MAF/year in 1972 to 102 in 2012, whereas water requirement is 202 MAF / year to fully develop the agriculture in Indus plain, which will then grow enough food for a population of 260 million. This can only be achieved if the floods of the Indus system are captured by building a series of dams on the Indus at every feasible site. Floods offer a great challenge and to properly handle them is of vital importance for the economic survival of Pakistan. To address the water shortage in Karachi desalination plants, working on alternate energy sources like solar and wind power, are a

[124] Ministry of Water Resources. Pakistan-National Water Policy; Government of Pakistan: Islamabad, Pakistan, 2018. Available online: https://ffc.gov.pk/wp-content/uploads/2018/12/National-Water-Policy-April-2018- FINAL_3.pdf (accessed on 22 January 2020).
[125] Ibid.
[126] Cumming, S.G. and P.J. Burton, (1996): *Phenology-mediated effects of climatic change on some simulated British Columbia forests*. Climatic Change, 34(2), 213-222.

viable option. Such plants are being used in Saudi Arabia and other countries in the Middle East for providing water for domestic, irrigation and industrial use.[127]

3.4.1. WATERSHED

A watershed, also called a drainage basin or catchment area, is defined as an area in which all water flowing into it goes to a common outlet. People and livestock are the integral part of watershed and their activities affect the productive status of watersheds and vice versa. From the hydrological point of view, the different phases of hydrological cycle in a watershed are dependent on the various natural features and human activities. Watershed is not simply the hydrological unit but also a socio-political-ecological entity which plays a crucial role in determining food, social, and economic security and provides life support services to rural people.[128]

3.4.1.1. DELINEATION OF WATERSHED

Hydro-logically, watershed is an area from which the runoff flows to a common point on the drainage system. Every stream, tributary, or river has an associated watershed, and small watersheds aggregate together to become larger watersheds. Water travels from headwater to the downward location and meets with similar strength of stream, and then it forms one order higher stream as shown in Figure below.

The stream order is a measure of the degree of stream branching within a watershed. Each length of stream is indicated by its order (for example, first-order, second-order, etc.). The start or headwaters of a stream, with no other streams flowing into it, is called the first-order stream. First-order streams flow together to form a second-order stream. Second-order streams flow into a third-order stream and so on. Stream order describes the relative location of the reach in the watershed. Identifying stream order is useful to understand the amount of water availability in reach and its quality; and also used as criteria to divide larger watershed into smaller unit. Moreover, criteria for selecting watershed size also depend on the objectives of the development and terrain slope. A large watershed can be managed in plain valley areas or where forest or pasture development is the main objective.

[127]Sharma,E., Molden, D., Rahman, A., Khatiwada, Y.R., Zhang, L.,Singh, S.P.,Yao, T.and Wester, P. (2018), *"Introduction to the Hindu Kush Himalaya assessment", British Columbia forests. Climatic Change*, 34(2), 613-226

[128] Stephenson, D. B., Chauvin, F., and Royer, J-F., 1998. *Simulation of the Asian summer monsoon and its dependence on model horizontal resolution.* Journal of the Met. Soc. of Japan, Vole 76, 2, pp. 237-265.

In hilly areas or where intensive agriculture development is planned the size of watershed relatively preferred is small.[129]

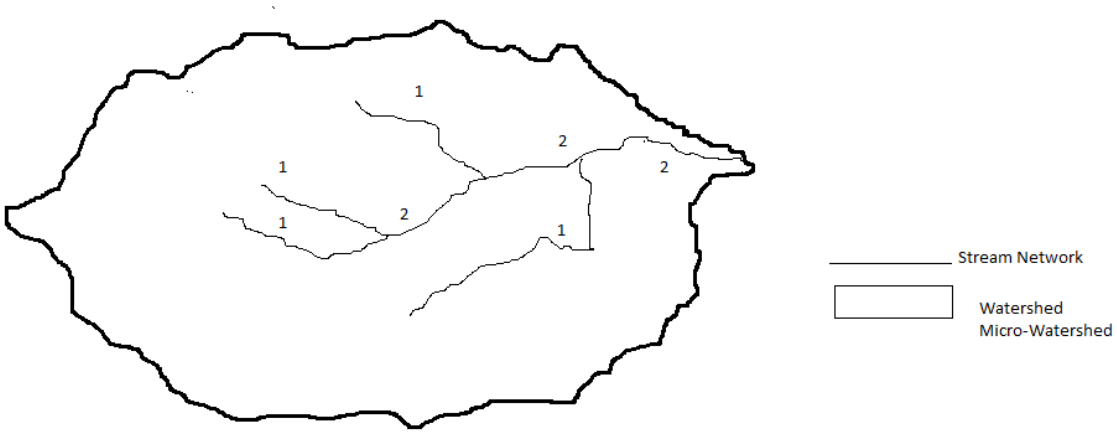

Figure 2: ***DELINEATION OF WATERSHED***

3.5. PAKISTAN WATER RESOURCES MANAGEMENT

The water supply has been increased from 2,961 cubic meters per person in the year 2000. A recent report shows that the current water level is less than 1,000 cubic meters per person, which put Pakistan in a state of elevated pressure. As indicated by the United Nations "Water Development Organization", which can be said to make full use of information from Central Government of Planning and Development of Pakistan, total water availability declined from 1,299 cubic meters per person in 1996-97 to 1,101 cubic meters per person per 2004- 05. Due to rapid population growth, urbanization and industrial growth, the situation is likely to deteriorate. In any case, unnecessary digging of groundwater continues. Apart from the reduction of the water table, yearly growth rate of electric cylinders has shown at 6.7 percent and in diesel tape sources at about 7.4 percent in adding up, growing pollution and disruption of salt water undermine the nation's water resources. About 36 percent of groundwater is supplied with high salinity.

3.6. WATERSHED MANAGEMENT APPROACHES

3.6.1. INTEGRATED APPROACH

Approach suggests the amalgamation of technology within the normal limits of drainage vicinity for best possible development of water, land, and plants resources to gather the essential wants of animals and people in a sustainable way. This move toward

[129] Hastenrath, S and Greischar, L., 1997. *Glacier recession on Kilimanjaro, East Africa*, 1912-89. Journal of Glaciology 43 (145), 455-459.

aims to develop the standard of livelihood of ordinary people by mounting his earning capability by contribution all conveniences required for best possible fabrication.[130]In order to attain its goal, "integrated watershed management" suggest to assume water and land protection practices, water harvest in ponds and recharge of ground-water for growing water resources latent and stress on yield diversification, use of enhanced variety of seed, included nutrient management with integrated pest management practice.[131]

3.6.2. THE CONSORTIUM APPROACH

Consortium approach stresses upon communal action and society contribution together with of non-government organizations, prime stakeholders, administration, and other organization. Watersheds management involves multi-disciplinary expertise and competencies. Simple entrée and appropriate assistance to peasants are essential drivers for the experiential notable watershed impacts.[132] These lead to increase awareness of the farmers and their aptitude to refer with the right people when problems arise. It requires multidisciplinary skill in the field of agronomy, forestry, engineering, animal husbandry, entomology, horticulture, economic social science, and marketing. It is not permanently possible to get all the vital support and skills-set in one institute. Thus, the consortium approach brings collected the expertise of different capacities to expand the efficiency of the various watershed interventions and initiatives.[133]

3.6.3. COMMENDATIONS FOR PRACTITIONERS

- Select watershed spots where dire want exists in terms of improving soil and water preservation, improving productivity and improving the livelihoods.
- Adopt complete and participating consortium approach from the beginning i.e., from assortment of watershed.
- Confirm that ground rules for procedure are made clear to the communal as well as consortium partners.

[130] S. B. Cheema, G. Rasul, & D. H. *Kazmi, Evaluation of Projected Minimum Temperatures for Northern Pakistan.* Pakistan Journal of Meteorology, (2011) 63-70.
[131] ibid
[132] Khan, A.G. (2003), *Northern Areas Strategy for Sustainable Development:* Background Paper on Range lands and Livestock, IUCN Northern Areas Programme, Gilgit.
[133] Khan, A.G. (2003), *Northern Areas Strategy for Sustainable Development: Background Paper on Range lands and Livestock,* IUCN Northern Areas Programme, Gilgit.

- Embrace knowledge-based entry point method to build rapport with the public and ensure touchable economic benefits for the communal.[134]

3.7. EFFECTS OF CLIMATE CHANGE IN PAKISTAN'S WATER SECTOR

The aquatic environment is probably the most affected area by the effects of change in climate. Pakistan has the world's largest Indus Basin Irrigation system, which relies heavily on rain, ice, ice and groundwater. Major water sources are rain during the storm (50 million square meters [MAF] section), and the flow of waterways (142 MAF) to the IRS. Groundwater provides approximately 48% of the surface water that reaches the surface of the water framework. Water is now used for agribusiness (92%), businesses (3%), and home and framework (5%). It is common that over time, the need for water supply has increased due to changing events and population growth.[135]

The streams of waterways have very high peaks at certain times of the year, when the higher streams almost double the streams, and all the streams flowing through the caliphate often replicate the seasonal streams of rabies. Investigations of broadcast streams from 1947-2003 show a decrease in pattern in annual streams. There was a sharp decline especially in the years 1998 to 2003, caused by the constant dry spelling from 1998-2004. The fluctuations of the annual streams are most evident in the Kotri Barrage Rivers where during the normal year, the annual stream decreases from 77.3 MAF to 39.2 MAF. In the post-Kotri / Mangla period, there were 33 ordinary days with zero streams during the rabbinic period. This has a real impact on the Indus Delta areas such as Hyderabad, Thatta, and Badin, where seawater enters agricultural areas, and eliminates the agribusiness framework and quality of groundwater drinking water. [136]

The "Team on Climate Change" in 2010 distinguished some environmental change-related dangers to water security, as follows:

1. Expanded changeability of waterway streams because of an expansion in the inconstancy of storm and winter downpours, and loss of regular repositories as icy masses.

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[134] Ibid.

[135] IPCC (2016) *Special Report on Emissions Scenarios, IPCC Working Group III,* Intergovernmental Panel on Climate Change.

[136] Bandaragoda D J, 1999, ``*Institutional change and shared management of water resources in large canal systems: results of an action research program in Pakistan'',* RR 36, International Water Management Institute, Colombo.

2. Expanded interest for water system water on account of higher vanishing rate at raised temperature in the wake of diminishing per capita accessibility of water assets and expanding in general water interest.
3. Expansion in silt stream because of expanded rates of focused energy downpours, bringing about more fast loss of repository limit.
4. Expanded rates of high-height snow torrential slides and frosty lake upheaval floods (GLOFs) produced by flooding feeder ice sheets hindering principle un-glaciated valleys.
5. Expanded corruption of surface water quality because of expansion in outrageous environment occasions like floods and dry spells.
6. Absence of current information and observing exertion on environmental change impacts in the HKH district, and absence of comprehension and demonstrating capacity about the examples of glacial mass dissolve and precipitation taking care of the IRS and their relating sway on IRS streams.[137]

The effects of weight loss on river discharge due to environmental changes will be of great interest to the Indus basin due to the large size of the discharge from the soft water. This could create many forms of future water supply to the IRS. Western Himalayan ice sheets are expected to be phased out over the next 50 years, first causing the Indus River to expand. At that time, at the same time, glacial mass deposits will not be filled, bringing about 30% to 40% reduction of streams over the next 50 years. Looking at the full spectacle elsewhere in 1997 and 2002, it is estimated that the vast majority of Karakoram people with 40-70 miles [40-70 km] of snow - show a height of 5 to 15 feet [5 to 15 m] at most evacuation sites. This discovery of the impact of ecological change on the Karakoram glaciers and the Indus River is uncertain.[138]

[137] Task Force on Change in climate, 2010.
[138] Bandaragoda, D.J.; Rehman, S. Ur. *Warabandi in Pakistan's Canal Irrigation Systems: Widening Gap between Theory and Practice;* IWMI Books, Reports; International Water Management Institute: Colombo, Sri Lanka, 1995.

CHAPTER-04: UTILIZATION AND SOURCES OF WATER IN SKARDU

4.1. WATER FOR DRINKING

Glaciers and snow deposits are vulnerable to the impacts of climate change. The melted water from glaciers and snow enters streams, which subsequently feed man-made channels that bring water into the settlement for agriculture use, domestic requirements, and livestock.[139] Conventionally rural areas depend mainly on the irrigation channels for the supply of water for domestic purposes and livestock usage. Water from the dug pits generally reserved for drinking and cooking purposes. Water availability during winter is minimum, due to reduced snow and glacier-melt, which affect the quality of stored water. In summers, the water is replenished more frequently.[140]

Urban centers including Gilgit, Skardu and secondary cities receive clean water that is supplied through pipes from a central water storage system which is continuously fed from the nearest natural stream. There is need to promote access to safe drinking water and sewage facilities and ensure proper maintenance involving the beneficiaries of these schemes, create awareness among communities particularly in disaster prone areas to conserve water as much as possible and promote mechanisms for reuse and recycling of wastewater. Furthermore, identification and mapping of drinking water and infrastructure needs in areas that are prone to the impacts of climate change and suggest appropriate measures.[141]

4.1.1. PROVISION OF SAFE DRINKING WATER

The Government of Pakistan recognizes that access to drinking water is a fundamental human right implied in the Constitution of Pakistan under the Article 9, and that it has commitment for provision of safe drinking water to all its citizens. To fulfill the assurance made in the Constitution of Pakistan, the Government of Gilgit-Baltistan, is committed to providing adequate quantity of safe drinking water to the entire population of Gilgit-Baltistan in an affordable, equitable, efficient, and sustainable manner. Safe water is an essential pre-requisite for better health and socio-economic development. The Pakistan's

[139] Keller, F., Kienast, F., and Beniston, M., 2000: *Evidence of the response of vegetation to environmental change* at high elevation sites in the Swiss AlpS

[140] Haider G, Prathapar SA, Afzal M, Qureshi AS (1999).*Water for environment in Pakistan.* Global water partnership workshop, Islamabad, Pakistan.

[141] Muhammad Latif, *"Spatial Productivity along a Canal Irrigation System in Pakistan,"* Irrigation and Drainage 56, no. 5 (2007): 509–21.

Vision 2025 developed in arrangement with the Sustainable Development Goals (SDGs), is striving to eliminate drinking water deprivation of its citizens in an accelerated mode. Water management will be crucial whether the world achieves Agenda 2030, because water is linked to nearly every SDG, and it will be a critical determinant of success.[142]

This research aims to provide an inclusive guiding framework and principles to the Gilgit-Baltistan Government, Local Government and Rural Development Department, relevant government authorities, non-governmental organizations, and private sector to address the key issues and challenges in provision of safely managed drinking water to the citizens of Skardu.[143]

4.1.2. DEFINITIONS

Drinking water referred to in this research, means that the water used for domestic purposes including drinking, cooking, hygiene, and other domestic uses. The terms "safe water" refers to the water complying with National Drinking Water Quality Standards, and the "safely managed drinking water" as defined in Sustainable Development Goals is an improved facility located on premises, water available when needed and free from contamination. "Access" means at least 45 and 120 liters per capita per day of drinking water is available for rural and urban areas respectively, within the house compound or at such distance that the total time required for a round trip to collect water is not more than 30 minutes. "Enabling environment" refers to a set of interrelated sector functions that enable government, public and private partners to engage in a sustained and effective water supply service delivery process. "Reducing inequalities" refers to achieving access for all subgroups within the population, incorporating the needs of women and girls, poor, vulnerable, and differently able groups, and the geographical disparities within districts and settlements. "Water governance" is defined as a set of rules, practices and processes that determines who gets what water, when, and how.[144]

[142] World Bank, Global Facility for Disaster Risk Reduction (GFDRR) (2012) *Disaster risk management in South Asia: a regional overview.* World Bank, Washington, DC
[143] UNFCCC (2008*) Report of the conference of the parties thirteenth session*, 3–15 December 2007. Decision 1/CP.13 Bali Action Plan, United Nations Framework Convention on Climate Change
[144] UNDP, United Nations Development Programme (2008) *Negotiations on additional investment and financial flows to address climate change in developing countries.* An Environment and Energy Group Publication, New York

4.2. SECTOR OVERVIEW

Safe drinking water is a key necessity of human existence and is one of the vital factors for improved health, school attendance and livelihood. Pakistan is ranked 80 out of 122 nations in the maintenance of water quality standards, and water related diseases result in a loss of an enormous amount of national income, which is calculated as US$ 380 to 9934 million losses of the nation's GDP. According to the World Health Organization (WHO) 13.6% of total deaths in Pakistan are attributed to water, sanitation, and hygiene.[145]A recent report published by the World Bank estimated that currently about PRs. 1,390 per capita is being spent on water and sanitation in Pakistan, which is about 1% of GDP. The Government of Gilgit-Baltistan allocated a consolidated budget of PRs. 499.86 million in Annual Development Program 2016-17, and with an increased PRs. 625.68 million for the water and sanitation sector in 2017-18, Annual Development Program. The joint monitoring program of WHO/UNICEF revealed that about 6.5 billion people (89%) use improved drinking water sources that need no more than half an hour per trip to gather domestic water. It is further observed that conditions for access to basic drinking water facilities have been improved during the period 2000-15.[146]In Pakistan, 89 percent of total population has accessibility to at least basic facilities of water for drinking.[147] However, the annual rate of change is negative for basic drinking water supply facilities that confirm a failing condition of drinking water facilities in the country. On the other hand, the national estimates for safe drinking water facilities are dismal. The percentage of the population using enhanced water supply was 38 percent in 2000, while it was estimated at 36 % in 2015 with a considerable fall in improved water supplies.[148] The Government of Gilgit-Baltistan has achieved major improvements in the drinking water sector in recent decades. Gilgit-Baltistan leads in water and sanitation sector when compared with the rest of the country (World Bank, 2010). An estimated 62 per cent of households had access to tap

[145] World Bank (2010a) *Pakistan floods 2010: preliminary damage and needs assessment.* Asian Development Bank/World Bank, Islamabad

[146] UNFCCC (2008) *Report of the conference of the parties thirteenth session,* 3–15 December 2007. Decision 1/CP.13 Bali Action Plan, United Nations Framework Convention on Climate Change

[147] Chaudhary,P.,Rai,S.,Wandi,S.,Mao,A.,Rehman,N.,Chettri,S.andBawa,K.S.(2011), *"Consistency of local perceptions of climate change in the kangchen junga himalaya land scape",* Current Science, Vol.101No.4,pp.504.

[148] World Wide Fund. 2012. *Facing the Future with Confidence Shigar Community Adapts to Changing Environment and Economics.* WWF

water within a reasonable 79 per cent in 2016-17, with a ratio of 95% in the urban areas as well as 76% in the rural areas. However, the situation for safe drinking water is bleak.[149]

As reported by the Gilgit-Baltistan Multi Indicator Cluster Survey (MICS) the most common drinking water source in Gilgit-Baltistan is piped water; available in yards/compounds for 37% and in dwelling areas for 26% of the population. In Gilgit division 89% of the population has accessibility to enhanced drinking water source; in Baltistan division 85% and 56% population in Diamer division have accessibility to enhanced drinking water sources. However, there are variations among divisions with respect to common drinking water sources [150]In Gilgit division 61% population is using piped water as the most common source of drinking water available in yard/compound and in Baltistan division 37% population use piped water into dwellings. In the Diamer division 39% of the population use unprotected water sources including rivers, streams, lakes, ponds, canals, and irrigation channels as most common sources for drinking purposes. Lowest in Gilgit division, only 17% population relates to piped water facility into dwelling as compared to 23% in Diamer division and 37% in Baltistan division. Significant variations also found among districts related to coverage and use of improved drinking water sources. In Hunza district 97% population use improved drinking water sources as compared to Diamer district where only 47% population has accessibility to enhanced safe drinking water source. The accessibility of water at premises is related with larger use, better health and better family hygiene and livelihood outcome. If the water source is located at more than 30 minutes required time for a round trip, it has observed that household carry comparatively fewer water and are probably to consume less water thus compromising minimal basic drinking water needs.[151] Generally, compared to the urban areas, a higher proportion of households in rural areas spend additional time to collect drinking water from distant water sources.[152]As MICS reported, divisional variations exist in applying water treatment methods at the family circle level. The use of water treatment ways inside the household is calculated almost zero in the Diamer division compared to 14% in the Gilgit division. Among total interviewed households who use unimproved water

[149] Pakistan Meteorological Department, 2009*, Climate Change indicators of Pakistan*, Technical Report No. PMD-22/2009, August 2009.
[150] Ibid.
[151] Pakistan Meteorological Department, 2009, *Climate Change indicators of Pakistan*, Technical Report No. PMD-22/2009, August 2009.
[152]GOP, Government of Pakistan (2010) *Final report of the task force on climate change*. Planning Commission, Islamabad.

sources, only 3% apply an appropriate water treatment method inside the household. Thus, 97% households are still using contaminated drinking water sources. In Gilgit-Baltistan, more than 97% of the population uses surface water for drinking purposes. Such water comes from snow-melting, springs, and rivers, navigating through streams, irrigation channels and piped networks. In most of the cases, gravity flow water supply systems relate to water reservoirs and water complexes, supplying untreated or partially treated water to the population. (The WASH.[153] Unit and EPA after carrying out water quality tests of several water supply systems affirmed that most of the existing drinking water sources are unfit for human consumption due to bacteriological contamination and presence of toxic metals in the water.[154]

4.2.1. WATER FOR POWER

Mountain glaciers and snow are main sources of water in Gilgit-Baltistan, ice and snow melt water flows down through the streams. The water from the streams and rivers is diverted for agriculture, power generation and domestic use. Hydropower is the major source of electricity in the region, and the efficient functioning of water and power sector is thus essential to the regional economy.[155] The climate change may have damaging impacts on water and power infrastructure. Efficient functioning of water and power sector, effective management, conservation of water resources and wise use of hydropower potential in is pivotal.

4.2.2. WATER FOR IRRIGATION

Gilgit-Baltistan has a complex network of irrigation water system that remains exposed to climate related disasters. Irrigation is the largest sector consuming water in the region and is strongly interlinked with arable land and food security. Water channels are constructed based on local wisdom and modern engineering techniques. However, water sector is confronted with several challenges. For example, due to huge variations in the stream flow and seasonal water shortages, the irrigation systems cannot be operated on the demand basis. Moreover, large quantities of water on way from the source to the arable

[153] GOP, Government of Pakistan (2014*). Environment and climate change outlook of Pakistan.* Climate Change Division, Islamabad

[154] IUCN Pakistan Program, 2003*, background paper on water, Northern Areas Strategy for sustainable development.*

[155] Ibid.

land is lost, in some cases, the losses are as high as 70%. [156] The increasing amount of silt and sediment deposition in channels leads to decrease in the water carrying and conveyance capacity affecting the overall operational efficiency of irrigation system. Water management is presently governed by 'water customs' that are voluntarily followed by the members of the beneficiary community. This traditional system of water management may work well in specific circumstances but creates water inequalities between different valleys.[157]Communities living in one water catchment have equal user rights on water though ownership rights may differ. It is important to develop a system of water governance and institutions that will allow fair distribution of water resources and replace water inequalities with regulatory rules by the government across the region. This can be materialized by creating water organizations at tehsil level and water boards at district level; and allow increased participation of water users in the design, development, operation, maintenance, and financing. Furthermore, water resource mapping will have to be conducted while introducing and adopting efficient design and construction of water channels and courses. Mapping of villages vulnerable to droughts and floods should be done; and take appropriate measures for, adaptation and resilience**.** [158]

4.3. WATER FOR AGRICULTURE

Gilgit-Baltistan agriculture production is strongly linked with the seasonal and long-term variations resulting from climate change. Has nearly 2% cultivable land out of its total area of 72,971 Km2. More than 80% population engages in subsistence farming by which cereal crops, fruits, vegetables, and fodders for livestock are produced. Wheat, Maize and Barley as basic Staple food for human population and fodder for livestock are major part of rural economy. During summer cropping season, 70% of cultivable land is devoted to growing wheat or barley followed by maize. Fruits and nuts are widely grown throughout the region, including cherries, mulberries, apples, apricots, pears, grapes, plums, walnuts, and almonds.[159] Most of which is used for domestic consumption and the surpluses are either dried or wasted. Vegetables such as tomatoes, beans, peas, onions, carrots, turnips,

[156] Jaffery, S. H. I., Khan, M., Ali, L., Khan, H. A., Mufti, R. A., Khan, A., & Jaffery, S. M. (2014).*The potential of solar powered transportation and the case for solar powered railway in Pakistan*. Renewable and Sustainable Energy Reviews, 39, 270-276

[157] WWF (2015b), *Socio-Economic Baseline of Naltar and Rakaposhi, World Wide Fund for Nature Pakistan, Gilgit.*

[158] ibid

[159] UNFCCC (2008), *Report of the conference of the parties thirteenth session, 3–15 December 2007.* Decision 1/CP.13 Bali Action Plan, United Nations Framework Convention on Climate Change.

capsicums, spinach, potatoes etc. are also produced. Cash crops like potatoes and peas have been commercialized and are being exported to down country and abroad. Exportation of fresh fruits and dry fruits processed and semi-processed is increasing with the passage of time since government has facilitated the system and NGOs also assisted the farmers. Due to harsh mountainous geography and fragile balance of ecosystem, Gilgit-Baltistan may not be suitable for intensive farming practices involving use of high yielding varieties and high inputs of fertilizers, herbicides, and pesticides. Environmentally friendly, modern, and ecologically suitable ways of farming will help the region counter the climate change effects.

The water supply available for agriculture is derived from three main sources:

1. Rainfall which occurs directly on crop areas.
2. Surface water from rivers
3. Ground water from aquifers

Rainfall is usually inadequate to bear more than a very little level of agricultural production, mainly in the semi-arid conditions of Pakistan. Irrigation water (surface and ground) is diminishing resource in Pakistan and the whole world.[160]

4.3.1. MEANS OF EFFECTIVE USE OF WATER IN THE AGRICULTURE

Pakistan agriculture is largely based on irrigation; where about 93 percent of the accessible water is used in agriculture. Pakistan's system of river water is one of the biggest systems in the world which came into existence after the influx of Britain's in the sub-continent. This structure was stretched up to the large area after ratification of the Indus [161]River Basin Treaty. It is assessed that about 16 million hectares of land is grounded on Indus River irrigation system. Pakistan's accessible water means are less as matched to the world. Additionally, out of accessible water, over 60percent of it is lost during transportation in watercourses and canals during application in the grounds. The rise in population has resulted in rise in food supplies putting further pressure on the accessible water resources. Keeping in sight the situation, it is essential to increase the water storing by building large and small dams where conceivable on one hand and competently use the

[160] Pakistan Meteorological Department, 2009, *Climate Change indicators of Pakistan, Technical Report No.* PMD-22/2009, August 2009

[161] IUCN Pakistan Program, 2003, *background paper on water, Northern Areas Strategy for sustainable development.*

available water on the other hand. By using the subsequent techniques, a noteworthy volume of water could be saved.

4.3.2. LINING OF WATER CHANNELS

Approximately 50 percent of water is mislaid from unlined watercourse which is not just the depletion of freshwater but also increase the ground water table. This creates the water logging and salinity troubles. Lining of watercourse improves the water transportation competence and helps to defeat the problem of water logging and salinity. The save water may be used for flat expansion of crops (bringing further area under crop growing) or perpendicular expansion (rising the cropping strength).[162]

4.3.3. LAND LEVELING

Irregular lands not merely cause the loss of nutrients present in the soil but also loss of water. Leveling of ground not only protect these nutrients but also increase the harvest yield. Leveling of land throughout laser increase the irrigation effectiveness and ensure even division of water in the field. It has been anticipated that laser land leveling increase the land use competence up to 63 percent and harvest yield up to 70 percent. With laser leveled fields, smaller amount water is requisite for irrigation.[163]

4.3.4. PATTERNS OF CROPPING

Patterns of cropping affects to an immense degree on the water utilization and thus the water save. High water requires crops such as sugarcane and rice should be limited to those areas where rainfall is comparatively high and additional water is offered. Furthermore, as a substitute of growing high delta crop, little delta crops should be grown which not only saves water but also increase the agriculture revenue.[164]

4.3.5. SUITABLE IRRIGATION ARRANGEMENT

Every crop has its definite water requisite which changes along its expansion stage. It is extremely important to water according to crop requirements. Generally, farmers do not have awareness of crop water condition. They have the fallacy that more water will

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[162] Chaudhary,P.,Rai,S.,Wandi,S.,Mao,A.,Rehman,N.,Chettri,S.andBawa,K.S.(2011*), "Consistency of local perceptions of climate change in the kangchen junga himalaya land scape"*,Current Science, Vol.101No.4,pp.504-513.

[163] Jaffery, S. H. I., Khan, M., Ali, L., Khan, H. A., Mufti, R. A., Khan, A., & Jaffery, S. M. (2014).*The potential of solar powered transportation and the case for solar powered railway in Pakistan.* Renewable and Sustainable Energy Reviews, 39, 270-276.

[164] GOP, Government of Pakistan (2010), *Final report of the task force on climate change.* Planning Commission, Islamabad.

yield additional crops. Though, the surplus water than the real required seep into the ground consequential into problems of salinity and water logging. The water that leaches out of the root sector also carries valuable nutrients with it. The losses of these components from the soil affect the crop.[165]

4.3.6. DRIP IRRIGATION

By means of drip irrigation system healthier crops can be full-grown with less quantity of water. This system is practical for row crops and orchards. In this method, water is applied according to plants requisite. Four times additional area can be irrigated with the similar amount of water used for conservative irrigation. Additionally, the fertilizer is also applying directly in the roots of plant. As the water is provide straight to the roots of plant, consequently wild plant germination is less in the left behind areas. The obligation of land leveling is also eliminate. This technique has received fame around the world. Keeping in sight the rising water paucity in Pakistan, there is a dreadful need to adopt drip irrigation system. The stuff for this system is now being fabricated in Pakistan.

4.3.7. IRRIGATION THROUGH SPRINKLER

In this way of irrigation, water is apply to the crop throughout sprinklers in which land leveling is not obligatory and water is also provided to the crop according to its necessities. More than 50 percent of water can be save as compare to the conservative means of irrigation. Particularly, for pre-sowing irrigation, less amount of water is essential which cannot be applied by conservative methods.[166] When applied during conventional method, one has to stay for several days until field ability is achieved resulting in stoppage in sowing of crops. The Government of Pakistan has introduced a jumbo project for drip and sprinkler irrigation system. Farmers are directed to get utmost benefit from the projects so that the problem of water shortage may be defeat by adopting the competent water management technique.

4.3.8. AGRICULTURE THROUGH RAIN FED

Dry land farming exclusively depends on rainfall. It is so, crucial to preserve rainwater in the soil or stock in the pools which can be used as and when necessary. To protect the rainwater in the soil, the land is protected by construction bunds and soil masses

[165] Ibid.

[166] GOP, Government of Pakistan (2014) *Environment and climate change outlook of Pakistan.* Climate Change Division, Islamabad

are broken by planking.[167] Ploughing of ground is carried out in reverse direction of the gradient of land. By undertaking this, a proportion of rainwater can be stowed and erosion of land can also be secure. Do not till the land again and again. In its place of Ploughing after rainwater collecting, crop should be planted with a drill monitored by a light planking (Shag). In this mode, the moistness present in the soil will be preserved. Further this, rainwater can be stowed at some suitable places in the form of ponds/ mini dams which can be used for supplementary irrigation.[168]

The construction of the horticulture is strongly linked to the occasional and long-drawn species that come as a result of environmental changes. Gilgit-Baltistan has about 2% of its whole land area of 72,971 square Km. More than eighty percent of people participate in planting methods where grain crops, natural products, vegetables, and pet food are exported. Barley, Maize and Wheat as the staple food used for humans and animal grain are the mainstays of the country's economy. During the summer planning, 70% of the arable land is given to the development of wheat or maize followed by maize. Soil products are generally developed all through the area, including pears, pecans, plums, grapes, cherries, apricots, apples, mulberries and almonds. Most of it is used for local use and the excess will be dried or disposed of vegetables such as capsicum, onions, carrots, beans, peas, turnips, tomatoes, spinach, potatoes and more are added. Cash crops such as peas and potatoes have been popular and exported. Exports of freshly grown food from organic and hand-prepared natural products are increasing over the course of time since a government official worked with the framework and NGOs are also assisting farmers.[169] Due to poor landforms and the inequality of the biological system, Gilgit-Baltistan may be unsuitable for rooted planting activities including the use of a variety of high-yielding products and high contributions of pesticides, herbicides, and fertilizers. Harmless to the ecosystem, current farming methods and ecosystems will help the region combat the effects of climate change. [170]

[167] Khan, B. and Ali, F. (2011), *"Understanding sectoral impacts of climate change on Gilgit-baltistan, regional climate risk reduction project (RCRRP),* UNDP-ECHO initiative, Pakistan

[168] F. Ali, (2010, Dec 2). *Climate change probability in gilgit-baltistan. Retrieved* Feb 1, 2013, from Pamir Times: http://pamirtimes.wordpress.com/tag/climate-change/.

[169] Beniston, M., Diaz, H. F., and Bradley, R. S., 1997: *Climatic change at high elevation sites; a review.* Climatic Change, 36, 233 - 251

[170] Korner, C. (2004*), "Mountain Biodiversity, its causes and function",* Ambio, Vol.13, pp.11-17.

4.4. PROTECTION AND CONSERVATION OF WATER RESOURCES

1. To develop and adopt an integrated water resource management approach with multi-sectorial engagement to regulate water conservation processes that can aid in meeting rising demand for drinking water.
2. To introduce required measures to protect surface water sources e.g., lakes, springs, rivers, mullahs, streams, and water channels from water pollutants by mobilizing communities and enforcing Gilgit-Baltistan Environmental Protection Act 2015.
3. Catchment management can be ensured in developing watershed management projects and involving communities living upstream and nearer to water catchment areas to prevent pollution and depletion of water resources.
4. To introduce water meters, water saving plumbing equipment, and water efficient technologies, devices, and appliances to avoid indiscriminate use and wastage of drinking water.
5. Climate change adaptation measures will be considered in planning, designing and construction of drinking water supply systems to overcome adverse impacts of climate change.[171]

4.5. CAUSES OF WATER CRISIS IN SKARDU CITY

Skardu city is facing severe water shortage due to dependence only upon water source Satpara Lake, which is a medium-size multi-purpose concrete-faced earth-filled dam located downstream from Satpara Lake on the Satpara Stream approximately 4 km from the town of Skardu in Gilgit-Baltistan.. Total area of Satpara Lake is (93000AF) , having installed capacity of 17.36 MW of hydroelectricity, supplies power to approximately 30,000 households in the Skardu Valley, irrigates 15,536 acres (62.87 km2) of land and supplies 3.1 million gallons per day (13 cusecs) of drinking water to Skardu city. Main source of water is melting ice of the Deosai plains during the summer seasons.

To increase the storage capacity of the main dam, diversion of Shatung Nullah was also included in the original scope of the dam project in 2010. Complete irrigation system and power houses were designed as per original scope having Shatung Nullah one of the main components. Dam provide a range of economic, environmental, and social benefits,

[171] Ibid.

including recreation, flood control, water supply, hydroelectric power, waste management, river navigation and wildlife habitat. Presently Skardu city is facing serious water crisis due to increase in population and the declining water resources. Since the construction of the Satpara Dam, the population has increased up to 0.15 million and is estimated to go up to 0.50 million by the year 2025. Population growth is as under:-

District	Area (km2)	Population 1998	Population 2017
Ghanche	4,052	88366	160000
Shigar	8,500	45321	75000
Kharmang	5,500	42598	60000
Skardu	8,700	131290	250000

Table 2: **POPULATION GROWTH**

Over the past 50 years, the average temperature around the Karakoram area has increased by 0.5 * C over a decade, leading to a much shorter winter. At 18 %, there was an increase in winter and summer rainfall in the region. Differences in low and high temperatures are more pronounced in winter than in summer. A comparison of Gilgit-Baltistan with surrounding areas shows that the annual increase in temperatures of Gilgit-Baltistan 0.07 * C by ten years is almost the same as that of neighboring India, from 1894. Emerging from 1961, it is almost identical to the neighboring Tibetan region. China. Similarly, the entire mountainous region of South Asia, which includes the largest range of mountains, namely, Karakorum, Himalayas, and Hindu Kush, where mid-winter temperatures rose from 0.27-0.55 * C is actually highly dependent on global warming. This situation has reached the Deosai Plain.

4.5.1. COMPARISON OF SATPARA LAKE LEVEL (LAST TEN YEARS)

Lake Level	Year	Difference of water level as on 30th June 2018
8669.30	2018	60.80 ft. (below)
8730.10	2017	34.70 ft. (below)
8704.00	2016	42.95 ft. (below)
8712.35	2015	10.75 ft. (below)
8680.95	2014	39.35 ft. (below)
8707.65	2013	8.35 ft. (below)
8677.65	2012	13 ft. (below)
8682.40	2011	20 ft. (below)

8689.00	2010	12 ft. (below)
8672.18	2009	12 ft. (below)

Table 3: **COMPARISON CHART**

4.5.2. WATER SITUATION OF SATPARA LAKE IN 2018

Lake level	8669.30 FASL
Live Storage	14214 Acre Feet
Expected date of Inflow	31.07.2018
Level expected at 31.07.2018	8680 FASL
Live storage at 31.07.2018	18889 Acre feet
Expected inflow in August and September	60 – 70 cusecs

1. Water channels that have not been tracked due to water loss are increasing significantly.
2. Negative communication between stakeholders and officials of Satpara Dam during annual operation and maintenance of the dam.
3. Absence of Groundwater Monitoring and Management Cells in the Department of Water Management is recommended to appoint a competent consultant to build equipment and design an effective model of groundwater management.
4. Population growth and dependence on water availability at Satpara Dam.
5. Use of water supply for irrigation / kitchen gardens.
6. Damage to the Dam from water outlets that are not connected to the water supply system.
7. Damaged irrigation stations and drainage cables.
8. There is no system of high tanks and customs of open tabs especially for summer watering and avoiding cold water supply lines in winter.
9. Lack of solar tubes of required capacity in water shortage areas.
10. Inadequacy of new ponds of required size and capacity in areas of water shortage.

4.5.3. WATER SCARCITY HAS AN IMPACT ON THE ECONOMY AND SOCIETY

The negative effects of water shortages on agriculture will have a significant impact on poverty levels.

1. Low water means low agricultural yields.
2. Raising livestock is a livelihood in rural areas. It is also an important economic activity, and will be affected by water shortages.

3. Skardu Town fruit trees bring home a healthy amount, which can be affected by water shortages.
4. Due to the limited production of major crops, namely wheat, potatoes, barley, maize etc. related industries will suffer greatly.
5. The limited water and water budget for drinking and irrigation purposes will be a major shortage of energy in Skardu Town depending on the Satpara Dam only.
6. Lack of power will disrupt the business community and may create a climate of law and order in Skardu.

FINDINGS AND CONCLUSION

The researcher has concluded that climate change is a reality and its impacts on the globe cannot be neglected. Global temperature has risen from 1.5° C – 2°C affecting the world's third pole i.e. Himalaya-Karakoram-Hindu Kush (H-K-H) after the North and South poles. Water from melting glaciers has created hundreds of new lakes and endangered existing ones. The year 2021 was termed as the sixth warmest year on record, continuing a long term upward trend since 1880.

Supply of water depends on Sadpara Lake in Skardu city. Water shortage can be overcome by diverting water of Shadong nullah in Deosai plain to Sadpara Lake. Mega-management outweighs Mega-projects. Climate change is a reality and awareness needs to inculcate in masses. This is immensely disturbing all segments of society. Water shortage has created alarming situation. Skardu is the capital of Baltistan division and falling prey to water issues. Population volume is increasing. It has become difficult to cater to the demands of tourists in summer. Cultivation takes place in summer and this is only possible for six months. Sadpara dam is unable to fulfill the needs. People have started installing tube-wells which results in shortage of sub-surface water. Loss of water must be minimized.. Leakage of water from Kuhul (Canal) wastes it in large quantity. Lining of Kuhul (canal) is the need of the hour. We are forced by severe weather to keep our taps open 24/7 in winter. Constant flowing restricts water from freezing. Special pipes are needed which may resist minus temperature. Latest technology like Drip irrigation and Irrigation through sprinkling needs to be adopted and farmers should be properly trained. Small dams need to be constructed in the outlying areas of Skardu like on Hussain-abad nallah and Hotu nallah so that water can be stored. River Indus passes from Skardu. Its water can be lifted by using water pumps.

RECOMMENDATIONS

LONG TERM MEASURES

1. There is urgent need of installing computerized telemetry system in major nullahs and distributaries to compute inflow and outflow of water for developing well-planned future water strategies based on accurate data.
2. Serious conservation steps need to be taken to improve the efficiency of water use in agriculture. Potential savings would be even higher if the technology switch were combined with more precise irrigation scheduling and partial shift from lower value, water-intensive crops to higher-value, and more water-efficient crops. Drip Irrigation Program is launched to reduce water waste over the next years.
3. Lining of water courses will be useful for saving of precious water in consultation with the users and water right holders.
4. Main nullahs may be lined at critical points to minimize huge conveyance losses. To reduce the conveyance losses in main nullahs situated in Sad Para Dam command area, Check Dams may be constructed that will help in reduction of flow velocity and erosion and it will also improve the ground water recharge capacity.
5. Authorities should take appropriate steps to curb the illegal extraction of drinking water and ensure its equitable distribution.

SHORT TERM MEASURES

1. Installation of solar powered tube wells along with distribution system at various wards/ Mohall's of Skardu Town and surroundings to share the burden on Sad Para Lake for drinking purpose.
2. Provisions of funds for installation of hand pumps at household level to deal with the drinking water emergency.
3. Installation of solar powered submersible pumps at Indus for irrigation and water supply purpose.
4. Storage mechanism for water at household level such as storage tanks.
5. Drinking water needs to be supplied through pipes and that needs to be used for drinking purpose only. Whereas irrigation water needs to be supplied through water channels.
6. There is a need of water rationing limiting the supply of drinking water on demand basis.

7. The sub surface flow of the Hargisa mullahs must be tapped for re-use as drinking water.

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ANNEXURE-01: MAP OF GILGIT-BALTISTAN

Figure 3: **MAP OF GILGIGT-BALTISTAN**

ANNEXURE-02: ABBREVIATIONS AND ACRONYMS

AKAH	Aga Khan Agency for Habitat
AKRSP	Aga Khan Rural Support Program
B&R	Building & Roads
BAP	Biodiversity Action Plan
CDM	Clean Development Mechanism
CRI	Climate Risk Index
CSR	Corporate Social Responsibility
DRR	Disaster Risk Reduction
ENERCON	National Energy Conservation Centre
ETI	Economic Transformation Initiative
GB	Gilgit-Baltistan
GBC	Gilgit-Baltistan Council
GBEPA	Gilgit-Baltistan Environmental Protection Agency
GBLA	Gilgit-Baltistan Legislative Assembly
GCISC	Global Change Impact Studies Centre
GDA	Gilgit Development Authority
GHG	Green House Gases
GLOF	Glacial Lake Outburst Flood
HEIS	High Efficiency Irrigation System
HKH	Hindu Kush-Karakoram-Himalaya
HVRA	Hazard Vulnerability Risk Assessment
ICT	Information and Communication Technology
IFAD	International Fund For Agriculture Development
INDC's	Intended National Determined Contributions
iNGO's	International Non-Governmental Organizations
IPCC	Intergovernmental Panel on Climate Change
IRS	Indus River System
IRSA	Indus River System Authority
KIU	Karakoram International University
LG&RDD	Local Government and Rural Development Department
LSO	Local Support Organization
LUCF	Land Use Change and Forestry
LULUCF	Land Use, Land Use Change and Forestry

MACP	Mountain Area Conservation Project
MaSL	Meters above Sea Level
MNB	Multi-Nutrient Blocks
MRV	Measurement Reporting and Verification
NADP	Northern Areas Development Project
NCCP	National Climate Change Policy-Pakistan
NESPAK	National Engineering Services of Pakistan
NGO	Non-Governmental Organization
NOC	Non-Objection Certificate
NTFP's	Non Timber Forest Products
PEPA	Pakistan Environmental Protection Agency
PEPA-97	Pakistan Environmental Protection Act-1997
PFI	Pakistan Forest Institute
PMD	Pakistan Meteorological Department
PPPS	Public Private Partnership Schemes
PRCS	Pakistan Red Crescent Society
R&D	Research & Development
REDD	Reducing Emissions from Deforestation and Forest Degradation
SAARC	South Asian Association for Regional Cooperation
SDA	Skardu Development Authority
SUPARCO	Space & Upper Atmosphere Research Commission
UN	United Nation
UNFCCC	United Nation Framework Convention on Climate Change
WASA	Water and Sanitation Authority
WASEP	Water and Sanitation Extension Program
WCS	Wildlife Conservation Society
WMO	World Meteorological Organization
WWF	World Wildlife Fund

ANNEXURE-03: POLITICAL MAP OF GILGIT-BALTISTAN

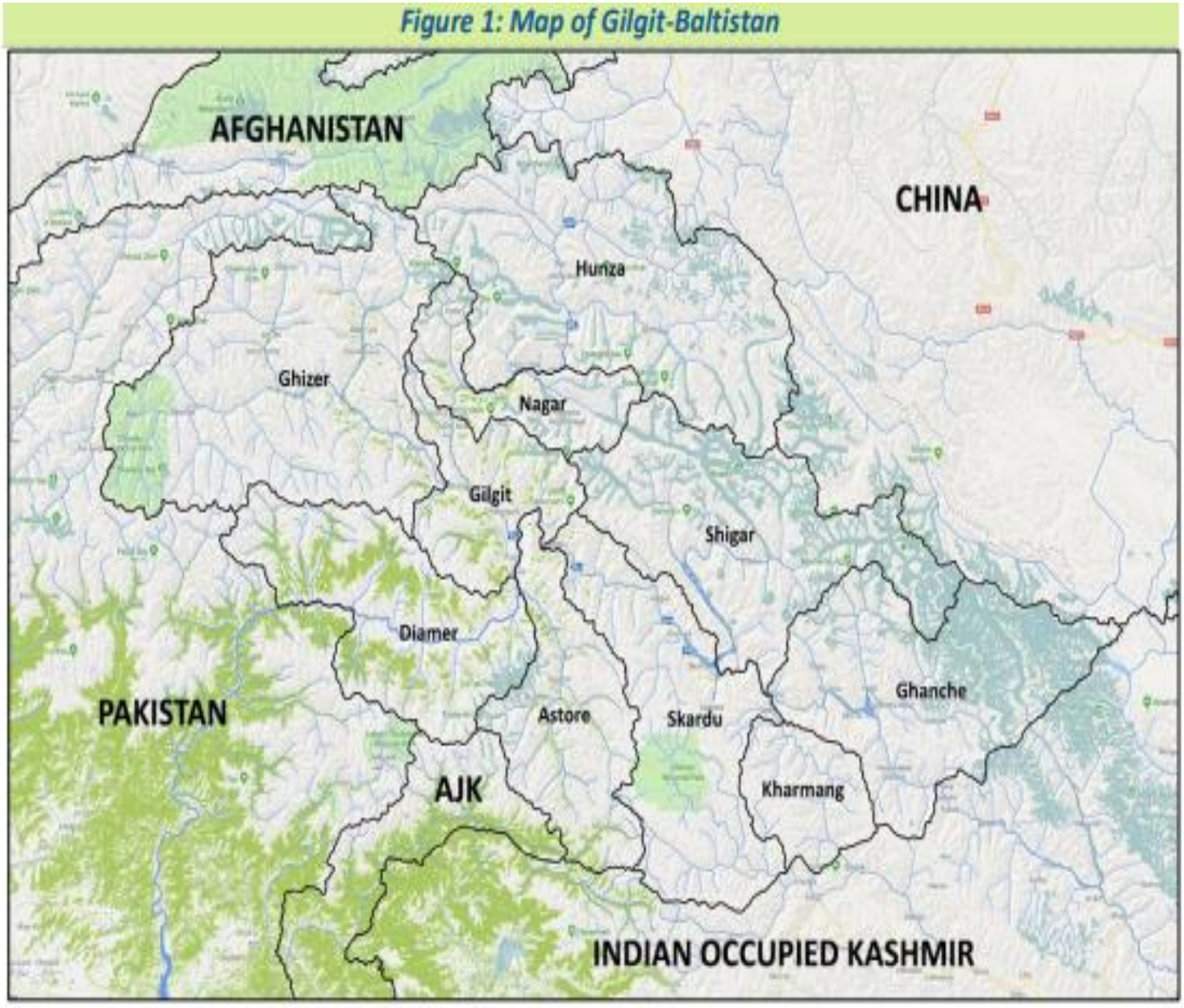


Figure 4: **POLITICAL MAP OF GILGIT-BALTISTAN**

ANNEXURE-04: AVERAGE TEMPERATURE AND PRECIPITATION OF FIVE WEATHER STATIONS

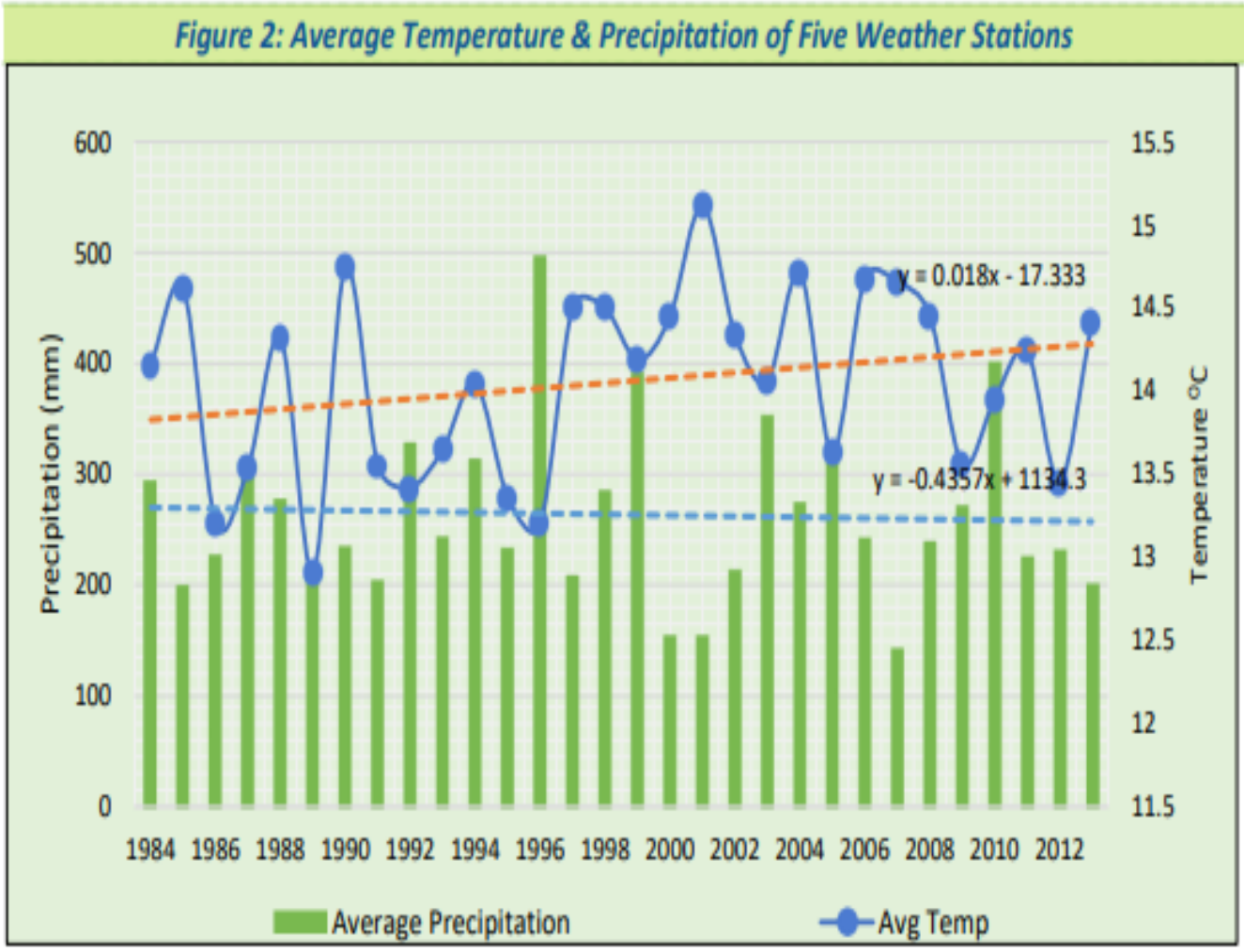


Figure 5: **TEMPERATURE AND WEATHER STATIONS**

ANNEXURE-05: SEASONAL SHIFT OF PRECIPITATION

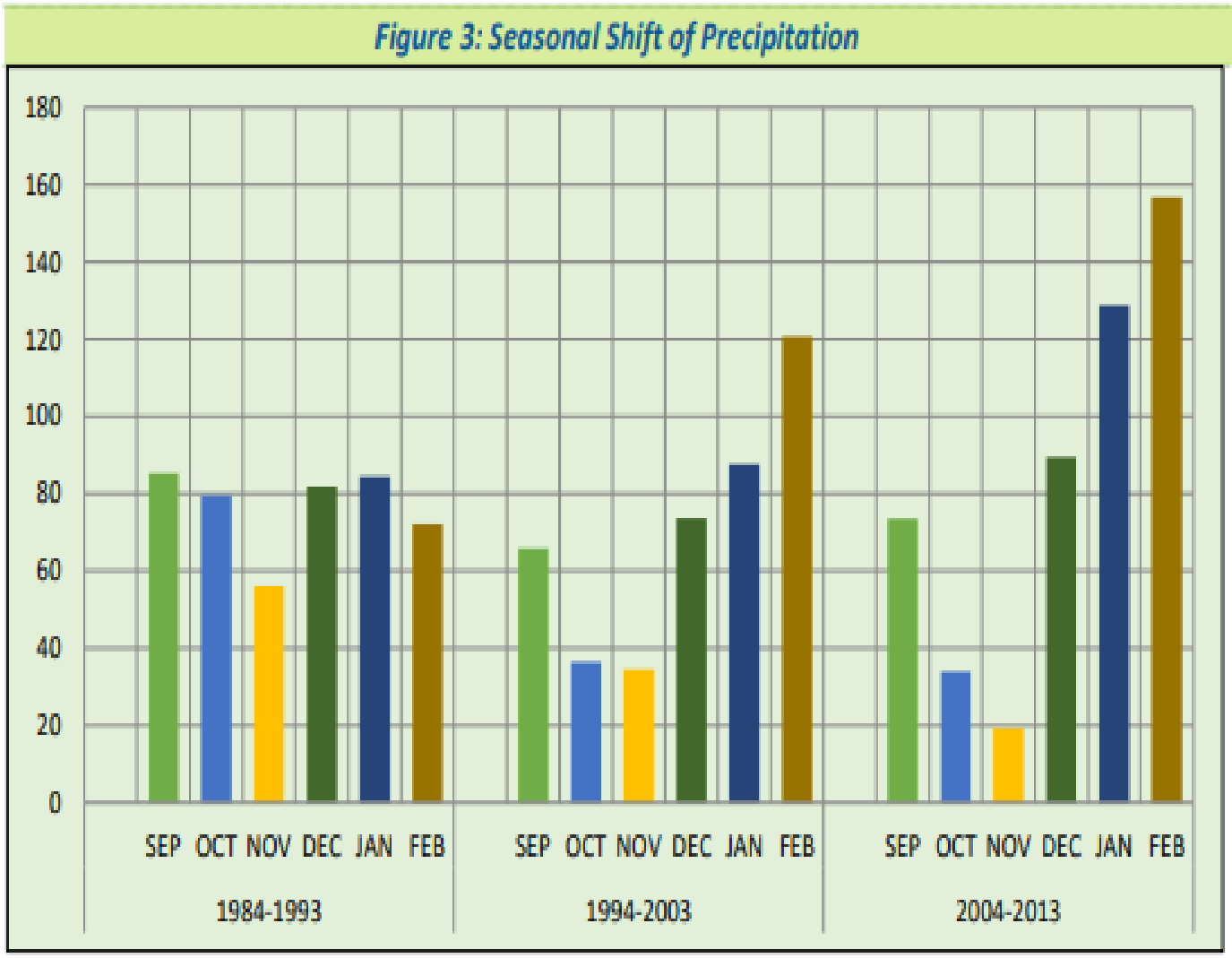


Figure 6: **SEASONAL SHIF PRECIPITATION**

ANNEXURE-06: IMAGES OF LAND SLIDING IN GILGIT-BALTISTAN

Following are few images of hazardous events that have occurred in the region in recent years.

In April 2012, an avalanche hit a Pakistani Military Base in Gyari Sector, near the Siachen Glacier region, trapping 140 soldiers and civilian contractors under deep snow; later found dead.

A massive landslide blockaded Hunza river at Attabad creating 25 km long lake back in 2010. At least five villages and KKH was submerged upstream. About 20 were killed and thousands were displaced.

Scene of landslide on KKH.

People stranded due to blockade of KKH during March 2016.

Figure 7: **LAND SLIDING**

ANNEXURE-07: EMISSION OF CO_2

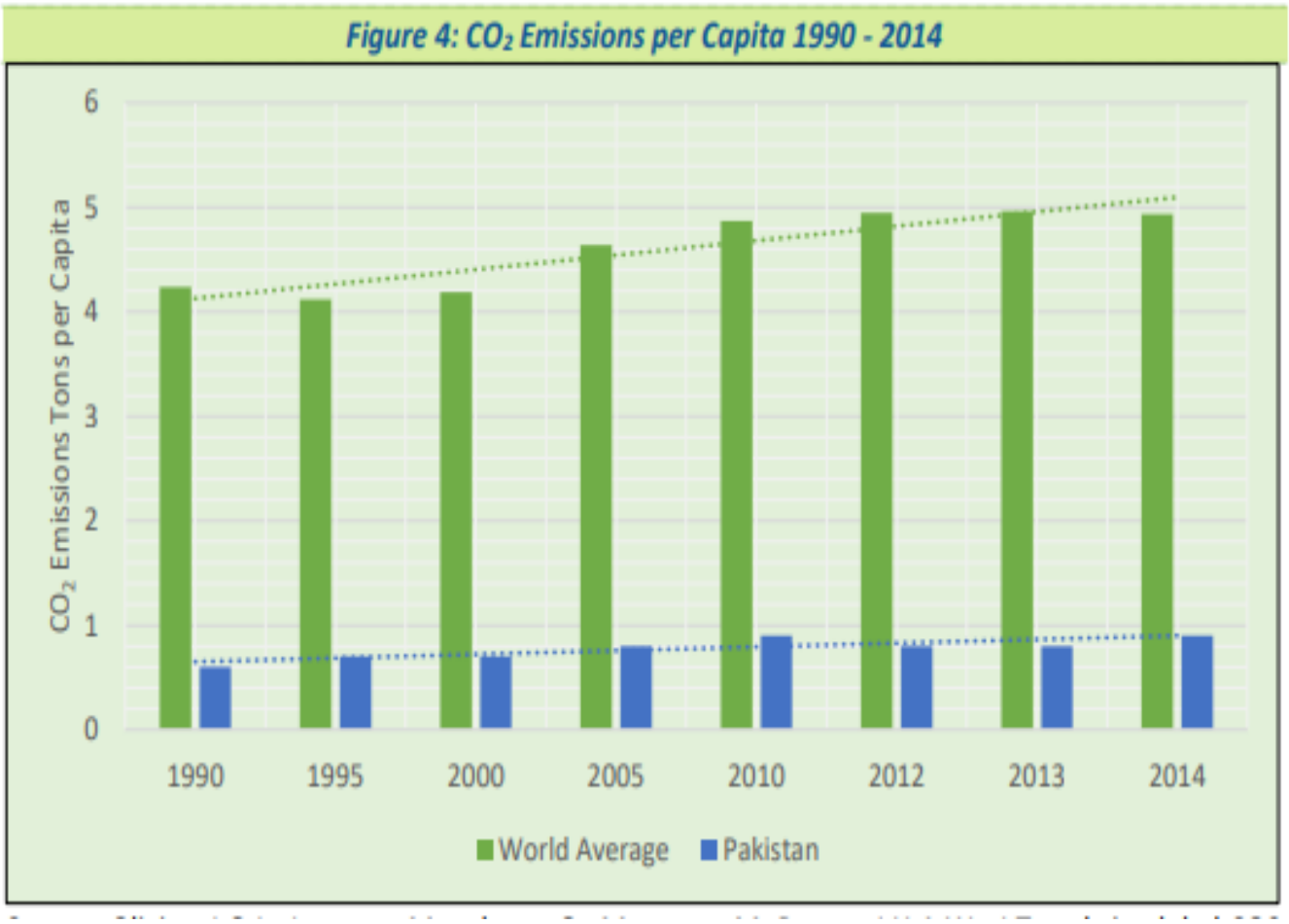


Figure 8: **EMISSION OF CO2**

Source: Olivier, J.G.J., Janssens-Maenhout, G., Muntean, M. Peters, J.H.A.W., J Trends in global CO2 emissions 2015 report , RC report 98184 / PBL report 1803, November 2015

GHG emissions of Pakistan are 0.9 tons of CO2 emissions per capita. This is much lower when compared to the current global average of nearly 5 tons. Yet the country has committed to reduce its carbon emissions by 30% in the next ten years as part of 'Intended Nationally Determined Contributions' (INDCs) towards the reduction of GHGs and mitigation of climate change.

ANNEXURE-08: AVERAGE ANNUAL TEMPERATURE OF FIVE WEATHER STATIONS IN GILGIT-BALTISTAN

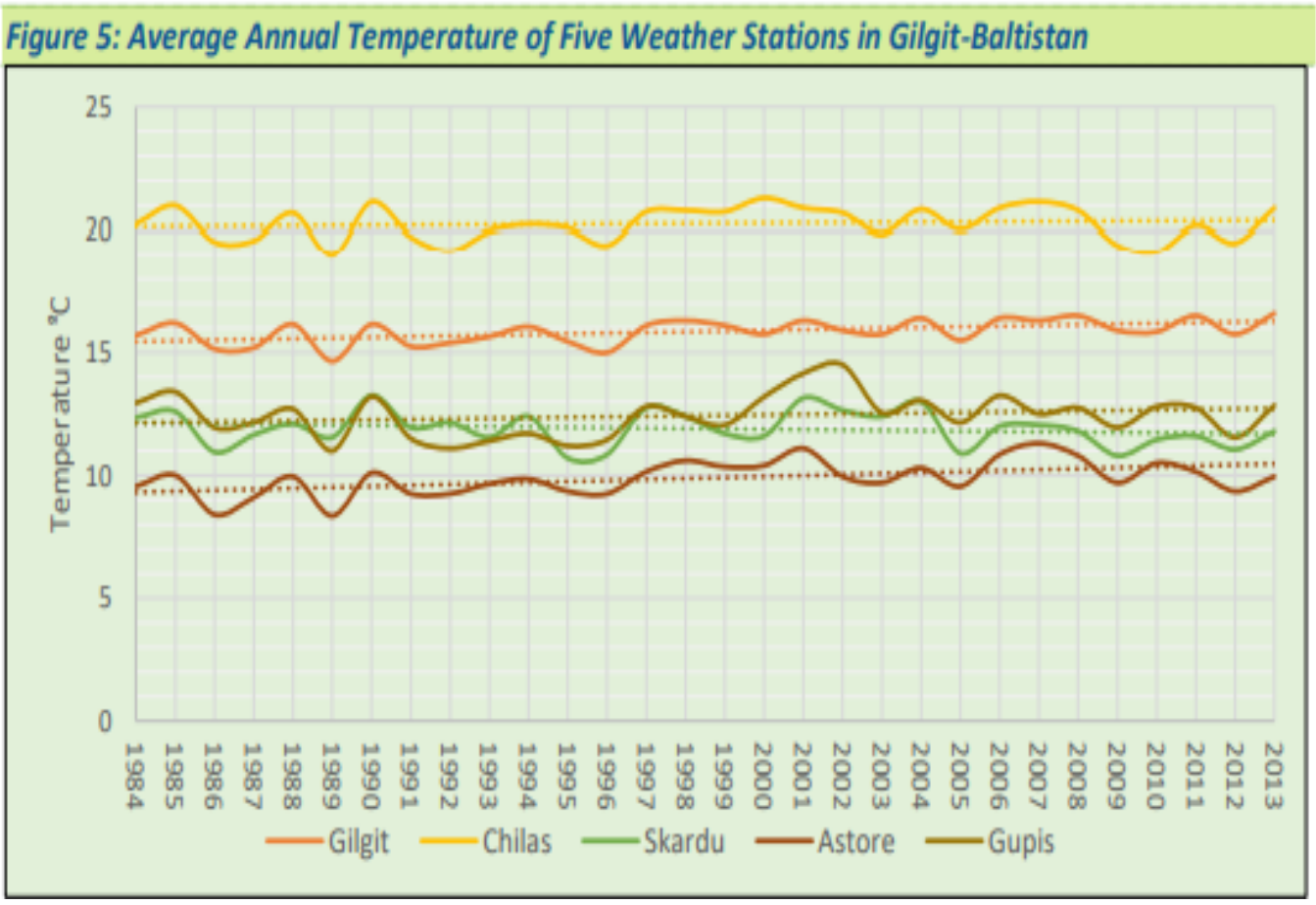


Figure 9: **AVERAGE ANNUAL TEMPERATURE OF FIVE STATIONS**

An annual increase in average temperatures for five weather stations can be found in all temperature records except of Skardu, mean temperatures for Gilgit, Gupis, Chilas and Astore for the period of 1984 to 2013 showed an overall annual increasing trend of +0.85, +0.84, +0.25 and +1.197 °C one to one. Whereas, Skardu showed a decreasing trend of -0.45 °C.

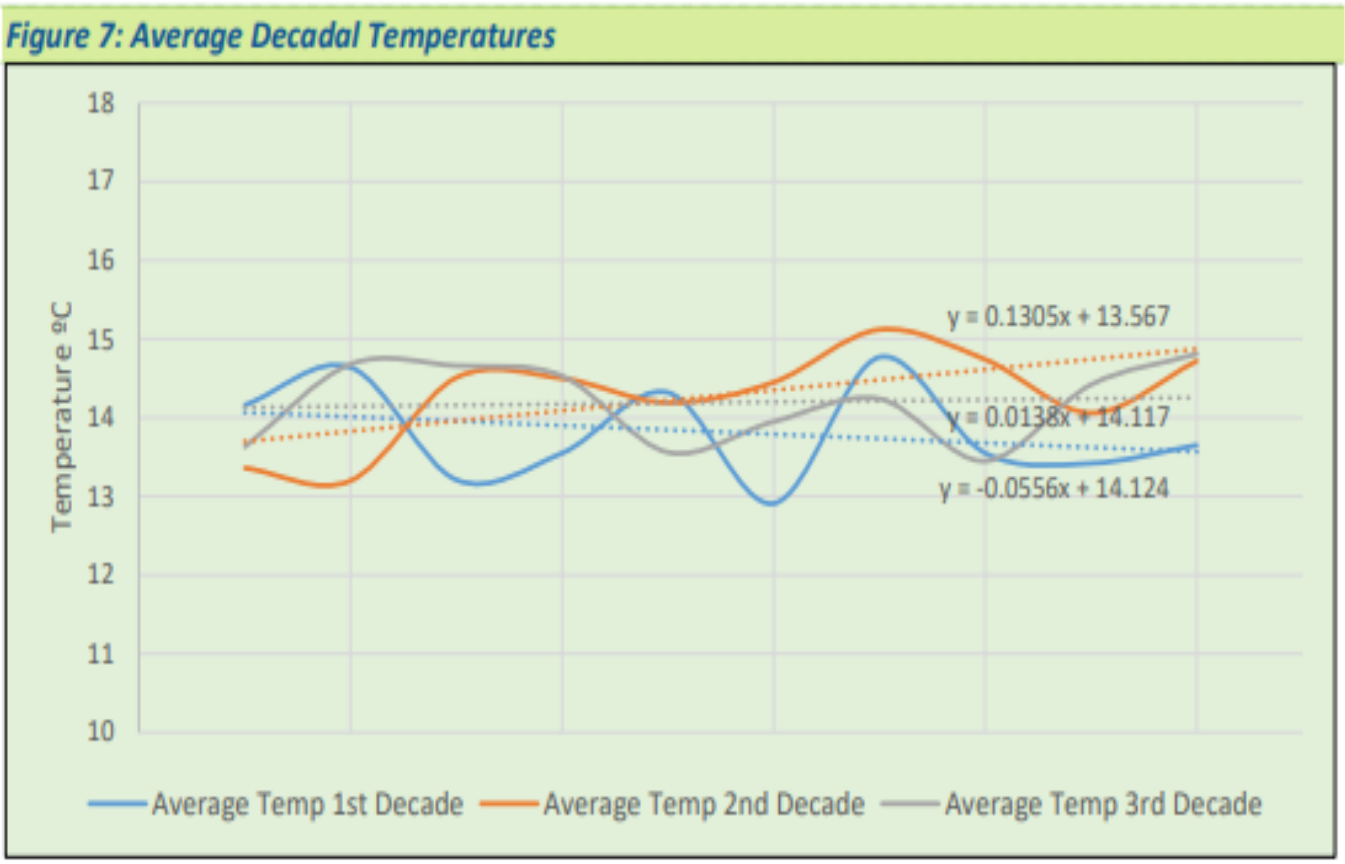


Figure 10: **AVERAGE DECADAL TEMPERATURES**

A decrease of - 0.5 °C was recorded during 1st decade (1984-1993) followed by an upsurge of 1.2 °C in the course of 2nd decade (1994-2003) and a decline of -0.5 °C for 3rd decade (2004-2013). Decade 1st and 3rd showed an equal decreasing trend but a shift of +0.68 °C can be seen among these two decades.

Figure 8: Average Seasonal Temperature of Five Weather Stations in Gilgit-Baltistan

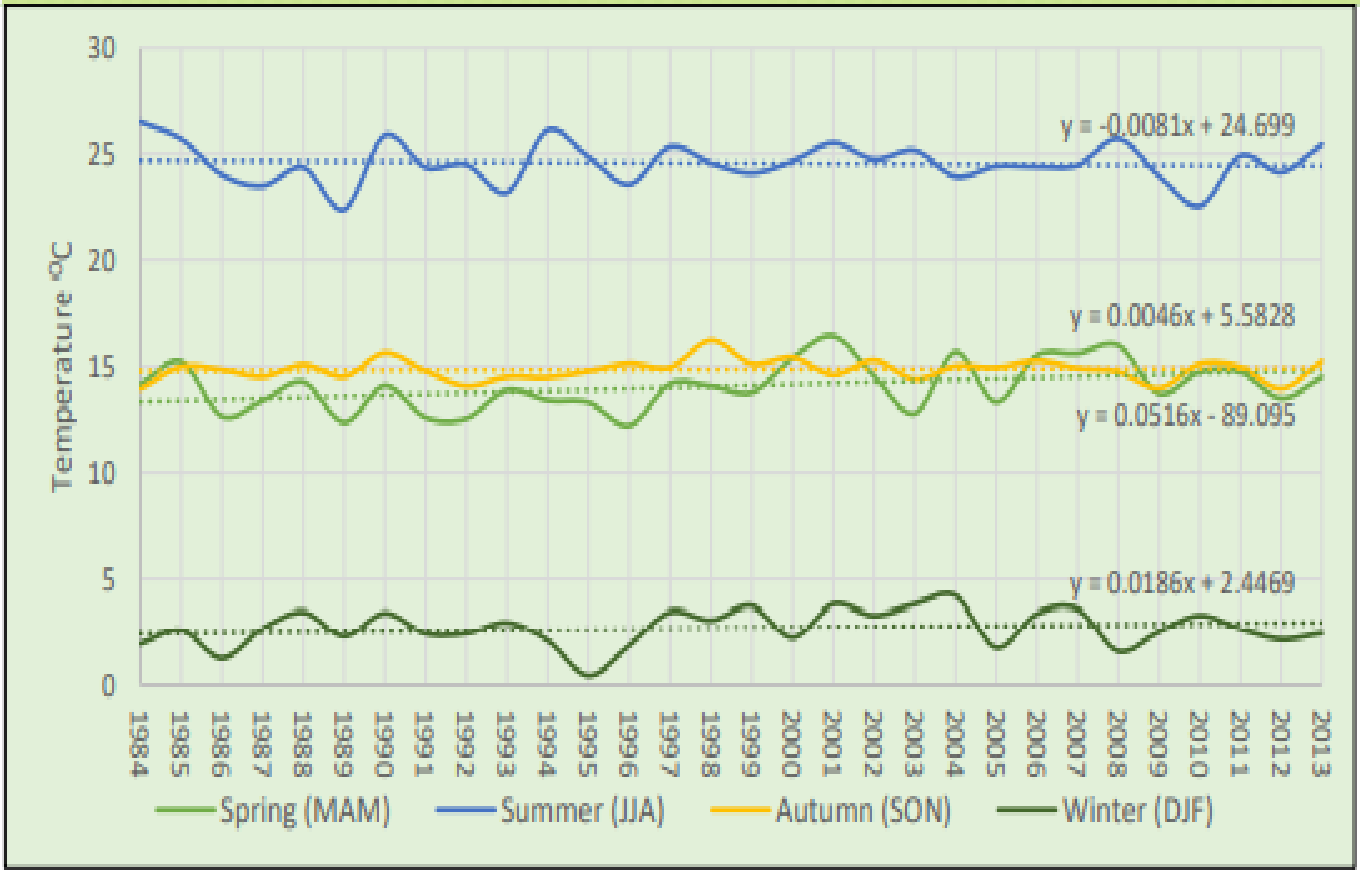


Figure 11: **AVERAGE SEASONAL TEMPERATURE**

A seasonal increase in annual mean temperature of five weather stations during winter (DJF), autumn (SON) and spring (MAM), and a decrease in summer can be shown in all-time series. An upsurge of +0.5, +0.138 and + 1.548 °C for winter, autumn and spring was recorded respectively while summers showed a decreasing trend of -0.243 °C. This reflects warming in winters, spring and autumn and cooling in summer temperature.

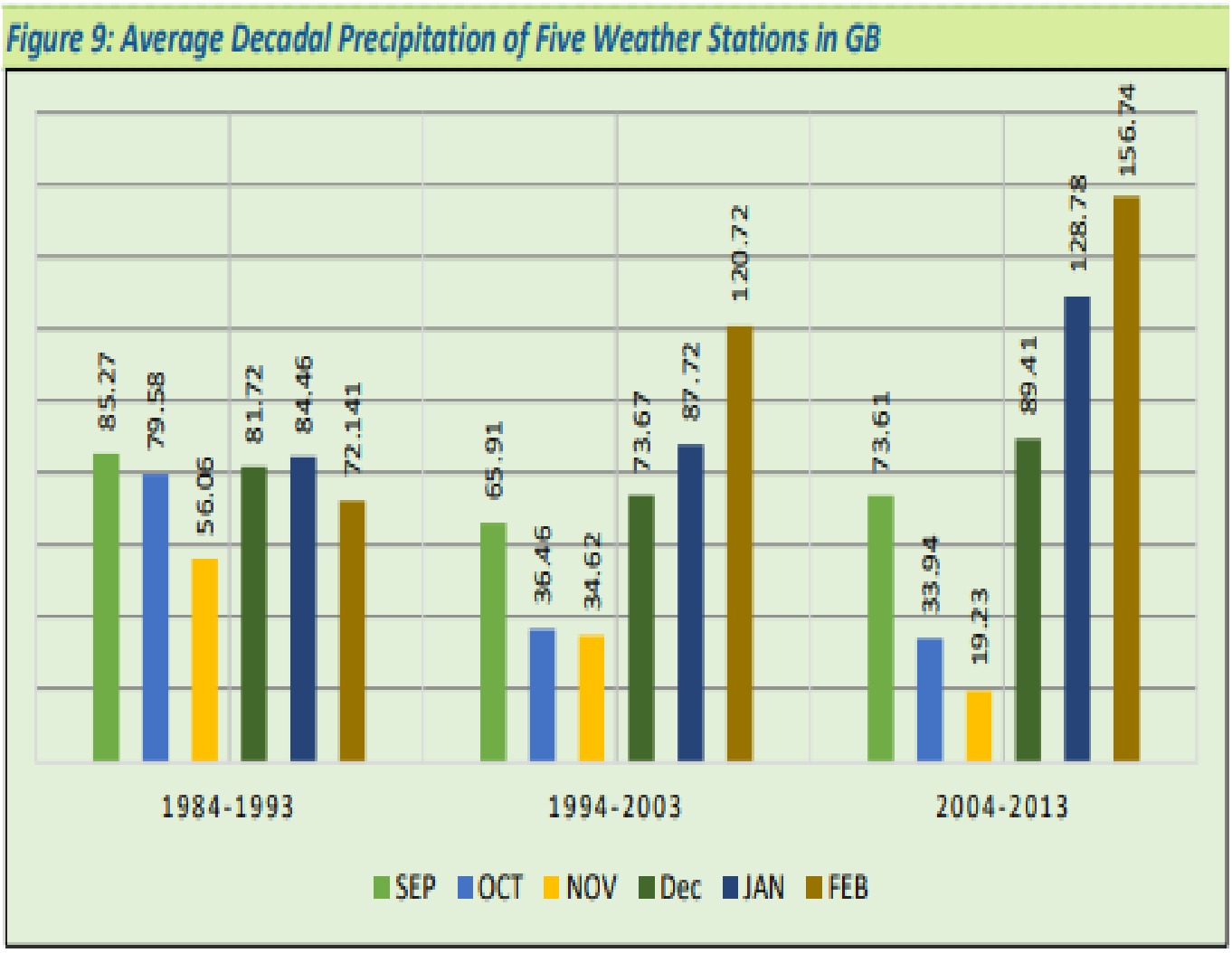


Figure 12: **AVERAGE DECADAL PRECIPITATION OF STATIONS**

During 1st decade the average precipitation was increased by 60 mm, followed by a decrease of 76 and 40 mm during second and third decade. A decreasing trend in precipitation of September, October and November and increasing in January and February from 1984 to 2013 can be observed in the above exhibit. The exhibit below shows an average decrease of 8 mm in precipitation for a recorded period of thirty years.

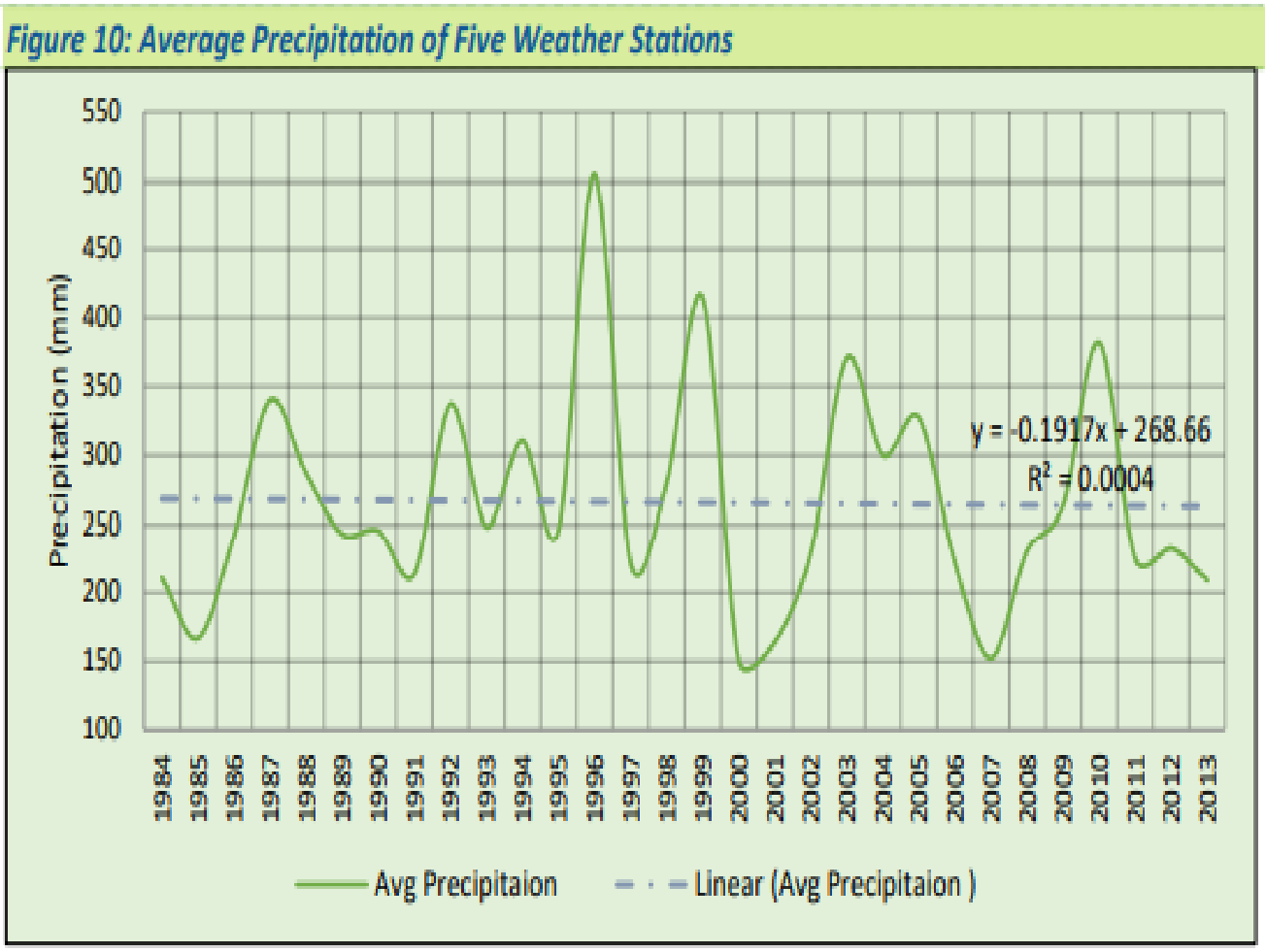


Figure 13: **AVERAGE PRECIPITATION OF FIVE STATIONS**

QUESTIONNOIRE

CLIMATE CHANGE AND MANAGEMENT OF WATER RESOURCES IN SKARDU

Written by Akbar Abbas Balti

* Required

What is your Age *

What is your Name?

Gender of Respondent? *

- ◯ Male
- ◯ Female

4. **Write your Email? ***

_____

5. **Write your Contact Number? ***

_____

6. **Write your City? ***

_____

DRINKING WATER

Which of the following sources of drinking water are available in your neighborhood? *

- Bore Well / Hand pump
- Public Tap
- Household Water Supply
- Other

8. Which of the following sources of drinking water does your household use? *

Mark only one oval.

- Bore Well / Hand pump
- Public Tap
- Household Water Supply
- Other

9. What is your main source of water? *

Mark only one oval.

- Bore Well / Hand pump
- Public Tap
- Household Water Supply
- Other

What is the frequency of water supply? *

- 24 Hour supply
- More than once a day
- Once a day
- Once in two or three days

11. Is this frequency sufficient for your needs? *

Mark only one oval.

- Yes
- No

12. How often would you like to get water? *

Mark only one oval.

- Once a day
- More than once a day

COMMON QUESTIONS

13. Is the quantity of water that you receive (from your main source of water) adequate? *

Mark only one oval.

- Yes
- No

Which months do you face scarcity? *

- [ ] January
- [ ] Feburary
- [ ] March
- [ ] April
- [ ] May
- [ ] June
- [ ] July
- [ ] August
- [ ] September
- [ ] October
- [ ] November
- [ ] December

15. Generally, how does the water smell? *

Mark only one oval.

- ◯ Yes
- ◯ No

16. Generally, does the water have a taste? *

Mark only one oval.

- ◯ Yes
- ◯ No

Generally, What does the water look like? *

- ◯ Clear
- ◯ Cloudy / Dirty

18. Do you pay for water? *

Mark only one oval.

- ◯ Yes
- ◯ No

19. How much do you pay a month? *

_____

20. Are the bills that you receive accurate? *

Mark only one oval.

- ◯ Yes
- ◯ No

CLIMATE CHANGE

21. Are you aware of climate change? *

Mark only one oval.

- ◯ Yes
- ◯ No

Do you think human activity is responsible for increasing Climate change? *

- Yes
- No

23. Do you believe that climate change can endanger your life? *

Mark only one oval.

- Yes
- No

24. Can personal preparation for climate change save your life? *

Mark only one oval.

- Yes
- No

25. Do you think that you have the ability and power to protect yourself from dangerous events from climate change? *

Mark only one oval.

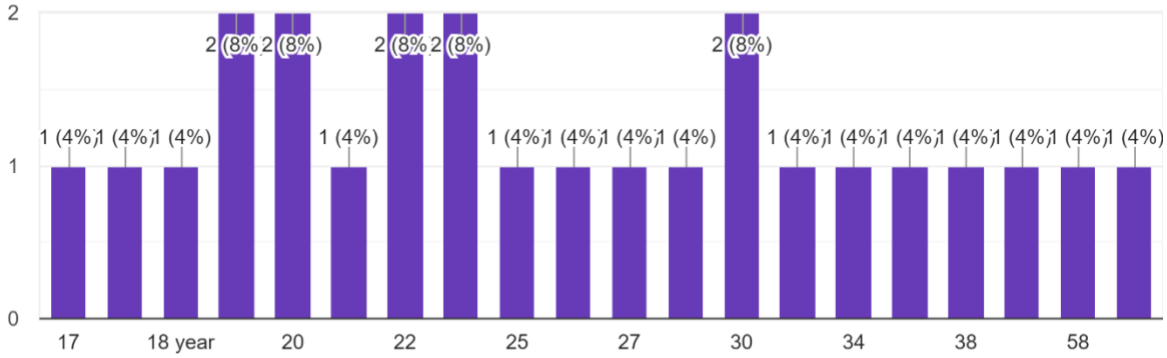
- Yes
- No

26. Are you personally prepared to do something about climate change? *

- [ ] Yes
- [ ] No

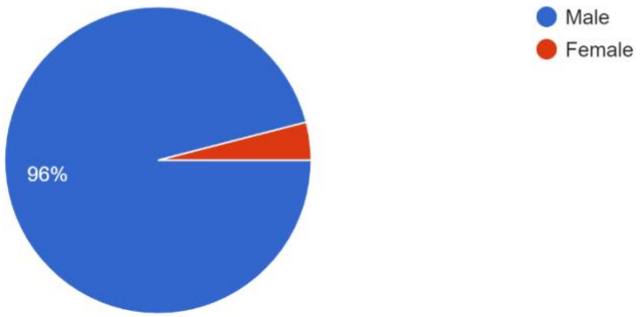
What is your Age

25 responses



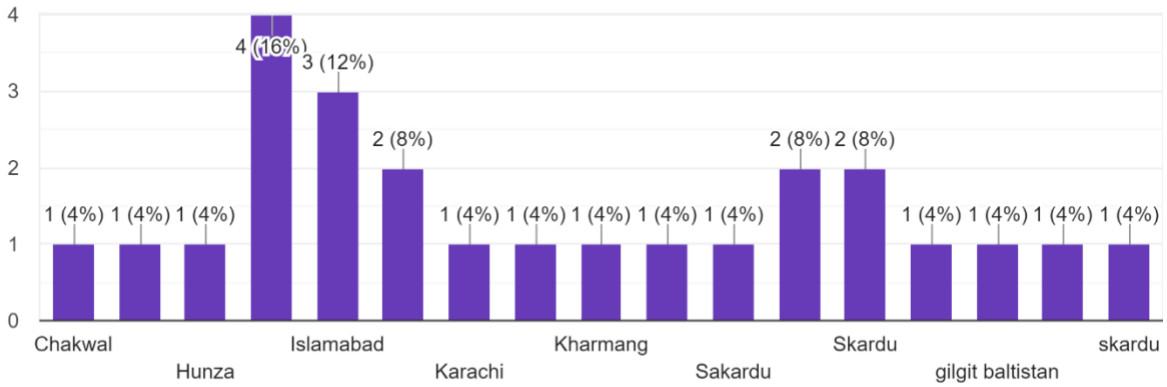
Gender of Respondent?

25 responses



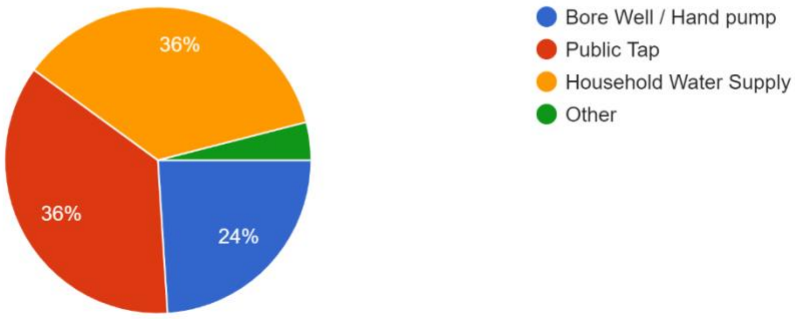
Write your City?

25 responses



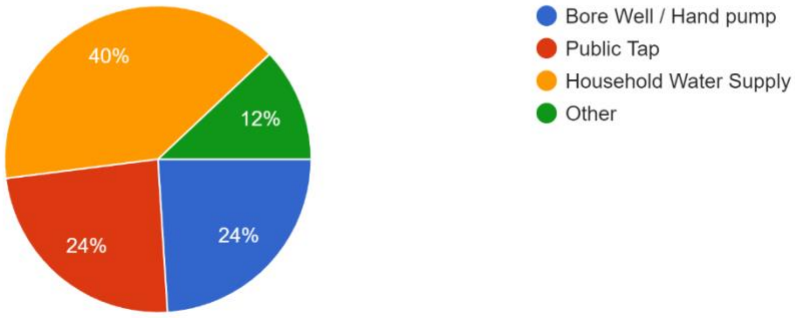
Which of the following sources of drinking water are available in your neighborhood?

25 responses



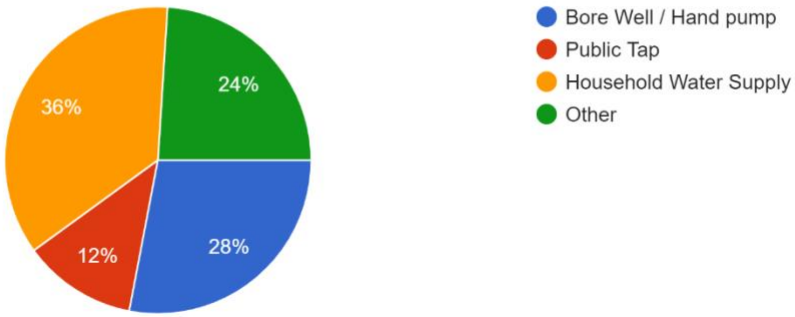
Which of the following sources of drinking water does your household use?

25 responses



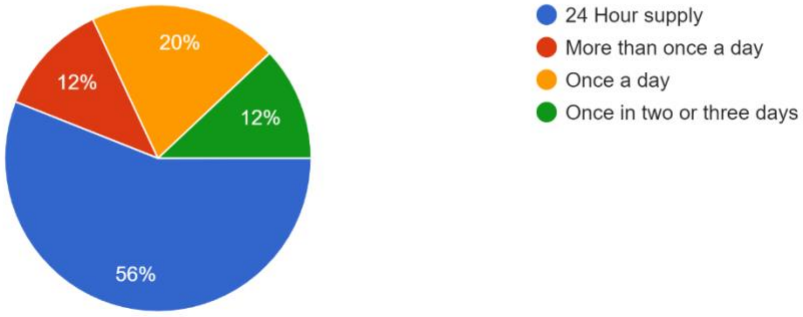
What is your main source of water?

25 responses



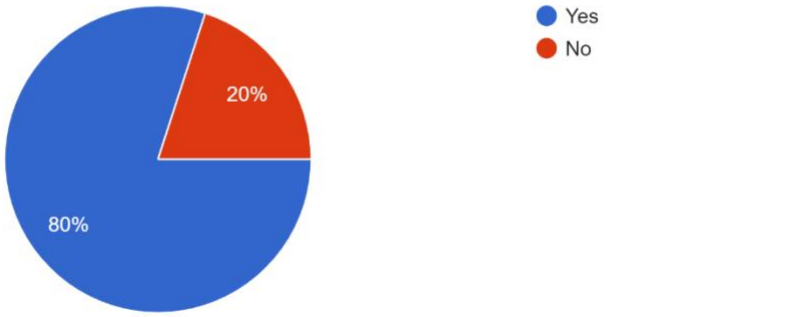
What is the frequency of water supply?

25 responses



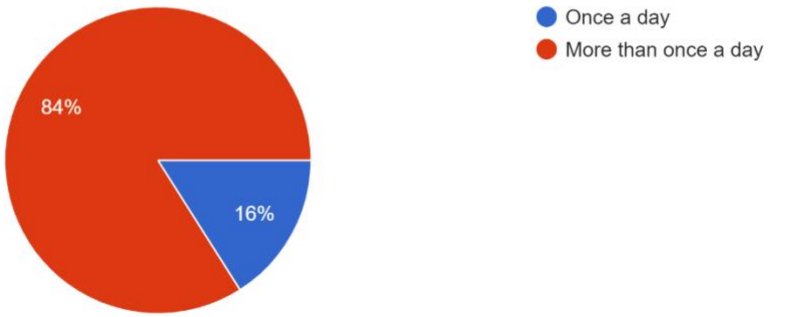
Is this frequency sufficient for your needs?

25 responses



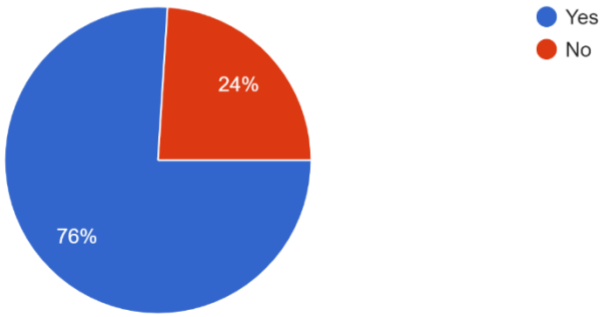
How often would you like to get water?

25 responses



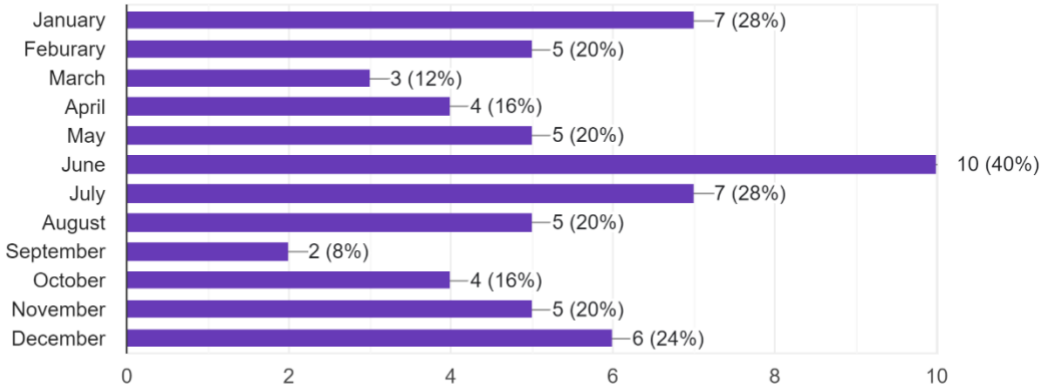
Is the quantity of water that you receive (from your main source of water) adequate?

25 responses



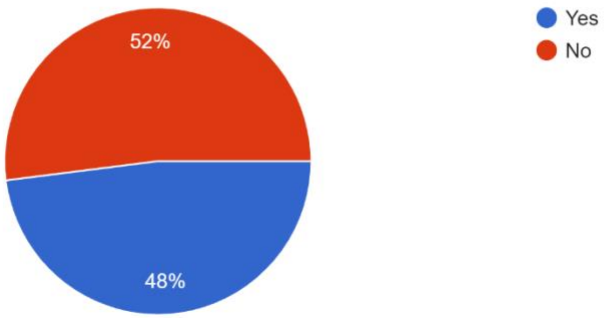
Which months do you face scarcity?

25 responses



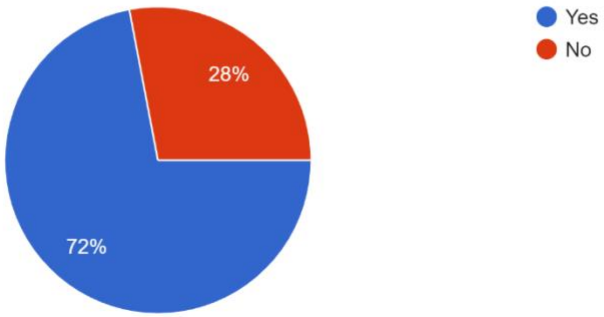
Generally, how does the water smell?

25 responses



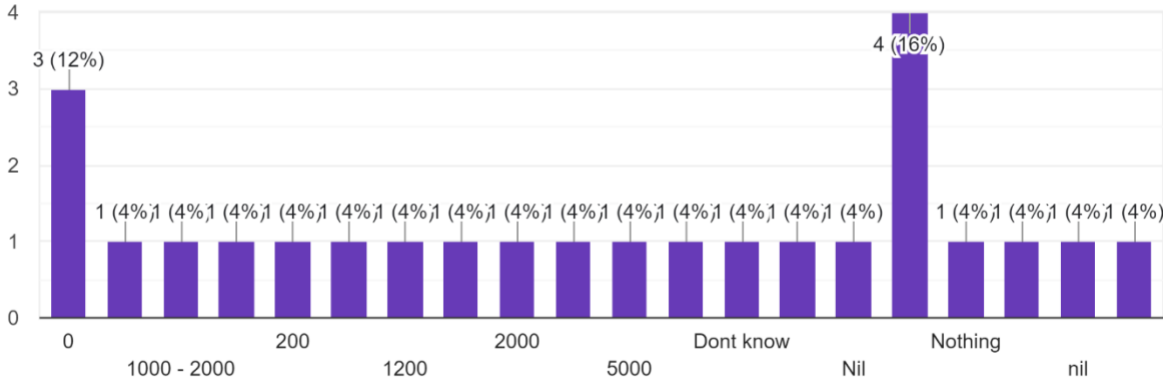
Generally, does the water have a taste?

25 responses



How much do you pay a month?

25 responses



Do you think that you have the ability and power to protect yourself from dangerous events from climate change?

25 responses