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Review

Climate change due to increasing concentration of carbon dioxide and its impacts on environment in 21st century; a mini review

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ABSTRACT

The good quality of life, growth, nutrition and development of all living beings directly or indirectly depends upon natural surroundings. Urbanization, agriculture, industrial work and greenhouse effects are the leading causes of the climatic changes all over the world. These climatic changes are responsible to increase Carbon dioxide (CO_2) and temperature on surface of the earth every year. All components of environment i.e. air, water and soil are altering mainly due to anthropogenic activities especially with changing life styles. The objective of this mini review is to elaborate the different climate changes, their causes and effects. Generally, climate change refers to any disturbance in climate which can cause negative impacts on living organisms which include humans, plants, and animals, which will be adverse for environment. With increase in population on the earth and industrialization the environment of the world is being disturbed every day. Human is destroying natural resources continuously for his own pleasure and convenience. Due to Carbon dioxide and other dangerous gases expelling from automobiles and industries are continuously poisoning air. Factories are releasing their wastes directly in water bodies without proper treatment and making them unfit for aquatic life. Plants act as filters which trap all pollutants to make environment cool, clean and green. Increase in population multiplication without increasing the plantation would completely damage the quality of life and our society in future. Plants are natural purifier of environment. Due to increasing concentration of carbon dioxide and global warming, temperature of earth is increasing day by day which cause various disorders in environment. The purpose of this review is to highlight climate change which is mostly occurring when there is rise in temperature and CO_2 concentration and its impacts on environment. This change in climate is not beneficial rather it causes the damage of an ecosystem. So, human activities are changing the environment adversely. Increasing climate changes have affected life in different aspects. It is concluded that if we don't plan the strategies to overcome these changes, in coming few years life on the earth will not be an easy task, and situation will be out of hand.

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Contents

1. Introduction

The climate is an important environmental factor of an area, any country and the globe. The changes in environmental factors of an area over long period of time constitute climatic change. It includes quantity of light, temperature, humidity, wind, gases, air, water and soil which average for about 30 years. These changes affect the agriculture sector, animals, hydrological cycle, wind pattern, distribution of rainfall, growth and development of plants and even whole food chain as plants are producers on crust of earth (Ahmad et al. 2022). The agriculture sector of Pakistan is facing many problems including global warming, climate change and floods regarding yields and other factors related to growth (Abid et al., 2001; Rao et al., 2013; Ashraf et al., 2014; Muzafar et al., 2015). Climatic changes are decreasing the global crops growth, productivity, and quality of grains. A suboptimal range of temperature increase at any important stage for extended duration can harmfully affect the rate of growth, development and processes of yield formation (Ahmed et al. 2020; Waqas et al., 2021; Zafar et al. 2022). Climate smart agriculture practice for a definite cropping system includes different practices or techniques that can help farmers adjust best to climate change and reduce in productivity losses. These activities are attracting gradually more important to moderate the unfavorable impacts of temperature extreme (Xiukang et al., 2015; Steward et al., 2018). A latest study with yield and climatic factors from 1980 to 2015 noted yield decrease up to 20% in variety of wheat (*Triticum aestivum* L.) and about 40% in maize (*Zea mays* L.) due to high drought (low water contents of atmosphere) on a large scale (Daryanto et al., 2016).

Chief sources of climate change are production of greenhouse gases (GHG) from different sources including urbanization, industrialization and transportation which result to increase in atmospheric temperature. The condition is more problematic by altering conditions of climate, resulting in regular increase of temperature in addition to altering the rainfall frequency and pattern, thus raising a food security concern at global level. The circumstances can be contest by developing different rice varieties with tremendous genetics and improved morphological, biochemical, molecular and physiological mechanisms, which together can decrease the unfavorable effects of heat stress (Zafar et al., 2018). Heat tolerance or resistant is usually coping with different plants which can reduce the stress effects and generate satisfactory economic yields at very high stress of temperature (Wahid et al. 2007).

Agriculture sector is facing many challenges to ensure world wide food security by enhancing yields while dropping environmental costs (Tilman et al., 2011). Global agriculture sector is facing extraordinary risks and challenges. Rates of yield and growth of different crops have decreased since the 1980 s (Alston et al., 2009), and even declined in many regions (Ray et al., 2012, 2013). Meanwhile, agriculture sector deserve substantial environmental costs, as well as emissions of different greenhouse gases (Davidson, 2009), biodiversity loss (Christopher and Tilman, 2008), and degradation of freshwater and land (Diaz and Rosenberg, 2008). Heat index and stress has become a severe crisis of agriculture sector in many regions of the world (Ahmad et al., 2016; Zafar et al., 2016). It is an essential environmental pressure that limits plant growth and development, disturb its different metabolic and physiological activities and production of yield at global level (Hasanuzzaman et al., 2013; Bakhtavar et al., 2015).

Photosynthesis is a vital growth regulating process in all normal plants and especially in crop plants. Several researchers have shown the inhibitory effects of different heat stresses on photosynthesis rate in crop plants which can be illustrated by determining the contents of photosynthetic pigments of leaf (Larcher, 2003). The rate of photosynthetic reaction to increasing temperature can be expected due to destruction to components of photosystem-II existing in the thylakoid membrane of chloroplast (Al-Khatib and Paulsen, 1999). The water relations and cell membrane stability are two essential physiological mechanisms in plants life span which are directly affected by high temperature stress (Wahid et al., 2007; Waqas et al., 2017).

Since the 1960 s, the improvement for yield rate of some important food crops such as maize, rice and wheat has slowed down (Long et al., 2010), and present yield trends are not enough to meet future requirements of increasing human population (Bajzelj et al., 2014). Furthermore, enhancement in productivity of crop may be possible in a highly unpredictable climate. Increasing and intensified harsh climatic factors (heavy rainfall, drought, heat wave, storms, frost etc.) are predictable in the future (Ummenhofer and Meehl, 2017). These unprecedented harsh climatic conditions will badly control plant growth and development, human comfort and ecosystem functions (Zafar et al., 2018).

Global emission for the greenhouse gas, CO_2 measured was about 35.8 Gt CO_2/year (2017 data) discharged into the air and were estimated to expand by an additional 2.6% in 2018 (Le Quere et al., 2018). To limit a rise of earth's atmosphere temperature to < 2 °C by the top of the 21st century, the International Panel on global climate change (IPCC) proposed that GHG emissions should be reduce by 45–50% by 2050, with continued reductions during the rest of the 21st century (Moomaw et al., 2011). The climatic change is considered a global issue, but many developing and less developed countries are more affected; the main cause is that they are more vulnerable to climatic changes and their capacity to moderate the effects of climate change is low. Pakistan is threatened by global climate change. The latest report of the United Nations Climate Change Commission shows that Pakistan is one in the list of the top ten countries most vulnerable or threatened by climatic changes. In the 21st century of science and technology, the average temperature of the earth is expected to rise from 2.5 °C to 4.5 °C. According to the Pakistan Meteorological Department, February 2021 was one of the warmest and driest month on record for Pakistan. According to IPCC-2014, the time span between the 19th and 21st centuries is considered the warmest period of previous history. Under harsh weather conditions, the frequency of global warming is estimated to increase, which will disrupt the global ecosystem. Being a part of environment and getting many benefits from it humen must protect and restore earth's ecosystem. Harvest reproduction displaying examines dependent on future atmosphere situations, done in Pakistan and different nations highlight impressive misfortunes in harvest yield. Fischer et al. (2002) reported that considerable misfortunes are likely in the downpour taken care of regions of wheat creation in south and southeast Asia. The populace should develop around a billion of every 2050 and food prerequisites are relied upon to raise by about 85%. Climate change has a negative impact on food. Pakistan is one of the countries that have a negative impact on climate change because it has a strong tolerance for extreme events and low adaptability. In response to worsen global climatic change and recognizing carbon neutrality by 2050, the most important and a considerable challenge to alter the current production system is to reduce GHG emission. It also involve to promote the capturing of CO_2 from atmosphere especially by different techniques including plants as they are natural sink of CO_2 from environment (Wang et al., 2021).

The scientific and technological revolution of 21st century has given multiple facilities to mankind, but at the same time manmade (Anthropogenic) activities are accountable for depletion of resources and disturbing the delicate balance between the different components of the environment. They are, unnecessary use of fossils fuels, deforestation, desertification, loss of fertility of soil, rapid industrialization and increase of automobiles. Changes in the atmosphere conditions are resulting in serious problems like green house effect, depletion of ozone layer and rise of world temperature. Taking into account all these problems this study is designed to investigate and understand these problems in depth and highlight their solutions. The main focuses of this study are to elaborate the increasing concentration of carbon dioxide, their impacts on environment and consequences of different climate changes in Pakistan, their causes, impacts and consequences.

Thus, taking into account the factors influencing environment and its components the possible solution for degradations of environment and its components is restoration of natural conditions for existence and growth of living organisms, especially plants which are producers and natural lungs on surface of the earth. The objectives of this study include assessment of anthropogenic activities which are destroying the environment by increasing CO_2 and temperature. We need to make environment cool, clean and green only by green revolution (plantation). A need to write this type of review is that we must focus to natural and pure environment which is essential for existence of life on surface of the earth. Our major issue is that we use natural resources extensively and then are not responsible for consequences. We hope such type of mini review will contribute to create awareness for those who are environmentally friends and want to give sustainable environment to our next coming generations.

2. Source for collection of secondary data

The data for the study was collected from the already published data. Different research papers of the interest were reviewed for many times and data was collected about sources and impacts of climate change.

3. Impacts of carbon dioxide on environment

For Pakistan, environmental change could be disastrous. It implies icy mass softening. Pakistan has more icy mass than some other nations on the planet outside polar locales. The cold surge from lakes raised gas multiple times since 2015 as ice. Sindh territory is the most week hotspot. It contributes 30% of the public Gross Domestic Product (GDP). The second most weak hotspot is the thickly populated region of Punjab which contributes 53.3 percent of Pakistan GDP. Changes in precipitation and temperature take steps to block the future development of these locales. All extreme creatures in the world are affected by extreme environmental conditions. Greenhouse gas (GHG) emissions are still rising rapidly, and the damage to the earth's climate is increasing. It is need of the day to work hard to protect our biosphere to avoid the tremendous suffering caused by the climate crisis (IPCC 2018). Rising temperature affects most plants, resulting in increased crop yields and complex growth responses. Many public discussions regarding to climatic changes are only based on increasing global earth's surface temperature, which is not enough to reflect human activity and real breathing. A wide range of planetary indications are needed by policymakers to extensively recognize the full ranges of consequences resulting in climatic changes (Briggs et al., 2015). Environmental degradation and climatic changes are increasingly acknowledged as topmost global main concern, essentially associated for humen wellbeing in terms of sustainability risks (Wassenius and Crona 2022). The long reported proof of increasing temperature on surface remains an essential indicator of climate change, and a measure of direct significance to interests of environmental friendly scientists via impacts of temperature on health, economies and food production. In the western mountains, rising temperature may affect the water resources that our country's agriculture and energy production depend on, thereby exacerbating the process of glacier melting. Agricultural activity is the main source of support for most rural families and depends on urban populations in many developing countries of the world like in Pakistan. This activity affected due to increasing CO_2 and temperature which are resulting in severe modifications in rate of photosynthesis, growth performance, dry matter, and enzyme actions under low / high temperature and together limited productivity of maize (Waqas et al., 2021). Climatic changes and food insecurity are two major issues in the 21st century. Food security and agricultural production are considered to be appropriately affected by severe weather. It is predicted that areas which are mostly affected by climatic changes they will likely face consequences of decrease in water resources, especially in those areas of world which are already under water-stress due to drought condition, population pressure and water resources extraction (IPCC-2014).

3.1. Causes of climate change

Presence of the ozone layer (umbrella) in stratosphere is a protective layer on the surface of the earth which contains usually high concentration of ozone (O_3). This protective layer assimilates 94–99 % of the sun's high reappearance bright light which can damage to life existing on surface of the earth (Albritton and Daniel, 1998). A discovery of the ozone gas was made in 1913 by two French physicists Henri Buisson and Charles Fabry. Its characteristics were observed in detail by Dobson, the British meteorologist who invented a simple spectro-photometer (Dobson meter). This meter could be used to estimate stratospheric ozone gas from the ground. Dobson established an international network of ozone checking stations between 1928 and 1958 which goes on to operate today. The "Dobson unit", a suitable measure of total quantity of ozone in a column of overhead, it is named as so based on his honor. During the 1970′s it was revealed that in every spring, a "hole" was created in the stratospheric ozone layer particularly over Antarctica, and that some substances made by humans were accountable for this destruction of ozone (Saradva, 2016). There have been many concerns on the earth about ozone depletion. These problems and causes related with ozone depletion are arising from anthropogenic activities. Unlike different types of pollution which have several causes, chlorofluorocarbons (CFCs) is one specific chemical substance that is responsible for reduction of the ozone layer (Saradva, 2016).

Because of expanded an Earth-wide temperature boost ozone layer is getting drained due to increasing concentrations of carbon dioxide. Expanding concentrations of nursery gas emanation is considered as a prime reason for the issue. Greenhouse gases that have a significant impact on the environment include CO_2, CH_4, N_2O, HFC, PFC and SF6 (IPCC, 1996). Among them, carbon dioxide is considered as the most important factor leading to global climate change. Although the 2020 COVID-19 pandemic and lockdown strategies not only affected production activities and people's lifestyles, but also cause major changes in energy consumption and CO_2 emissions. The carbon dioxide content in the troposphere varies from time to time and from place to place. Carbon dioxide production sources include both by natural and man-made, and its concentration has enhanced by 25 % in the last 125 years (Thurman et al., 2001). Climate change anxiety is increasing very rapidly which involves human population's self-reported negative emotional reaction linked with their understanding for importance of climate change (Clayton, 2020). Major anthropogenic sources of climate change are emission of greenhouse gases especially CO_2 emissions, which are resulting in increase in temperature of atmospheric (Zafar et al., 2018).

Human industrial activities, particularly from the industrial revolution, have tremendously increased the CO_2 contents of the atmosphere. As we all know from history that in past about 200 years concentration of CO_2 in the stratosphere has increased by over 30–31% (i.e., from a concentrations of 280 ppm by volume (ppmv) in 1700 to about 380 ppmv in 2000). We also know that the CO_2 concentration was moderately constant (approximately within ± 10 ppmv of 275) for more than 1,000 years earlier to the human stimulated rapid increase into the atmospheric CO_2 (Houghton et al., 2001).

3.2. Effects of climate change

Due to climatic changes biodiversity loss take place and forest area shifts northward. The frequency of forest fires due to increased heat and irregular rainfall will increase, thereby destroying regeneration and planting areas. In the arid mountainous areas of the western part of the region, rising temperature may affect the water resources that our agriculture relies on to produce energy, thereby exacerbating the process of glacier melting. As the earth's temperature raises, the risk of skin diseases, eye diseases and other diseases will be high. Climate is a major factor in agricultural production and global climate change. Scale may affect the country's local agriculture (Table 1).

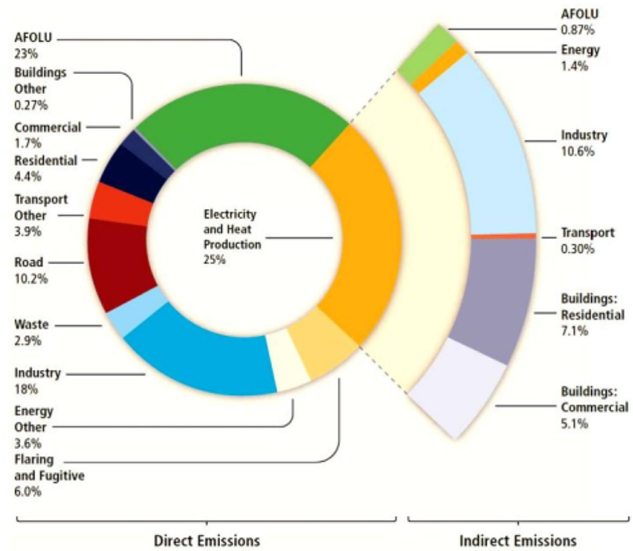

Fig. 1. The total global anthropogenic greenhouse gases (GHG) productions in 2010 separated by economic sectors. Red shade is for transportation. The inner circle of fig. showed the share of the direct emissions, the outer circle revealed indirect emissions from heat production and electricity sources. AFOLU abbreviated for agriculture, forestry and other land use (Victor et al., 2014).

It is observed that buildings, industries and transportation are three main anthropogenic activities which are increasing continuously day by day with increase in human population. These activities are mainly responsible for direct and indirect emission of greenhouse gases particularly CO_2 which are contributing towards increase in temperature (Fig. 1). A large percentage (25%) of GHG is involved in production of electricity and heat which is also responsible for increasing the temperature of earth's surface. Transportation division is one of the larger sector in terms of world-wide emissions of different gases, which share about 15% of the Kyoto gas emissions by concerning the emission metric global warming potential with a 100 years time horizon (Victor et al., 2014).

There are many ethical decisions that human being make with respect to the environment. Human beings are the main source of concern for cool, clean and sustainable environment. They are allowed to a healthy, good and fruitful life in according to nature. Coral reefs, forests, grasslands, mangroves, phytoplankton, peat lands, savannas, soils, wetlands, and sea grasses contribute significantly to sequestration of atmospheric CO (Griscom et al., 2017). Human being should be environment friend and we should think about these points ethically:

1. Should we carry on to clear cut forests for the purpose of human utilization?

Table 1
Climate Risk Index (CRI): The top 10 countries, mostly effected from 2000 to 2020 (annual averages).

CRI 2000–2020 (1999–2019)	Name of Country	CRI score	Death toll	Death / 1,00,000 individuals	Total losses counted in million (US$)	Losses per unit GDP in %	Number of total events (1999–2019)
1(1)	Puerto Rico	6.68	150	4.10	4565.06	3.75	26
2(3)	Myanmar	10.30	7052	14.30	1631.06	0.82	56
3(4)	Haiti	13.82	274	2.82	389.93	2.40	79
4(5)	Philippines	17.65	870	0.95	3117.68	0.55	316
5(8)	**Pakistan**	**28.82**	**500**	**0.31**	**3791.52**	**0.51**	**151**
6(9)	Vietnam	29.85	286	0.35	2019.77	0.49	225
7(7)	Bangladesh	30.01	578	0.40	1685.33	0.45	190
8(13)	Thailand	31.10	140	0.20	7765.06	0.85	146
9(11)	Nepal	31.50	228	0.85	226.86	0.40	180
10(10)	Dominica	32.30	3	4.70	134.02	20.82	9

2. Should we continue to proliferate?
3. Should we prefer industries over plantation and agriculture?
4. Should we go on to make petrol powered vehicles?
5. What environmental responsibility do we need to keep for coming generation?

This graph showed that how global temperature have fluctuated from the expected temperature over the last 1.4 century. The increase in greenhouse gases especially CO_2 that absorbs heat seems to have influenced a trend in rising global temperature. If these gases continue to increase in their concentration at continuous's rates, the world have faced an average temperature rise of nearly 2.5 °C by the year 2020 (Fig. 2).

3.3. Check on global warming

Global warming can be checked by reducing the concentration of CO_2, methane, nitrogen oxides and CFCs in the atmosphere by adopting the following measures:

i. Plantation of trees at large scale.
ii. Increasing the diffusing capacity of oceans for CO_2.

In the photosynthetic process green plants use CO_2 to prepare their food material and release O_2 as a by-product. Therefore, planting trees on waste land and replanting of new trees in place of destroyed trees are most important. If one-third part of the world is covered by the forest then CO_2 will be stabilized. Thus green plants cause decrease of CO_2 concentration through photosynthesis which can ultimately result to low the temperature. From religious point of view plantation is a perpetual charity and is also our duty to save the environment's beauty by keeping it cool, clean and green. The current government of Pakistan is also focusing to this activity and Pakistan has hosted the world environmental day i.e. June 5th, 2021 and it happened first time in history of Pakistan. This is not only the responsibility of Government of Pakistan to plant trees. In all civilized nations, people plant trees individually in and outside of their houses and public places.

Afterwards, ocean plays a significant role in reduction of CO_2 (Falkowski et al., 1998). Carbon dioxide is continuously dissolving in the oceans which are stabilized in the form of carbonate rocks at the bottom of sea. According to an estimation (Prentice et al., 2000) half of the CO_2 evolved is absorbed by the seas and their phytoplankton (free-floating plants). This is a new method to reduce the CO_2 concentration in environment. According to Martin and Gordon (1988) the growth of phytoplankton can be enhanced by spraying iron supplement in the ocean. Phytoplankton takes CO_2 from sea water in greater amount due to which CO_2 will decrease in the oceans. Therefore, more CO_2 will dissolve in the oceans resulting in the decrease of CO_2, concentration in the atmosphere. In 1955, 454 kg ferrous sulphate was sprayed in 1600 square km area of the Pacific Ocean. After few days there was plenty of growth of phytoplankton in sea water of that area and due to that the colour of water became green in place of blue. About 6–21 percent CO_2 can be reduced by this method.

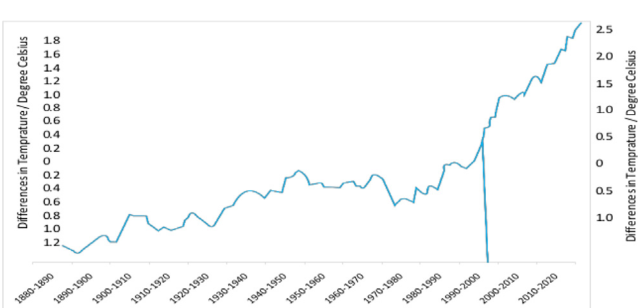

Fig. 2. Global temperature fluctuated from 1880 to 2020.

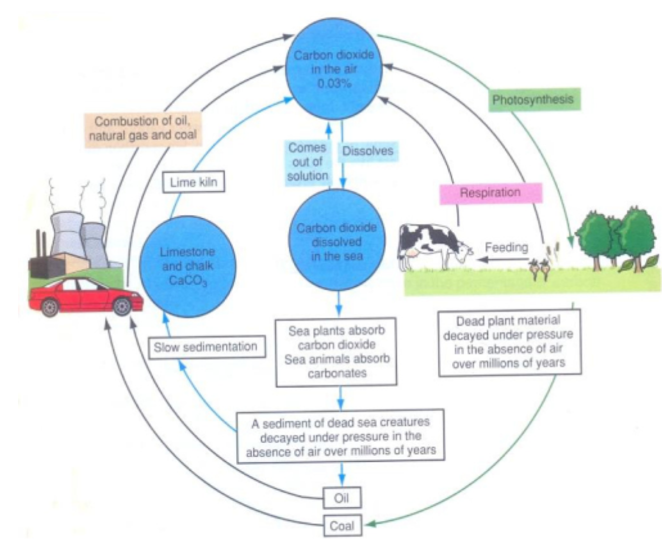

Fig. 3. The carbon cycle (Ramsden, 1997).

The processes which take carbon dioxide from the air and those which put CO_2 into the air are balanced so that its percentage in air stays at 0.032 % by a balance of carbon cycle (Fig. 3). Animals, microorganisms, marine and terrestrial plants, play very important roles in carbon and nutrient cycling, maintaining balance and storage (Allen, 1990). Optimal management of nutrient policies can extensively reduce N & C fertilizer rates without declining crop yields (Chen et al., 2006; Wang et al., 2007; Ju et al., 2009), with many benefits to environment and agriculture (Howarth et al., 2021), including the slowing of hazardous rates of anthropogenic (man-made) acidification. Soil acidification due to deposition of atmospheric nitrogen in grassland and forest and excessive carbon and nitrogen fertilizer applications in croplands must also be keep away to reduce the losses of soil inorganic carbon (Guo et al., 2010). Acidification can adversely affect biota and alter the biogeochemistry of ecosystems (Delhaize and Ryan 1995; Guldberg et al., 2007). Inadequately buffered freshwater systems of the earth have been changed significantly by anthropogenic acidification (Vitousek et al., 1997), mostly by nitric and sulfuric acids, the surface of ocean has acidified visibly from increasing concentration of carbon dioxide in atmosphere, raising issues for marine biodiversity and normal functions of an ecosystem (Feely et al., 2004; Orr et al., 2005; Hall-Spencer et al., 2008). Applications of crushed magnesium and calcium rich silicate rocks to soil are planned for large scale CO_2 removal (Beerling, 2020). This technology was named as enhanced rock weathering, which can increase soil alkalinity, and thus atmospheric CO_2 can be changed into dissolved inorganic C and is finally transported to the aquatic habitat (ocean), where the stored carbon (C) has a long lifespan as compared to runoff of land surface.

Trees consume a tremendous amount of CO_2, and thus help to control the concentration of this gas in the atmosphere. So green revolution (plantation) is the best solution to arrest the increasing concentration of CO_2 and increase in temperature on surface of the earth. Further research is needed to find out whether any more techniques will be efficient or economically possible. Implementation of this approach may depends, in large area, on policy decisions made at international and national levels.

4. Conclusions and recommendations

In this study it is concluded that changes in climate is taking place in Pakistan and causing many problems. Climate change cause problem in many aspects like it affect the productivity rate of the crops due to low quantity of water which in result is causing agriculture loss and have an impacts on the economy of the country. The rise in temperature is causing many issues to human beings, plants, and animal also. Awareness policies about climate change should be planned in urban areas of the country. So that, we can overcome the climatic changes by reducing the use of GHG emissions especially CO_2 by more plantation and by restoration of water reservoirs. In this regard, every citizen of the country is responsible and should work on self-responsibility. So request to all humanity on surface of the earth is that save the environment to save yourself. We seriously need to plant millions and billions of trees and need to educate people about the importance of trees in environment. Educational institutes must cooperate and have a significant role in this regard. If we will not consider increasing concentration of CO_2 and temperature as a critical issue the destruction of habitat on surface of earth will be more adverse and situations will be out of control.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jksus.2023.102693.

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