CHAPTER 2: LITERATURE REVIEW

This literature review will discuss the topics such as, drought's concept and definitions, history of drought in Afghanistan, coping mechanisms, drought's impact and vulnerability, governmental policies and early warning systems of drought, drought management around the world and in Afghanistan.

2.1 The Concept and Definition of Drought

2.1.1 Concept

Drought is a recurrent and normal climatic feature that affects majority of the countries to some extent (Wilhite, 1996). Wilhite D.A. (2000) described drought as hazard that has a slow onset, which means it progresses over months to years and affects a large area but follows with little cultural damage.

However, the onset and end of the drought and its severity is often difficult to determine. Meanwhile, its far more difficult to quantify the impacts and provision of disaster relief (Wilhite, 1996). There are three reasons for this difficulty, first, drought is a creeping phenomenon that slowly accumulates over time and may linger for years even after the termination of the event. Secondly, there is a confusion about the existence and severity of drought due to the absence of a universally accepted definition of drought. Thirdly, although drought's impact covers larger geographical areas, it rarely causes structural damages, which makes its impact less obvious (Olaleye, 2010).

According to Hisdal and Tallaksen (2000), Drought is an extreme rainfall shortage which results into the periods of low water flow, affecting the water managements in terms of river pollution, irrigation, reservoir design and management and drinking water supply. They believe that drought, by far, is one of the costliest natural disaster to our society. It affects more people and animals than if it was hurricanes, blizzards, or wildfire combined. Drought and its affects stays with the civilization for a long period of time unlike other disasters. Although all climatic areas may experience drought, but the feature can vary between different regions. The most vulnerable regions are arid and semi-arid lands.

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Generally, according to meteorologist drought is defined as a long period of dry weather or in atmospheric circulations its a result of the persistent large-scale fluctuations which may cause subsidence over an area (Agnew, 1989; Wilhite and Glantz, 1985), which may bring little to no rainfall to that specific location (Mather, 1984). The effects of drought that brings in other socio-economic pressure may cause disruption in the society that leads to human, material, and environmental losses. These losses may exceed society's coping ability by utilizing its own resources (Fitzgibbon and Hennessy, 2003). It is then that external interventions or support is required for people to cope with the vulnerability created. Of the most important activity is to produce the capacity and expertise for a timely and effective respond to drought disasters across various communities. Currently, the response to drought in Afghanistan is reactive when in reality it should be proactive.

2.1.2 Definition

The approaches taken to define drought is dependent on the impact and that specific region. The importance of drought is dependent on the impacts it has, the reason at times the government and people faced indecision or inaction on the parts of the policy makers and managers is due to the unavailability of specific definition.

According to Moneo and Iglesias (2004), drought definition depends on the region, as well as the demand people have placed on water. For example, a reduced rainfall on an area with low population or lack of, is also considered drought, however, the reduction of rainfall on a very populated area where agriculture is largely practiced is considered drought infested with the consequences that are rather harder in this case compare to the first case. The definition of drought is not restricted solely on a physical phenomenon, but it depends on the amount of water required by the country or society. Wilhite and Glantz (1985) categorized drought into conceptual definition and operational definition

2.1.2.1 Conceptual Definition

Conceptual definition is formulated in general terms (applicable to real-time drought assessments) to help with the understanding of the concept of drought as

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well as its effects. Here, drought is described as an extended period of rainfall shortage, causing widespread damages to crop and low yield. The conceptual definition of drought is considered to be important for the establishment of drought policies (Wilhite and Glantz, 1985). For instance, in Australia, drought policies incorporated the understanding of Normal Climate Variability to its policies, this way the country could provide assistance to farmers under the exceptional drought circumstances (National Drought Mitigation, 2006).

2.1.2.2 Operational Definition

Operational definition of drought is used to help people identify the beginning, end and droughts severity degree. It specifies the degree to which a departure from average of precipitation (or climatic variable) over a period occurs (National Drought Mitigation, 2006). The is normally carried out by comparing the 30-year period record of current situation to historic average. The term operational drought is often used in equivalence to water resource indicators, hence, it is not consistent with the broad definition provided by (Wilhite and Glantz, 1985)

2.1.2.3 Disciplinary Definition

Disciplinary definition of drought is classified based on:

Meteorological Drought: Meteorological drought is believed to be region-specific (the atmospheric conditions vary in different region) and is described as the first indicator of drought. It is expressed on the basis of the degree of dryness in comparison to "normal" or average amount and the duration of dry period (Wilhite and Glantz, 1985). The general concept used as a meteorological definition are: consecutive days of no perception, consecutive days of little precipitation, and specific period of time with little precipitation (Byun and Wilhite, 1999). Moreover, the definition given to "consecutive days", "no precipitation", "little precipitation", and "specific period" are quantified subjectively and empirical estimated values and not objectively. For example, some may regard less than 2mm a little precipitation while other meteorologist may regard less than 5mm as little precipitation. Similar with how consecutive days are defined, some use time frame

of more than 15 consecutive days of "no precipitation" while others use 25 days, months, season and other periods (Byun and Wilhite, 1999). Simply put, it is a deviation from average rainfall or snowfall which is calculated as dryness degree and duration of the dry weather due to below average precipitation (FAO, 2020).

Agricultural Drought: In Agricultural drought, we measure the drought as a physical phenomenon and it is when the amount of water in the soil does not meet the need of a particular crop (Backerberg and Viljoen, 2003), or in vegetation health and crop produce, it is a deviation which is calculated by the amount of soil moisture and state of vegetation and yield (FAO, 2020). According to Kumar and Panu (1997), there exists a close relationship between water stress and crop yield, hence, crop yield is considered a reliable indicator of agricultural drought. Meanwhile Wu and Wilhite (2004) used plant response to define agricultural drought, by using the extent to which the departure from the yield occurs; This was used as an indicator of the weather for a year.

Hydrological drought: hydrological drought expresses water shortages associated with precipitation shortage on a longer scale (12 months – 2 years and more (Rouault and Richard, 2003) in the surface and subsurface water and manifests the impacts and effects of the drought (Hisdal and Tallaksen, 2000). Hydrological drought is described by meteorologist in terms of the shortage of surface and subsurface water supplies, but it is also more concerned with the periods of precipitation shortfalls on the surface and subsurface water supply rather than with the percipitation shortfalls (Wilhite, 2000). Hydrological systems interconnects regions, that is why drought in upstream (changes in land i.e. deforestation… that changes runoff and soil infiltration rates) may affect the rate and severity of drought in downstream areas, as surface and subsurface supplies of water are affected. Though downstream region may (Wilhite, 1996).

Socio-economic drought: socio-economic drought deals with drought in terms of the supply and demand of goods and services. The Physical shortage of water that affects people, its effects are traced back to economic systems (Backerberg and Viljoen, 2003; Wilhite, 1996) For example, the supply of

economic good such as water and hydroelectricity depends on the weather; or the increase in demand due to population increase. With this concept of drought, we understand why there is a strong symbiosis between human activates and drought; and why it is important to properly manage natural resources. It comes about as a result of meteorological, hydrological, and agricultural drought and is calculated as the economic level changes i.e. income flows, poverty levels, and social factors i.e. migration, poor coping strategies (FAO, 2020).

2.2 Drought Prediction

The prediction of drought depends on its ability to forecast two fundamental meteorological surface parameters which is precipitation and temperature. The two methods through which droughts can be predicted is statistical and dynamical methods. The statistical method is based on historical records with no consideration to the physical mechanisms. It relies on the relationship between the indicator of drought that is to be predicted and the influencing factors (predictors) (Hao, 2018). Looking back at the historical record, we know that climate is inherently variable and that the anomalies of temperature and precipitation may last rom several months to decades (National Drought Mitigation Center). Dynamical method is based on the GCMs (Circulation models) or hydrological models that are capable of modelling the weather's and climate system's physical processes. Although adaptable to model extreme drought conditions, they do require huge investment in the development of model and parameterization. The hybrid statistical-dynamical method is recently used that merges both methods for more promising drought predictions (Hao, 2018).

It is important to make a long-term reliable drought prediction. However, because of the chaotic nature of the atmosphere, the ability to predict precipitation reduces after 2 weeks (Yuan *et al.*, 2011). This is considered a challenge in the prediction of meteorological, hydrological and agricultural drought (Hao, 2018). Another factor that poses difficulty in the prediction of drought is climate change and human activities. For example, when it comes to hydrological drought, it relates more to human activities i.e. irrigation, hence, modelling of human activities

becomes necessary for the prediction to be accurate. While the current drought prediction is more focused on natural aspect, research in the human aspects is growing but currently it's limited (Hao, 2018).

2.3 Drought around the world

According to (World Health Organisation (WHO), 2020), water shortage affects 40% of the world population with about 700 million potentially displaced by the year 2030 because of drought. As the severity, frequency and magnitude of drought has been increasing, concerns are rising as well as most countries are still practicing drought measurement in a reactive manner (Fasemore, 2017), For instance, north-eastern Brazil experienced drought in 2010 and 2013, but it was only later years that the government started to begin proactive planning (Gutiérrez *et al.*, 2014). India on the other hand, have been experiencing drought since 2015 which affects around 600 million people but despite that, water demand will double than what is available by 2030 (Roy, 2019). Since a huge amount of country's income comes from sectors such as agriculture and this sector is primarily dependent on rainwater, lack of rainfall greatly affected the economy (The Borgen Project, 2016).

In northern China, Shanxi province, around three million of the population are in serious need for water, meanwhile, this incoming drought has caused a third of the wheat crop to dry up in eight provinces (WorldAtlas, 2021). Local populations were forced to migrate with the wheat prices skyrocketing. In Australia, drought being in 1995 and until 2009 it has already spread across the whole of the country. This drought resulted in the exhaustion of reservoirs and reduction in crop production (Iceland, 2015), and forced various cities to depend on the desalination and recycling of the grey water as a drought mitigation (Worldcrunch, 2020). Moreover, Barcelona is reported to have imported water from France in 2008 (Iceland, 2015) and Syria is reported to have suffered drought from 2006 to 2011 (WorldAtlas, 2021)

Africa has also suffered from water shortage where the condition has worsen due to poor infrastructure (Shiferaw *et al.*, 2014). (Shiferaw *et al.*, 2014)As the

UNISDR (2011) puts it, that hazards only becomes a disaster when other human elements factors in, such as improper usage of resource, lack of proper infrastructure maintenance, poverty, and environmental degradation. Drought's impact is observed through poverty, income loss, outbreaks of diseases, and migrations (Fasemore, 2017). The frequency of drought occurrence in Africa is ranked high since 1960s with 382 drought events and 326 million people affected (Shiferaw *et al.*, 2014).

A complete research performed by Oboneng Cynthia Nonjola (2021) assessed the drought vulnerability and coping capacity of the village of Borakalalo's communal farmers located in northwest province of South Africa. The study indicated that the coping strategies that is implemented by the farmers are limited and the extent to which the vulnerability is addressed is very minimal. The research indicated that the government's approach towards drought management is reactive rather than proactive and it is suggested that collaboration between the government, farmers and tribal authorities is required in order to organize a proper approach to drought management. The findings of the research indicated livestock reduction due to factors of coping mechanism with drought or due to drought-induced mortality. Although the early warning system of the government is acknowledge by the farmers, but since there is resource placed to implement disaster reduction measures, communities cannot do much with the awareness programmes. Hence, the government is required to put effort into capacity building and make resources accessible to farmers (Oboneng Cynthia Nonjola, 2021).

Countries like Malawi, Zambia, Zimbabwe, Lesotho, Mozambique, and Swaziland are the few South African countries with major drought-related issues since 2002 with over 16million people affected and even facing starvation (Tadesse, 2016). Each of the countries are also affected differently, for example, in 2015 Zimbabweans lost their jobs and income in rural areas as the agricultural production failed, as well as loss of 60% of their cattle herd (Ndlovu, Prinsloo and Le Roux, 2020). Not only drought has caused mass migration of people to neighbouring

countries, but it has also shortened the life expectancy of the population (Frischen *et al.*, 2020)

In Central Asia, besides Afghanistan or Tajikistan, Kyrgyzstan has been affected. Kyrgyzstan is arid and semi-arid mountainous country which suffers from frequent drought occurrences. Similar to Afghanistan, agriculture plays an important role in the economy of the country and these drought events has affected their agricultural systems and animal husbandry. The regions with high agricultural vulnerability is mainly towards the southeast, southwest, and northwest regions while the central and northern regions of the country have lower vulnerability. Kyrgyzstan has abundant water resources but with the backward infrastructure, the irrigation facilities has become restricted hence hindering the development of agriculture. The suggested plan to reducing vulnerability of agricultural system in Kyrgyzstan is increase in the investment of infrastructure and the building of irrigation systems (Liang, Zhang and Qin, 2021).

These countries were given as an example since the socio-economic and political conditions of the listed countries has some similarities to Afghanistan. As evident, different countries deal with drought differently but the issues of drought and lack of governmental intervention is almost similar in majority of the listed countries. This indicates the important role the government plays in helping farmers and creating drought-resilient community.

2.4 Drought in Afghanistan

2.4.1 Afghanistan's Geography and Climate

Afghanistan is a land-locked, arid country Figure 3 located at the juncture of South, West, and Central Asia and covers over 652,000 km^2. The country is not in any direct contact with the sea but has many major rivers. One of the major rivers in Afghanistan is "Amu Darya" or Amu river/Oxus river Figure 4, which flows into the Aral Sea. The land surface of Afghanistan includes high peaks of various mountains that could reach as high as 7,000 meters examples of these mountains are Noshaq mountains, and Hindu Kush Mountain ranges. At lower latitudes, there

are significant desert regions at the southwestern platea and large arid steppe. Despite the lack of vegetation in these region, it still support unique landscapes and biodiversity of ecosystems (World Bank Group, 2020).

Figure 3 Afghanistan is a mountainous landlocked country bordered by Iran to the west, Pakistan to the southern and eastern, Uzbekistan and Turkmenistan at the north, Tajikistan and China to the north eastern
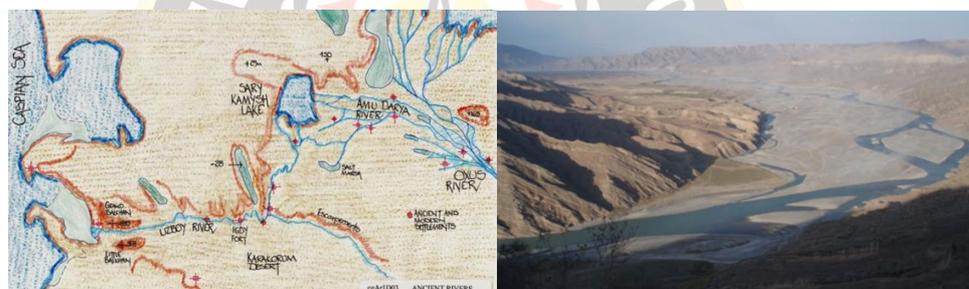

Figure 4 (To the left) Sketch of the old Amu Darya system that is connected to Caspian Sea by Uzboy river (Image from: Okar research website). (To the right) Panj and Amu Darya (Image from: University of Nebraska Omaha)

The temperature and precipitation in Afghanistan varies between each season with the country having an arid continental climate Figure 5. The temperature in Afghanistan varies greatly depending on the altitude, for example, mountainous regions experiences annual temperatures of below zero while southern arid regions experiences temperature of over 35°C. This is the case with precipitation as well, it varies based on the topography of regions, southwestern arid regions experiences less than 150 mm of rainfall every year while the north-eastern regions which are mountainous experiences more than 1,000 mm of yearly precipitation (Aich *et al.*, 2017).
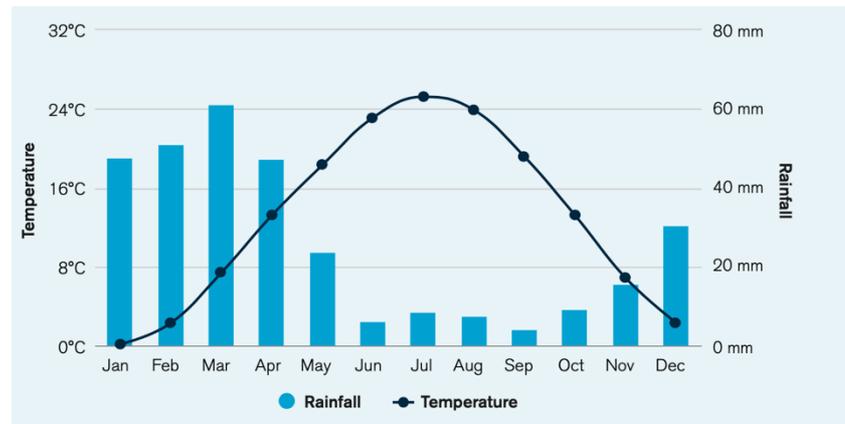
Figure 5. Shows month average rainfall and temperature in Afghanistan from 1901 – 2016 (WBG Climate Change Knowledge Portal (CCKP), 2019)

2.4.2 Drought Impact in Afghanistan

The variables that characterizes drought events are frequency, intensity, severity, onset, cessation, duration, end point, and area affected; the understanding of these variables are important from the perspective of drought risk management (FAO, 2020). Drought has become a common recurring disaster almost every year in Afghanistan since the 1997 and its only recently that drought occurrences have become more frequent. As shown in Figure 6 18 out of 34 Afghanistan's provinces are highly vulnerable to drought where at least one district of 60,000 people are frequently exposed to drought (UNICEF, 2016). Since the 1950s, droughts and floods have affected over 21 million people, and over 5000 deaths (AMD, 2020).
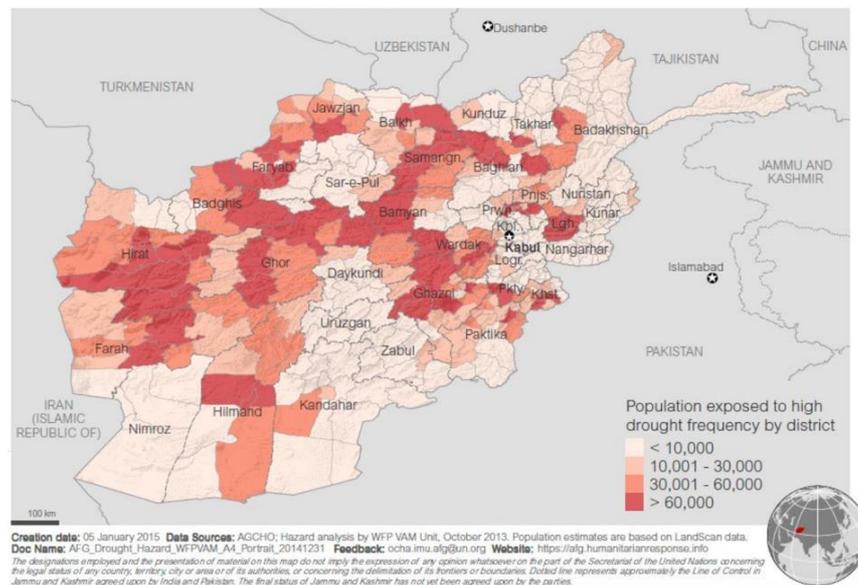
Figure 6. Exposed population to Drought

The two types of drought that affects Afghanistan is meteorological and hydrological. Meteorological drought is when there is a precipitation deficit and hydrological drought is when there is a deficit in surface and subsurface water. This combined with the failure in crop and land management have resulted in agricultural drought (Pervez, Budde and Rowland, 2014). For instance, water resource in some regions of Afghanistan are provided with great amount of runoff from the mountains but these runoffs are not well distributed to the communities that requires them the most and hence they are lost to inadequate and damaged infrastructures (Ward, Amer and Ziaee, 2013).

Meteorological drought in the northwest, central and northeastern regions is already increasing as the result of lower precipitation in spring and increase in evaporation. Meanwhile, hydrological drought is increasing in the northeast regions as there is reduced snowfall that feeds the river systems (National Environmental Protection Agency, 2013). The meltwater from the glacial of mountains has been the main source of water supply during the years of drought. It is predicted that if the rapid reduction in the glacial mass continues in the first half of the century, it may lead to lower runoff in the second half of the century. The reduction in the glacial of impacted regions due to lower snowfall and rapid melt in earlier decades

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has led to reduced runoff in the second half of the century, this will worsen drought impact on Afghanistan's water supply (Pritchard, 2019).

Famine Early Warning Systems Network (FEWS NET) is warning of another extreme multi-season drought in Afghanistan. This news comes after the US worked to mitigate the effects of severe drought in its southwest region. All the three regions which is southwestern US, eastern Horn of Africa and Afghanistan is said to experience extreme drought because of La Niña events. La Niña events are due to climate change and rising temperature (FEWS NET, 2020). Andrew Hoell, the principal investigator in FEWS NET, explained La Niña as an event that modifies the atmospheric circulation which leads to high pressure and reduces the storms, all of which results in the below average precipitation. He also explains that "climate change is a modifies that makes drought worse". La Niña events is intensified in two major ways. First is when climate change increases the temperature of sea surface in West Pacific and Indian oceans. This results in the increase in temperature contrast across the Pacific Ocean and hence leads to a far below average precipitation. Secondly is when climate change causes rise in temperature where there is greater demand for moisture by the atmosphere but the availability of moisture on the land surface is reduced. Increase in temperatures and increase of dryness both factors make coping with La Niña induced droughts challenging (FEWS NET, 2020).

The latest observation of precipitation in Afghanistan was based on the CHIRPS (Climate Hazards Group InfraRed Precipitation with Station Data) datasets which shows the below an average cumulative precipitation for 2021/2022 across the country, especially in Northern, Northeastern and central areas of the country (FEWS NET, 2022).

Seasonal Rainfall Accumulation Percent of Normal by pentad
2021-2022 season Oct - May
(Oct pentad 1 2021 thru May pentad 6 2022) / Avg (1981-2010) * 100

% of normal
< 55
55 - 70
70 - 85
85 - 95
95 - 105
105 - 115
115 - 130
130 - 145
> 145
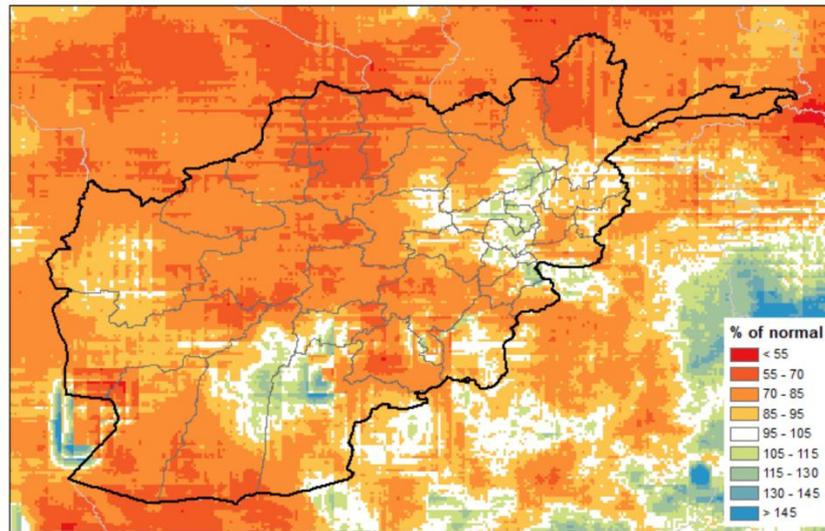
Source: CHIRPS version 2.0 final

Map produced by USGS/EROS

Figure 7. precipitation Observation indicating below cumulative precipitation for the wet season
(FEWS NET, 2022)

This consecutive below-average rainy season have left no room for groundwater recovery and has led to poor vegetation, all of which severely impact the livestock and agricultural livelihood. According to Hoell, even if there were adequate rainfall during the upcoming wet season, it will only do as much as to replenish the moisture in soil, but not really recharge the reservoirs. The recharge will only occur if the precipitation is average or above-average for consecutive seasons with a 5-10 year of successful rainy seasons to fully recover groundwater levels (FEWS NET, 2020).

Using a climate data from the period of 1978 to 2005, the current projection for Afghanistan's temperature until 2050 is set to show the temperature increase across the country. The most affected areas that will see a temperature rise of at least 2°C by 2050 is the high mountains of Central Highlands and North-eastern regions. Moreover, Northern areas will experience an annual decrease of around 22 mm of rain and far southwestern areas i.e. Farah and Nimroz will experience a

moderate increase (National Environmental Protection Agency, 2016). Evidently, by the middle century, there is the potential increase in the frequency of extreme drought events, information provided by Naumann *et al.* (2018). A 2018 research of drought impacts on farming households in the west of the country, Province of Herat, Afghanistan was performed that indicated negative environmental, social, and economic impact of drought is a great representative of the drought in Afghanistan (Iqbal *et al.*, 2018). Some of these impacts were the lower living standard, poor financial situation, and unemployment of unskilled workers who dependent on farming. Moreover, the social impact of drought consists of community's conflict over water resources, increase in migration, and deterioration of mental and physical health, and adverse impacts on educational outcomes. The existing policies and strategies used in Herat Province, for the severe cases of drought, has so far been ineffective (Iqbal *et al.*, 2018).

The nature of drought's impact is multi-sectoral, multi-scalar, and multi-temporal. Multi-sectoral is when the impact is seen at different sectors of water shortages to adverse effects on agriculture and livestock, and to food insecurity, increased school dropouts, early marriages and reduction in DGP. Multi-scalar is when the drought impact affects across the micro i.e. households and specific ecosystem to meso that covers watersheds, markets, larger ecosystems, districts and provinces, living zones to macro which is river-basins, demographic scales, agro-ecological zones, and from provinces to nationally. Scalar impacts are also experienced by provinces or districts that are not in the drought affected zones, for example; these provinces experiences depressed labour wage, increased food prices, skewed hydrological balances… The multi-temporal impacts extend over months to seasons and years over an agricultural season that results in loss of crop production, yield, and livestock.

Despite the fact that the country has continuously experience drought and coped, data and analysis is still scarce when it comes to drought impact. The most direct impacts of drought, over the past 25 years, have been in health and sanitation, natural resources, water, and agriculture.

The following are the direct impacts of drought in the country according to (FAO, 2020).

1- Reduction in yield and crop production.

2- Decrease in the productivity of livestock, diseases are also a contributing factor that at times have resulted to death.

3- Displacement and migration

4- Food insecurities

5- Increased child labour as adverse coping strategies were adopted.

6- Loss of productive soil due to the degradation of natural resources that eventually lead to desertification

7- Farmers and herders forced to adopt practices Independently, without government's supervision.

8- Unsustainable use of natural resources

9- Gender-based exploitation of young girls given forced into marriage

The indirect impacts of drought are as follows;

1- Household poverty, economic insecurity, indebtedness

2- Violence (including GBV)/ conflict/ societal disruptions

3- Human Capital Formation: Health and Education Outcomes

4- Degradation of Natural Resources

5- Reduction in GDP

2.4.3 Drought Vulnerability and Coping Mechanisms

The most vulnerable group of people are the ones that are directly dependent on the natural resources for their basic needs (Patrick, 2003). The people living on dry lands are considered to be the most politically and ecologically marginalized group of people with the limited natural resources i.e. water with disruptions in the rainfall that can initiates catastrophic level disasters such as famine. The term "vulnerable" is defined differently but the most basic definition of vulnerability is "to wound" taken from its latin root vulnerare. Hence vulnerability is the capacity to be wounded (Kates, 1985). Vulnerability as a concept has a common thread that

all agrees upon, is that vulnerability shows the degree of defencelessness of a community to a hazard due to different variabilities i.e. degree of exposure and coping abilities (Olga and Wilhite, 2002)

On the other hand, vulnerability is also defined from two perspectives, both of which is important when considering the implication of vulnerability for drought reduction: the first perspective is the "risk-centric view" where the vulnerability is defined as variability in the standard of living caused by the consumption or income shocks. The second is "right-centric view" where the vulnerability is said to be caused by the lack of political and social rights (Binayak, 1996). The contributing factors to vulnerability is economics, technology, social relations, biophysics, demographics, health and decision-makings (Dow, 1993). Vulnerability differs in developing and developed countries; in developing countries, vulnerability of drought is a threat to individual's livelihood and the ability of the country to maintain healthy and productive systems and economies. Meanwhile, vulnerability in developed economies poses major economic risks and costs for individuals, the governments, public enterprises, and commercial organizations (Downing and Bakker, 2000).

Meanwhile, according to Kivaria (2007), coping mechanism is individuals, groups or society's response to challenging situations based on their risk aversion or tolerance level. Coping mechanisms are set to minimize risk or tolerance level and manage losses. Adams, Cekan and Sauerborn (1998) on the other hand defines coping mechanism as short-term strategies that are adopted in response to crisis.

The vulnerability of Afghanistan to climate change is due to many factors such as social, political and geographical. The country's climate change vulnerability and other challenges as well as its resilience is ranked 176th out of 181 countries according to a 2019 ND-GAIN index by University of Notre Dame (2019). Meanwhile, Norway has received the highest score of rank 1st. If the scores are lower, it indicates country's high vulnerability; if the scores are higher, it indicates country's readiness to improve its resilience.

The effects of drought on agriculture have attracted a number of studies recently. One such study is by Meraj Sarwary *et al.* (2021) on "Climate Risks, Farmers Perception and Adaptation Strategies to Climate Variability in Afghanistan". This study discusses the vulnerability of the regions and the coping strategies of farmers under changing climate in the Provinces of Kabul, Bamiyan, Kapisa, Parwan, Panjshir, Wardak, and Ghazni (Meraj Sarwary *et al.*, 2021). The result of the study shows that around >80% of farmers perceives a "high to very high" degree of impacts due to climate which has resulted in unemployment, scarcity of labour, disease and pest outbreak and reduction in groundwater level. In general, the coping strategies implemented is the drilling of new boreholes, farm diversification, and changing the patterns of crop. When it comes to the policies, the strategies developed was to establish automatic weather stations, weather-based crop insurance, agricultural practices that are climate-smart, and providing agro advisory services.

Moreover, another study by Aliyar *et al.* (2022) revealed the perceptions and adaptation strategies of farmers in Bamiyan Province of Afghanistan. In this study, the perceptions of farmers with regards to drought and climate was compared with the meteorological data. The findings of the study showed that farmers perception about drought is due to increase in average temperature and reduction in average precipitation from 1998 – 2017. Their perception was further proved corrected by the analysis of meteorological data and climate data where the rainfed areas have suffered greatly by drought frequency and severity compared to the irrigated areas. There were two main adaptation strategies implemented by farmers a) on-farm adaptations which is the early sowing, sowing of drought-tolerant crops, crop diversification, and leaving behind the uncultivatable lands; b) off-farm adaptations strategies were the handicrafts, migration, labour wage, and the diversification of income (Aliyar *et al.*, 2022). In short, the findings from both of these researches indicates the need for localized strategies as it showed the differences in the vulnerability and adaptation strategies of farmers across different environment.(Aliyar *et al.*, 2022). These studies indicates that drought perception,

vulnerability and practices differs from place to place because of the interaction of the drought with diverse human factors (Udmale *et al.*, 2014).

Another study by Iqbal (2018) evaluated the farmers perception and adaptations to drought in Herat province, Afghanistan. The result of this study indicated the following serious impacts,

i) Economic impacts which has lowered farmers living standard and their financial situation i.e. loss of employment, and production reduction in crop and livestock.

ii) Social impacts which includes migration, conflict over water, health issues, illiteracy among children, malnutrition, and limited food options/

iii) Environmental impacts such as degradation of forests and grazing lands, water quality deterioration, groundwater depletion, temperature rise, and disruption of wildlife habitats.

The study also reported the local techniques used by the farmers. For example, the most successful technique in solving conflicts was through local elders, formal courts, and water-user associations.

2.4.4 Drought's Impact on the Agriculture Sector

Afghan people highly dependents on agriculture for livelihood. The sector of Agriculture employs almost half of the working population in the country. Hence why the country is under regular threat to its local production due to natural hazards. According to Pervez, Budde and Rowland (2014), During the years of water shortage, up to 30% reduction in the area of irrigated agricultural production can occur which is a major indicator of droughts livelihood impacts. Afghanistan's NC1 reported that the period of great drought impact was 1997-2007 when the country saw 50% reduction in livestock numbers. Moreover, during the droughts of 2017 – 2018, staple crops i.e. wheat experienced yield reduction of up to 50% (Government of the Islamic Republic of Afghanistan, 2018). Despite the size of agriculture sector in Afghanistan, in terms of financial value, the country still remains a net food

importer, hence vulnerable to external price shocks. For instance, recently the cereal imports to the country met with a 29% of annual domestic cereal production partly because the country lacks a wheat milling capacity (FAO, 2019). This is the case despite the fact that the country is mainly reliant on wheat for food consumption.

The impact of Climate change on agriculture production results on adverse health and productivity impact on the labour force. It is suggested by Dunne, Stouffer and John (2013) that the global labor productivity have dropped by 10% during the peak months of warming, and a further decline is expected by mid-century which can reach up to 20%. Moreover, the cases of drought have forced farmers to turn into an alternative option which is the cultivation of opium poppy. Opium poppy is resilient to drought hence the increase in its cultivation in the early 21st century (Parenti, 2015).

On the other hand, Some studies shows the positive impact of climate change on agriculture which is the atmospheric increase of CO_2 and longer period of growing season that may increase revenue (Mendelsohn, 2014). However, for it to be a positive impact, four factors are to be considered 1- proper water management; 2- utilizing and adapting new technologies i.e. new crop varieties, early warning systems…(Aich *et al.*, 2017); 3- take necessary actions to prepare and educate farmers about new pests and diseases (Shabani, Kumar and Esmaeili, 2014); and 4- preventing natural disaster with risk reduction.

2.4.5 Government's Drought Policy and Strategy

The occurrence and experience of drought and other disasters is nothing new to Afghan people, despite this, the country still lacks a proper coping strategy, data, and analysis when it comes to drought impact. The absence of a coherent government for a long time has led to ministries at provincial and national levels to withdraw from their traditional roles leaving the country with no proper institution to monitor the groundwater and surface water. Although in recent years, the data gathering and mapping of water has improved with the help of foreign organizations, but the country still faces the challenge of developing a proper and

long-lasting strategy and management as well as the effective use of the data (even if the information is insufficient). This is a continues struggle since 2002, for example in 2018 during severe drought, President Ashraf Ghani sent his Advisor Dr. Humayun Qayumi to the California University for the purpose of setting up an early warning system for drought in Afghanistan. However; the proposed project failed to meet the government's expectation. Afterward the president suggested the establishment of a research centre that involved professors from University of Kabul and Polytechnic, but so far little progress has been seen. This just proves the incompetency of the government and ministries in the implementation of the policies in different sectors. This lack of attention is especially the case towards the communal farmers.

The policy and institutional landscape of Afghanistan carries an imprint of the long history of dealing with multiple drought events. There have been multiple initiatives by GoIRA and development partners at policy, institutional and drought response, recovery and mitigation levels, which is a remarkable feat in the context of chronic political instability and the ensuing governance deficits. According to a report by FAO (2020), the Government of Islamic Republic of Afghanistan (GoIRA) in 2018 modified their drought managing approach to more proactive. This was performed under H.E. Dr. Mohammad Ashraf Ghani, Former President of Afghanistan. In the FAO (2020) report, H.E. Eng. Nasir Ahmad Durrani, Minister of the Ministry of Agriculture Irrigation and Livestock formulated a 2019-2030 drought-risk management strategy. The main focus point in the drought risk management action included: 1) The creation of prevention of the new risks, 2) mitigating and reducing the existing risks, 3) managing the residual risks through preparedness, early actions and fast-response, and 4) Mitigation actions are to be mitigated into annual sectoral working plan and budget. The suggested long-term strategy proposed here focused on all the aspects of drought management rather than only focusing on the preparedness and response management as was done on the previous suggested strategies.

The strategy focused on two sectors, agriculture and water, both of which were either hugely impacted by drought or were a contributing factor to the threats of drought. In the agriculture sector, the strategy covered croplands, livestock, forest, rangeland, and soil subsectors; Meanwhile, in the water sector, the strategy covered small, medium and major irrigation, watershed management, groundwater recharge, dams, river basins and sub-basin management, small storage, and rainwater harvesting (FAO, 2020)

The strategy vision was "drought disaster free Afghanistan" with providing ten guiding principles and four strategic priorities: 1- Strengthening drought-risk governance; 2- Improvement the capacity of drought risk assessment and vulnerability; 3- Improving early warning, action and monitoring system; and 4- investment in the drought risk mitigation and response. These strategic priorities aligned with the various sectoral policy instrument in the country and drawn upon the three High-Level Meeting pillars on the Drought Policies in Geneva in 2013.

2.4.6 Early Warning System in Afghanistan

Early Warning System or EWS is an approach used to minimize the risks of potential hazard and eventually improve community resilience against natural disaster. EWS is considered to be the most practical and cost-effective disaster risk prevention measure. According to United Nations International Strategy on Disaster Reduction (UNISDR) EWS is "The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organisations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss." For an effective EWS, the approach must integrate the key elements of risk knowledge, Monitoring and warning, Dissemination and Communication, and Response capability (UN Environment Programme, 2021).

In Afghanistan, the data collection and observation of the hydrological and meteorological data started in late 1940s followed by the analysis in mid 1950s. The hydrometric network reached its peak of 150 in the 80s (WB., 2018). Years of conflict and war destroyed most of the equipment that were rather most advanced

and functional before the year 1979. With the Taliban taking over in late 90s, most of the weather records were destroyed (NEPA, 2018). However, since 2001 rehabilitation and installation of the weather stations took place. Some of the old stations has been reinvented and new stations have been installed. The leading agency in collecting, processing and reporting of the data related to weather is Afghanistan Meteorological Department (AMD).

In the framework of disaster management in the country, the governing body is the National Disaster Management Commission (NDMC), established in 1971. It is the principle body that sets out policies related to risk management, vulnerability and emergency responds. NDMC works with ANDMA and ANDMA has provincial offices in all of the provinces. At provincial level, the Disaster Management Committees (PDMCs) are responsible and at a district level the governor plays the role of coordinating the district level disaster management committee (DDMC). Support is provided to DDMC by the district development assembly (DDA), municipalities and various agencies. Moreover, at local level the community development councils (CDCs) is responsible for disaster management(UN Environment Programme, 2021).

The EWS is included in most of Afghanistan's national disaster policies and other related-plans but it still lacks a long term strategic plan. The community-based early warning system was introduced by the Strategic National Action Plan (SNAP) in the year 2011 to help reduce the disaster risks and in 2015 a four-year strategy for the assessment and establishment of the existing EWS was developed by the Afghanistan National Disaster Management Authority (ANDMA., 2015). Currently at national level, AMD and NWARA are the two organization and monitor, forecast, and issue warning on natural disasters. In Afghanistan, AMD owns around 25, manually operated, active synoptic stations (SYNOP) and initially around 50 of SYNOP stations are required to provide complete coverage of the weather throughout Afghanistan. NWARA, on the other hand, owns around 30 Automatic weather stations and 125 hydrological stations (UN Environment Programme, 2021).

The warning system remains at a province scale and hence do not provide detailed information at a local scale for an efficient risk management to take place, hence, it is concluded that a systematic network of EWS do not exist in Afghanistan. The EWS challenges are mainly related to institutional arrangements, financial resources, and technical and technological capacity (UN Environment Programme, 2021). When it comes to the intuitional arrangements, the responsibilities of EWS is divided among many institutions which is why it has created some coordination and communication issues.

2.5 Drought in Balkh Province, Afghanistan

Balkh Province is one of Afghanistan's thirty-four provinces, located at the northern regions and bordering with Turkmenistan. The province serves as the second and main gateway to Central Asian countries, the other province is Kunduz's Sherkhan Bandar. The population is estimated about 1,509,183 (National Statistic and Information Authority (NSIA), 2021-22) which are ethnically diverse and with the majority in rural districts busy farming. There are total of 15 districts with Mazar-i-Sharif serving as the capital city of Balkh province and hence there are major ethnic groups such as Tajiks and Pashtoons followed by other ethnicities like Uzbek, Hazarars, Turkmen, Arabs and Baluch. Nearly half of the province is covered with mountains or semi-mountain terrains, meanwhile the other half of the province is just flat land. The mountainous areas is to the south of the province while farmlands are concentrated around the central-west areas.

Balkh Province is one of the most drought affected provinces and where people relies on agriculture. It is also one of the provinces which is affected by climate change, decrease in precipitation and snowfall Figure 1. Balkh is considered to be one of the areas consisting of major wheat production in Afghanistan which normally produces around 210,000 metric tons of wheat per year. According to Balkh's department of agriculture and livestock, the decline in wheat production and other agricultural products is due to the lack of rainfall in the past few years. This has contributed to 80% harvest decrease through rainfall and 40% harvest

decrease through irrigation. Most wheat grown in the districts of Balkh, Chamtal, Dehdadi, Chahar Bolak, Dawlatabad, and Shulgara (Hasht-E Subh, 2021).