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Climatic Events and Natural Disasters of 21st Century: A Perspective of Pakistan

Hafiz Muhammad Umer Aslam[1], Aisha Asif Butt[1], Humera Shabbir[1], Mohsin Javed[1], Shabbir Hussain,[2*] Sohail Nadeem[1], Hamid Raza[1], Shah Muhammad Harron,[1] Sidra Arshad[1]

[1]Department of Chemistry, School of Science, University of Management & Technology, Pakistan
[2]Department of Chemistry, Lahore Garrison University Lahore, Pakistan

*Email: dr.shabbirhussain@lgu.edu.pk

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Abstract: In recent years, the frequent occurrence of natural calamities in the world has gained much attention due to infrastructure and life losses. Increase in global temperature has threatened the earth's climate, causing unpredictable and extreme weather events more often. These events were both short-term as well as long-term. In spite of insufficient monitoring coverage of inner areas and high altitudes, an intensification of average yearly temperature has been observed after the 20th century in many regions of Asia. Pakistan has faced a number of natural disasters including severe floods, devastating earthquakes, disturbing droughts, distressing smog, extreme temperature and torrential rainfall patterns. These calamities have affected people economically, socially, physically and mentally by posing a threat to earth, its species and their livelihood. This paper was aimed to document the natural calamities in Pakistan since the beginning of 21st century till date. The country is facing the problem of intense and longer summers and has witnessed two intense heat waves. Moreover, in some areas, extensive droughts are threatening crops, freshwater supply and wildlife. In recent years, the problem of smog has emerged in Pakistan, especially in Punjab. The problem is getting worse in every coming year due to overpopulation, cities expansion, increased emission of greenhouse gases, open burning of crop residues and extreme reliance on fossil fuels for energy purpose. So far in this century, Pakistan has faced 3 droughts, 2 heat waves, 10 severe floods, 27 major earthquakes, 2 consecutive sessions of severe smog and extreme high and low temperature events. Some of the deadliest events were; 2005 Kashmir earthquake claiming 87,350 human lives and 2010 flood impacting nearly 20 million people with 1,781 causalities. Change in climate is posing a severe threat to species, livelihood of the human beings and the earth. Global warming is causing warming of oceans and consequently rise in sea level. Climate change affects average as well as extreme temperatures hence increasing the probability climate-related disasters. Thus, global warming is causing a chain of catastrophic events that make the problem even more complex to understand.

Keywords: Natural disasters, climate change, 21st century, heat waves.

Introduction

Climate can be defined as the weather conditions of an area that are observed over a long period of time. It includes atmospheric pressure, temperature, wind flow, precipitation, cloud cover, sunshine intensity, humidity etc. Climate change is defined as a change in weather patterns of an area compared with the past short and long-term records (Abas and Khan, 2014). Short-term changes in climate occur constantly in the environment while long-term variations are resulted mostly due to greenhouse gases like methane (16%), carbon dioxide (76%), CFC's (2%) and nitrous oxide (6%) (Pachauri et al., 2015).

Increase in global temperature is threatening the climate of earth, causing more unpredictable and extreme weather. For example, frequencies of intense heat waves are increasing and record droughts are also affecting many regions of the world (Crowley, 2000). In many regions of Asia, an increase in average yearly temperature has been observed after the 20th century despite insufficient monitoring coverage of inner areas and high altitudes. This warming tendency was very strong from November to March during 1901-2009 period, with a rise of 2.4ºC in the semi-arid region of Asia (Jingdong et al., 2016).

With the beginning of 21st century, Pakistan has been affected by a number of climatic calamities. These include severe floods, devastating earthquakes, droughts and extreme temperature and rainfall patterns (Rehman, et al., 2016). Weather calamities affect people socially, economically, physically and mentally. Earthquakes destroy buildings and structures, exposing people to extreme weather conditions in a helpless state. Famine causes the death of two to three children every day in the Thar desert and in Punjab, the same happens due to swine flu and dengue. Out of 1000 children, on average 111 die before their first birthday due to insufficient health facilities and lack of proper access to the polluted air, contaminated waters and adulterated foods. Changes in minimum and maximum temperatures, floods, droughts and modification in monsoons have badly affected agriculture in Pakistan (Abas and Khan., 2014).

Climate change is giving a tough time to wild animals and humans for their survival. Frequent and severe storms, droughts, heat waves, rising sea levels, warming oceans and melting glaciers directly or indirectly affect animals and plants, destroy their

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habitats and cause sufferings to the people. As a result of changes in climate, extreme calamities become more common, severe and frequent that causes vast destruction (Tangborn, 2003).

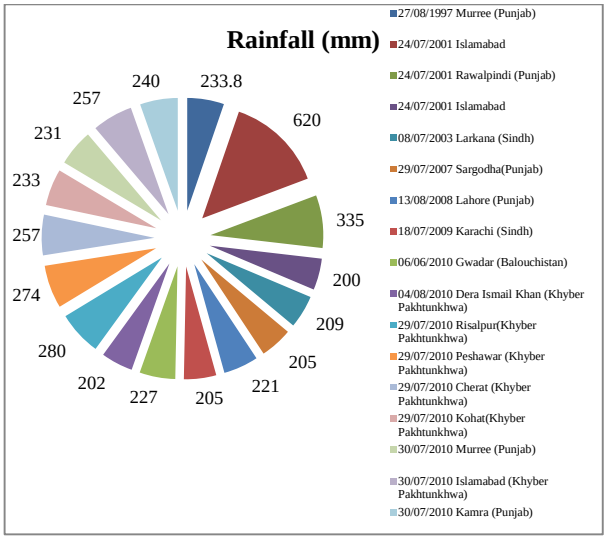


Fig. 1 Heaviest rainfall in Pakistan during 24 hours from 1997 to 2009(Kapadia, 2014; Qaiser, 2014; Salma et al., 2012).

Climate change is affecting the whole world with developing countries being highly prone. To resolve this issue, international climate debates are increasing day by day to properly address the issue and making people more aware and prepared for natural calamities (Anis, 2015).

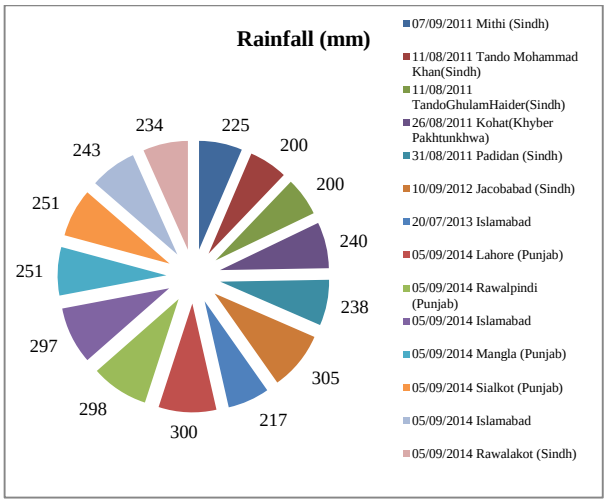


Fig. 2 Heaviest rainfall in Pakistan during 24 hours from 2011 to 2014 (Kapadia, 2014; Qaiser, 2014; Salma et al., 2012).

Important Natural Disasters in Pakistan

Rainfall Pattern

In Pakistan, western disturbance and monsoon are the two reasons of rainfall. Western disturbance takes place from October to May and brings heavy rainfall in northern part of the country. In the month of June western disturbances rarely hit northern Pakistan. Monsoon brings heavy rainfall from July- September in the whole country except western part of Baluchistan (Haq et al., 2012).

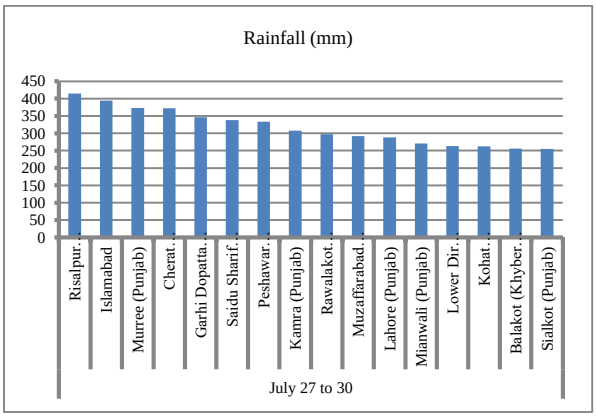


Fig. 3 Record-breaking rainfall of 2010 (Shah et al., 2010).

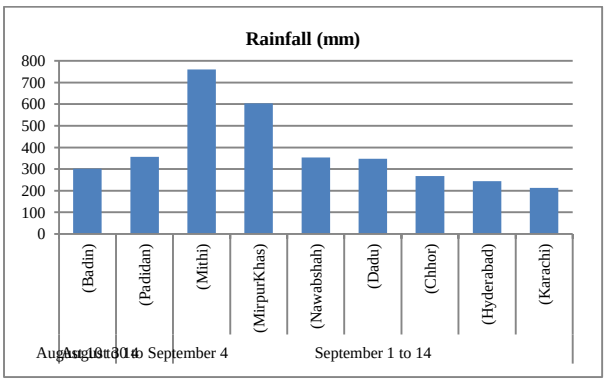


Fig. 4 Record-breaking rainfall of 2011 in Sindh (Guerin, 2011).

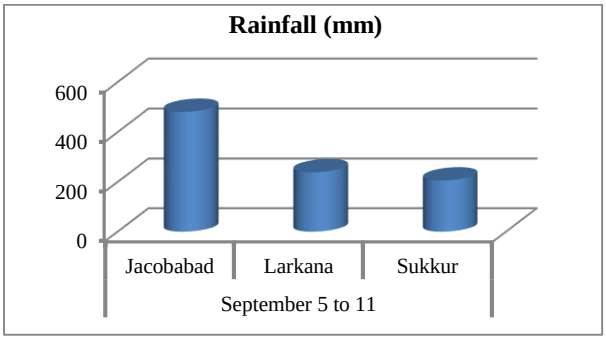


Fig. 5 Heavy rainfall in September 2012 in Sindh (Ali, 2013).

Floods

In 2007, European Union Floods directive has defined flood as the temporary covering of water on a piece of land that is usually not covered with it (Rasul et al., 2012). Normally flooding is caused due to normal weather events like heavy rainfall in short time span, extensive rainfall or by a combination of high tide with stormy conditions (Zhou et al., 2002, Krausmann and Mushtaq, 2008). Floods are responsible for causing many socio-economic problems like the movement of affected people, loss of infrastructure, destruction of roads, disease outbreak and food shortages (Hunteret al., 2005). Pakistan has also faced many floods in the history and unfortunately, there is a continuous rise of

floods in 21st century particularly in 2003, 2004, 2005, 2010 and 2011 (Ashfaq, 2011). Hydro-meteorological features of Pakistan make it more susceptible to floods that causes the occurrence of different types of floods every year like flash floods, monsoon floods, coastal floods and urban floods (Haq et al., 2010). Though, extreme rainfall will still remain the main driving force behind flooding (Delrieu, et al., 2005, Khan, 2013).

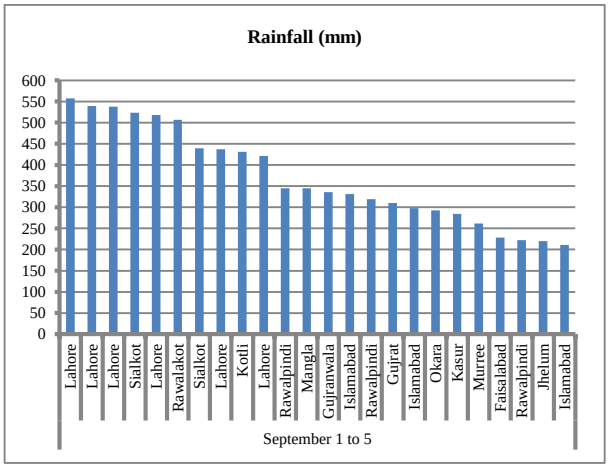


Fig. 6 Heavy rainfall recorded in September 2014 (Kapadia, 2014).

Lehner, et al. (2006), reported that flood can be caused by two main reasons. One is human induced (vegetation clearing and urban development) and the other is physical factors (climatic forces). Later contributes to the maximum of flooding due to extended rainfalls. Humans are causing floods due to trees cutting, deforestation, poor agricultural practices etc. According to Syvitski and Brakenridge (2013) it is difficult to prevent flooding but it is possible to minimize their effects by improved warning systems. How humans are affected by the flood is difficult to estimate because it not only affects them physically but also mentally and economically. Depending on the intensity, velocity and duration of the flood, it can damage buildings, roadways, bridges, canals and sewerage systems (Ruin, et al., 2008).

Flash floods are caused by heavy rainfall of five to six hours in an area with high destructive discharge (Zhou et al., 2000, Korytny and Kichigina, 2006, Ruin et al., 2008). In 2010, melting of glaciers and extremely heavy rainfall in monsoon generated disastrous flood (Khan, 2011, Tariq and Van De Giesen, 2012). This became an important factor of surface run-off and also the steep topography increased the gathering of water in river channels that causes flash floods in Panjkora and Swat rivers (Khan 2013). Hydrological processes of mountains seem to be highly influenced by precipitation, temperature, gradient, mountains and vegetation cover (Groisman et al., 2004). Areas having altitude between 2000m-4000m are more prone because to high river density, steep topography and heavy rainfall (Viviroli and Weingartner, 2004). Frequency of occurrence of flash floods is increasing due to unsuitable land use and development in river surroundings (Groisman et al., 2004).

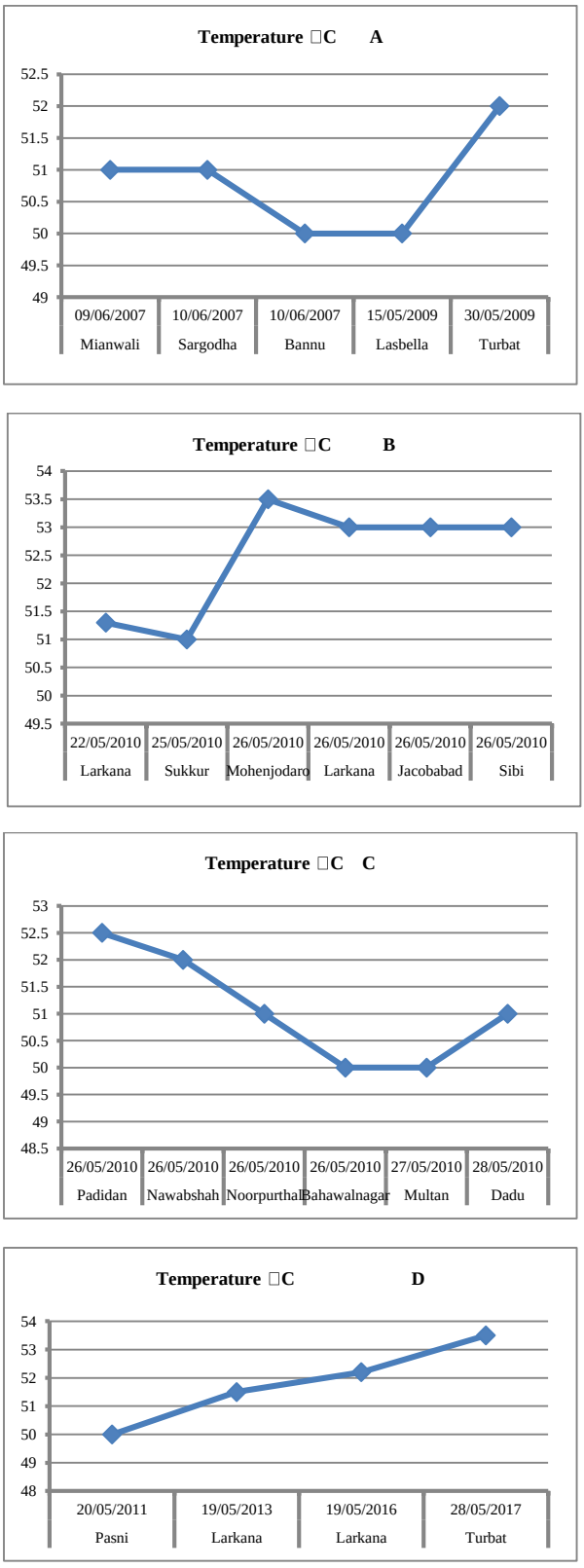


Fig. 7 Highest Temperatures in Pakistan from 2007-2017 (A) From 2007 to 2009 (B) & (C) 2010 (D) From 2011 to 2017 (Ahmad, 2010a; Bhagwandas, 2007; Wasif, 2015, 2017).

Sindh was badly affected by flood of 2003 because of excessive downpour of monsoon in the province.

Karachi was also affected by the heavy rainfall of 284.5 mm, which created massive destruction in the city. The worst condition was found in district Thatta where 404 mm rain was recorded. Flash flood was the consequence of the heavy rainfall, 4476 villages were affected by this event and 484 casualties were reported (Islamic Relief, 2003).

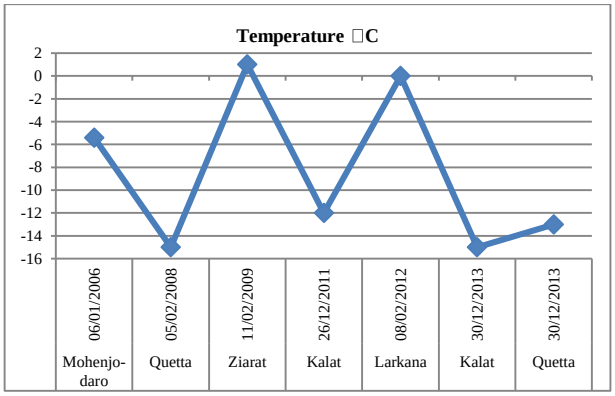


Fig. 8 Lowest Temperature in different regions of Pakistan (J. Ahmad, 2009; Babar, 2012).

In 2007coastal Baluchistan, Khyber Pakhtunkhwa and Sindh were affected by heavy rainfall of monsoon. Cyclone Yemyin of June and torrential rains of July and August affected the coastal Baluchistan and Sindh. Khyber Pakhtunkhwa was affected by severe rainfall and melting of glaciers. About 2000 people were evacuated, 130 people died in July and 22 people died in August in KPK. About 815 people lost their lives in Sindh and Baluchistan as a consequence of flash floods (World Bank, 2007).

In 2009 heavy rainfall hit Karachi which results in flood causing 26 deaths and 150 injuries. It was one of the heaviest rains faced by Karachi in thirty years. Hundreds of homes were destroyed in this fatal event (Ahmad, 2009).

Many floods hit Pakistan but the worst of all was the flood of 2010. This was the result of heaviest downpour of monsoon and lasted from July 28 to 31. About 20% land was swept away in this flood. Northeastern Punjab and KPK were affected badly during this time because lakes, rivers and dams overflowed (Kazi, 2014). According to the Federal Flood Commission, 2,966 injuries and 1781 deaths were reported. This flood lead to the destruction of 1.89 million homes and as a result more than 6 million people had been evacuated. Over 20 million of the country's population and all provinces together with AJK and Gilgit Baltistan were affected by this flood (Mahmood and Ullah, 2016).

In August 2011,record heavy rains of monsoon triggered flooding in 16 vicinities of Sindh (Haq, et al., 2012). Sindh is a productive province and is also known as the bread basket of the state. The effect of this flood on agricultural land was extensive and destroyed almost 1.7 million acres of fertile land. About 1.2 million homes were destroyed, 5.3 million people had been displaced and 270 deaths were also reported (Ashfaq, 2011).

Heavy rainfall of August resulted in flooding of Kohistan district in 2011. The flood was caused by the overnight heavy downpour of rain. It led to the destruction of dozens of houses. It also affected agricultural land, settlements and cattle including 63 deaths (Sadaqat, 2011).

Upper Sindh, KPK and southern Punjab faced a flood because of heavy monsoon rainfall in the month of September 2012. About 445 casualties were reported. This flood destroyed 1.1 million acres of agricultural land. More than 260,000 people have been displaced (BBC News, 2013).

Pakistan faced flash floods in 2013 as a result of heavy rainfall in August. About 83 people died and over 94 were injured. All provinces i.e., KPK, Kashmir, Sindh, Baluchistan and Punjab were affected. Moving water destroyed many houses and washed away many acres of arid land. Almost 66,000 people were affected as a whole by this flood and heavy rainfall (Saul, 2013).

In the last phase of monsoon, which was in September 2014, AJK, Pakistan and India received heavy rainfall which resulted in flooding. The river of Chenab flow was above the danger mark and destroyed many houses and agricultural land along its way. Many villages were completely destroyed by the flood. Strong post monsoon storm had affected Lahore, Sheikhupura, Gujranwala, Gujrat, Lahore, Hafizabad, Narowal, Mandi Bahauddin, Jhelum, Kotli, Rawalpindi, Mangla, Rawalakot and Multan villages (Geo News, 2014). In the Jhang and Multan districts 350 and 300 villages were flooded, respectively. More than 1.1 million people were affected by the flood and 257 people died, as reported by National Disaster Management Authority (Najar and Masood, 2014).

About 23 people were killed by the flood of 2017 in Karachi. Most of the deaths were recorded from electrocution. Main cause of flood as reported by Pakistan Meteorological Department was heavy monsoon rains in late August, 2017 (Khan, 2017).

Droughts

Pakistan faced extreme drought during 1998-2002. The drought actually began in 1997 with the development of El-Nino. In 1998, drought got worse and in 2000 it attained peak. This drought also affected the economic growth of Pakistan as warned by the World Bank. In the southern part of state almost 180 people died because of drought (Durrani, 2018).

The drought of 2004-2005) was an on and off phenomenon. Baluchistan and Sindh were affected by this drought. No deaths were reported in this duration (Pakistan Weather Portal, 2011).

Another drought started in mid-2009 continued till 2010 as El-Nino developed. The KPK, Kashmir, Northern Baluchistan and Punjab were affected by the drought. No casualties were reported during this duration (Kassim et al., 2011).

Heat Waves

During the summer heat wave of 2010 extended from May 22 to May 31, twelve cities of Pakistan observed temperature above 50 °C. Temperature of 53.5 °C temperature was recorded on May 26, 2010, which was one of the highest temperature ever documented in Asia and in the world it was on number 4 in the locality of Sindh (Mohenjo Daro). On the same day, the second highest temperature in Asia and fifth highest in the world was 53 °C in Larkana (Anis, 2015). Eighteen people died as a result of temperature higher than 45 °C in many areas of Pakistan on May 27, 2010. During this heat wave, 50 °C was observed in eleven cities, 53 °C in five cities and more than 45 °C but below 50 °C temperature was observed in eleven cities of Pakistan (Ahmad, 2010).

In April 2017, an extreme heat wave with temperatures as great as 50°C was observed in Pakistan, particularly in southern parts of the country. This was the record-breaking heat wave and broke the highest old temperature record of several cities in April and on 19 April, 50 °C temperature was observed in Larkana (Bhatti, 2017).

Highest and Lowest Temperatures

Climate change and variability in an area can be observed mainly on the basis of changes in surface temperature. Other contributing factors include minimum and maximum temperature and rainfall patterns. Tangborn (2003) stated that warming of land during last 50 years is very much related to increase in minimum and maximum temperatures. Braganza et al. (2004) reported that variations in mean minimum and maximum temperatures are more beneficial than average mean temperature as their impacts on agriculture and environment are more significant.

At the regional level, the temperature is crucial to understand the agricultural production (Gupta et al, 2010) especially for an agricultural country like Pakistan. Iqbal et al. (2011) reported that increase in temperature cause reduction in the growth cycle of the maize crop. As a developing country, Pakistan needs to understand the impacts of temperature fluctuations on crops productivity, the growth of the plant and different types of crops development (Wheeler, 2013).

The rise in temperature is not only affecting agricultural crops but also many other indirect impacts are included in its target list. The occurrence of natural disasters is increasing enormously causing disruptions in social, cultural and physical environments (Stocker et al., 2013). Floods, a serious catastrophe is giving a tough time to the people of Pakistan for two decades by affecting their social, physical and economic lives Changes in land use patterns and weather conditions have increased the frequency and intensity of floods throughout the world (Zhou et al., 2000).

Summer is the time when most of the countries experience heat waves but in Pakistan heat wave can be observed between April and September. Most of the time extremely high temperature is observed in May and June. Temperature of 50 °C or more can be found in some parts of southern Pakistan (Vidal and Walsh, 2010). Figure 7 displays the highest temperatures recorded in Pakistan from 2007-2017.

Winter is the time when most of the countries experience cold waves but in Pakistan cold wave can be observed between October and March. Most of the time extremely low temperature is observed in January and December. Few regions of western and northern Pakistan faced temperature below 0 °C. The extremely low temperature in Pakistan was observed during the cold wave of winter 2013. Figure 8 displays the lowest temperatures recorded in various regions of Pakistan from during 2006-2013.

Earthquakes

Pakistan is located in an earthquake-prone region due to the topographical setting of fault lines of the Himalayan region. Mild earthquakes and minor flooding hit this area frequently. Despite this, no proper and well-established management systems are available that causes massive losses (Kiani, et al, 2016). According to recent studies, global warming is considered as a reason of an increase in seismic activity. It is considered to be a strong reason why the Himalayas are facing more earthquakes in past two decades (Haider and Anis,2015).

Smog

Smog is a thick yellowish black fog which is suspended in air, it is also known as ground-level ozone. It is formed due to the presence of air pollution combined with emissions, fumes, with fog and sunlight. Once formed it is like a thick layer of smoke-film in the atmosphere. According to researchers, emissions from the industries and vehicles and cutting of trees are playing an important role in deteriorating the issue (Malik, 2017).

According to a warning released by Met Office describing the composition of smog – which includes nitrogen oxide, carbon monoxide, sulphur dioxide and other aerosols due to presence of cold high pressure in the upper atmosphere. A chain reaction occurs in lower atmosphere when suspended matter collides with water vapors resulting in the formation of smog (Malghani, 2017).

Lahore was mentioned in the list of top ten polluted cities affected by smog in 2014. During the past five years the problem has worsened mainly due to overpopulation, growth of cities, deforestation and extreme reliance on fossil fuels for energy purpose (Ahmed, 2017).The situation is not only caused by a single factor, rather it is due to multiple factors. According to NASA (2015), close proximity of agricultural fires in Punjab (India) played a crucial role in the formation of smog. The image captured by VIRS instrument mounted on satellite presented dense agricultural fires in India with few dispersed fires in some areas of Pakistan. It is also reported that burning of crop residue contributes in the production of carbon dioxide, di-nitrogen oxide, methane and green-house gases. The process also produced several other pollutants including ammonia, nitrogen oxides, carbon monoxide, oxides of sulfur and VOC's. Oxides of sulfur are considered main contributors in the formation of smog (Khan, 2015).

Additionally, there are evidences available which suggest that normally there is higher relative humidity in October that provided suitable conditions for smog formation over the region. The average humidity during this month was 63% ranging between 34%-92% (Abbas, 2017). As the problem is multi-faceted, wind speeds and directions may also be playing their role. Increased levels of dust, open garbage burning, industrial and automobile emissions are main causes of this havoc (Doshi, 2017).

Serious health risks have been imposed by the smog including heart problems, lung tissue damage, asthma, bronchial infections and numerous types of allergies. Public is badly exposed to the adverse effects of smog and have no other option but to wear glasses and masks to be safe from its effects. Many cases of eye irritation and respiratory disorders were reported by health professionals. Warning has been issued by Meteorology Department of Pakistan to public to avoid unnecessary outdoor visits and informed about the possible consequences. Monitoring reports published by EPD highlighted that the levels of CO_2, H_2S, and SO_2 are well beyond the levels of human acceptance. Wide-spread smog also contributed in global and local warming. Fortunately, nature helped to lessen the adversity of the problem by wiping out smog with rain pouring. According to different reports, many people were killed in various accidents caused by poor visibility on roads due to smog. The accidents occurred in different cities of Punjab (Wasif, 2017). Such threats demand serious actions and commitments in order to mitigate the situation, leaving an environment which is healthier and safer for the generations to come (Malghani, 2017).

Conclusion

Global warming is causing warming of oceans with consequent rise in sea level. Climate change affects average as well as extreme temperatures and thus, increasing the probability and likelihood of climate-related disasters. So far in this century, Pakistan has faced 3 droughts, 2 heat waves, 10 extreme floods, 27 major earthquakes, 2 consecutive sessions of severe smog and extreme high and low-temperature events. Two significant predictors of climate-related disasters are temperature and precipitation. Higher temperatures cause more disasters like heat waves, droughts, intense storms, wildfires and floods. Intense and extensive droughts are threatening crops, freshwater supply and wildlife. On the other hand, more precipitation is linked with flooding, land-sliding and storms. Melting of glaciers causes a rise in sea level which increases the frequency and severity of coastal flooding.

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