Chapter 2
Climatic Changes Impact on Water Availability

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Abstract Climate changes refer to long term changes in the global climate that is interconnected system of universe. This system includes sun, earth, oceans, wind, rain, snow, forests, deserts, savannas and all human activities. Availability of potable and non potable water major relies on rainfall and oceans reserves. Globally, rainfall pattern has changed because of rise in temperature as a result of climatic changes. As a result of climatic changes, water demand and availability of freshwater resources are affecting at local, regional and global levels. In addition, increased population growth, resulting urbanization, consequent industrialization, competing demands for water and altered socio-economic conditions have put additional pressure on the water supply. While, the demand increases quickly during prolonged hot spells. However an impact that we have on the environment with CO_2 emissions reaches their highest in the industrial time. Consequently, the prediction of potential impacts of climatic changes on water availability and demand is crucial to take suitable steps to mitigate the adverse impacts of climate change on water availability. This chapter will appraise the impact of climate change on water availability particularly in dry regions of the world. This study will guide water management systems to carry out effective and efficient long-term planning for the sustainable supply of water under different weather conditions and population scenarios.

Keywords Climate change · Global warming · Water pollution · Fresh water

2.1 Introduction

"NATURE! We are surrounded and embraced by her: powerless to separate ourselves from her, and powerless to penetrate beyond her". Consequently water is the lifeblood of our Nature (Rahaman 2012). Water cannot be separated from our-

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selves, it is vital for our very continued existence. Much interesting that water needs not to follow any political borders. How we use and manage our valuable and limited water capitals is very critical. Around the globe in many regions, human being has shown mismanagement and polluted the limited water reservoirs.

Drinking water is the major and current issue of this world (Richardson and Ternes 2011). Availability of water; safe to human health is alarming (Schwarzenbach et al. 2010). Next world war seems to be over water among superpowers on earth. Fresh water reservoirs are depleting day by day (Berger et al. 2014). Our earth came to exist many billion years ago (Swimme and Berry 1994). We cannot exactly predict the earth's daily weather was like in any particular place on any particular day billions of years ago (Palmer 2012). We only know lot about what the earth's climate was because of clues that remains in rocks, ice, trees and fossils. According to these clues, the earth's climate has changed many times. Initially, this planet was covered with ice, though some warmer periods have been detected too. Over the past decades, temperatures and carbon dioxide levels in the atmosphere have increased due to fossil fuel utility (Flannery 2006.). We however know that industrialization cannot occur without changing climate. But, global warming due to industrialization is resulted in extreme climatic events such as droughts, floods and heat waves (Beniston et al. 2007; Kovats et al. 2014; Bucak et al. 2017). Mediterranean regions suffering water scarcity and droughts due to extensive use of water in industries (Chenini 2010). Also, significant changes in freshwater availability are expected to occur with the ongoing climate changes.

Climatic projections for the Mediterranean region have predicted a significant decrease in precipitation and enhanced temperatures. This is resulting in increased dry days and more frequent heat waves (Erol and Randhir 2012; Christensen et al. 2013; Giannakopoulos et al. 2009). Consequently, water evaporation from sea and land surfaces due to higher temperatures may lead to a further decrease in water availability. These situations add problems to existing water scarcity all over the region (Calbó 2010).

Water planners and managers around the globe have main focus on climatic changes. It is important to change water managements by altering the availability of freshwater resources and water demand patterns (Jeuland and Whittington 2014). Due to industrialization and fossil fuel burning, more of the rise in temperature and changes in rainfall pattern are expected to occur in many part of the earth (Chadwick et al. 2014). Such changes are negatively affecting freshwater balance at local, regional and global levels. These changes will make safe water supply a big challenge to water managers (Chang 2007). Some other factors in addition of global warming are likely to affect fresh water availability in future which includes increasing population growth, increased water demand (McDonald et al. 2011), water pollution (Peters and Meybeck 2000) and rapid urbanization. Population in different continents, irrigatable land, and sustainable water supplies has presented in Table 2.1.

Alternative and suitable managements are necessary to keep balance between water supply and demand in current changing climate (Rosenzweig et al. 2004). Water demand also varies with climatic variables and seasons. During hot days and

Table 2.1 Population in different continents, irrigatable land, and sustainable water supplies (Vorosmarty et al. 2000)

Area	Population (millions)		Irrigated cropland	Observed water supply	Water supply required in 2025
	1985	2025	1000 km^2	km^3 year^{-1}	km^3 year^{-1}
Africa	543	1440	118	4520	4100
Asia	2930	4800	1690	13,700	13,300
Australia	22	33	26	714	692
Europe	667	682	273	2770	2790
North America	395	601	317	5890	5870
South America	267	454	95	11,700	10,400
Worldwide	4830	8010	2520	39,300	37,100

low rainfall, water demands increases for normal human activities and vice versa (Shahid 2011). Influence of the climatic variables on water availability has been reported by many studies. For example, rainfall is the one of key marker for water demand variables in Kathmandu, Nepal (Babel et al. 2007) for the prediction of domestic water. Gato et al. (2007) found that temperature and rainfall have statistically a significant correlation with water usage in Melbourne, Australia. In a review of the significant variables of domestic water demand. Babel and Shinde (2011) concluded that future water demand in Bangkok could be significantly affected by climate change, as meteorological variables such as temperature, rainfall and relative humidity have a considerable influence on longer term demand projection. Xiao-jun et al. (2015) found that future water demand in Yulin City, Northwest China would rise due to changes in climatic conditions, especially rise in temperature.

In Australian cities, water supply is more vulnerable to changes in climatic conditions as it is highly dependent on rainfall and storage capacity of surface water reservoirs. However, rainfall in Australia is highly variable (Sahin et al. 2013) and about 50–70% of the country is in the semiarid and arid regions where rainfall is very low (Zaman et al. 2012). During the droughts in Australia (2003–2009), most of the major reservoirs reached critical low water levels, thereby putting water supply at risk. The annual average temperature in Australia increased by 0.9 °C from 1910 to 2011 which is higher than the global average increase of 0.7 °C for the same period (Cleugh et al. 2011). Most of this increment in temperature has occurred since the 1950s, with the highest increment in the eastern part of Australia by 2 °C and the lowest increment in the northwest part by −0.4 °C.

Like many things in life, a little global warming is critical for your survival, while too much will destroy you. Global warming is the increasing rise in the earth's temperature through the increase in greenhouse gases (Ehrlich and Ehrlich 1991). The earth's temperature is regulated largely by gases that trap heat in the earth's atmosphere. Often this is referred to as the greenhouse effect. This warming

Table 2.2 Relative greenhouse impact by different greenhouse gases

Greenhouse gases	Relative impact	Reference
CO_2	1	Rodhe (1990)
CH_4	21	
N_2O	310	
SF_4	23,900	
PFCs	6500–9200	
HFCs	140–11,700	

has been critical in providing the earth with the right temperature that we need to survive. This trapping of the heat allows the earth's temperature to be in the range to support life (Lacis et al. 2010). Relative greenhouse impact by different greenhouse gases is presented in Table 2.2. Unfortunately, due to man's recent activities, we have increased the concentration of specific greenhouse gases and are now responsible for ever increasing temperatures. The greenhouse gases include such gases as carbon dioxide, methane (Mitsch et al. 2013), halocarbons (Lim et al. 2017), ozone (Fann et al. 2015) and nitrous oxide (Hartmann et al. 2013). They have the ability to absorb the heat radiated from the earth's surface.

It has been difficult to confirm that our effect on global warming is becoming critical because there always has been a natural variability in earth's temperature. However, it is now clear that human activities have been causing an increase in the earth's temperature. It is estimated that most of the current global warming has occurred since the mid-20th century (Knutson et al. 2016). Carbon dioxide has risen about 30% since the late 1800s (Rhein et al. 2013). This is a result of the burning of coal, oil and natural gas and the destruction of forests around the world.

2.2 Climatic Changes Over Bio-Planet

Climate change refers to a general change in climate pattern which, include temperature, rainfall, winds and other related factors, while global warming and cooling refers to change in the global average surface temperature. Increase in average global temperature is the major factor of climatic changes (IPCC 2014). Predominantly, human activities are major contributors of global warming because of increased industrialization and greenhouse gases.

2.2.1 Role of Greenhouse Gases

Greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), fluorinated industrial gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Among them, methane is 20 times as potent a greenhouse gas as carbon dioxide. Water vapors also included in greenhouse gases (Stocker 2014). Natural and industrial greenhouse impact on biosphere has been shown in Fig. 2.1. A planet with increased temperature steer the climate which in turn affect the weather in various ways. So, the term "greenhouse" is used in conjunction with the phenomenon known as the greenhouse effect. The greenhouse effect is the causing of global warming on earth as certain gases in the atmosphere trap sun energy. Sun-rays are the key drivers of earth's weather and climate as it heats the surface of planet. In turn, the earth bounces back the energy radiations into the space. Some greenhouse gases trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse. These gases are therefore known as greenhouse gases

Many of these greenhouse gases are actually important for life on earth, as without greenhouse gases, heat would not stay and as a result, the average temperature of the earth would be colder. In contrary, with increasing greenhouse effect, more heat gets trapped and the earth might become less suitable for humans, plants and animals. Carbon dioxide, though not the most potent of greenhouse gases, is the most significant one. Natural cycle of the greenhouse effect has affected by human activities. Climatic changes due to natural and human activities have been presented in Fig. 2.2. The natural fluctuation of carbon through the earth system, anthropogenic activities, particularly fossil fuel burning and deforestation are also releasing carbon dioxide into the atmosphere. In addition, fossil fuels like coal and oil use for energy purpose in transportation, heating, cooking, electricity, and manufacturing are effectively moving carbon rapidly into the atmosphere than is being removed. Dry wood contains 50% carbon which humans are converting into carbon dioxide by deforestation. The result is that humans are adding increasing amounts of extra carbon dioxide into the atmosphere.

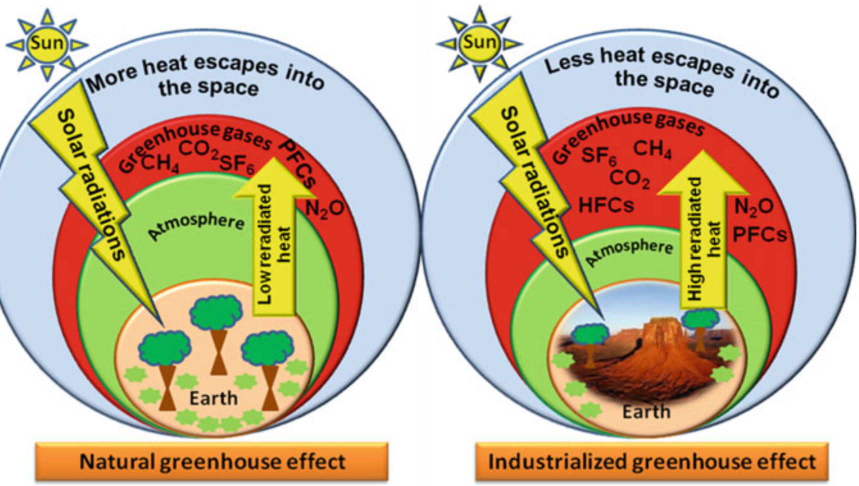

Fig. 2.1 Natural and industrial greenhouse impact on biosphere

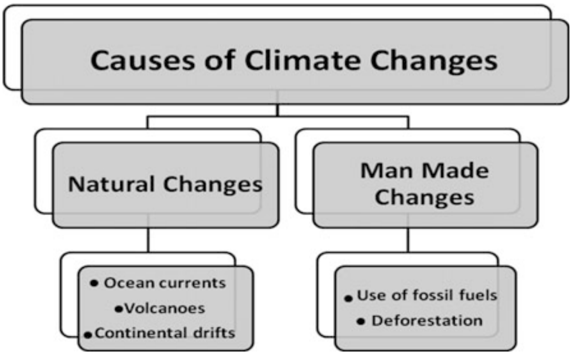

Fig. 2.2 Climatic changes due to natural and human activities

Climate has changed throughout the history of earth. However, past warming spells does mean today's warming is also natural. Recent warming has been shown to be due to human industrialization processes. Satellite observations show that the arctic sea ice is decreasing, and projections for the rest of the century predict even more shrinkage. Climate change impacts the rising of sea levels. Climate scientists have predicted about 20 cm rise in average sea level during past 100 years and expect it to rise more and more rapidly in the next 100 years as a part of climate change impacts. New York and such other coastal cities are already facing high flooding events and by 2050 many such cities expecting more and may require seawalls to survive. Estimates vary, but conservatively sea levels are expected to rise 1–4 ft (30 to 100 cm), enough to flood many small Pacific island states, famous beach resorts and coastal cities.

2.3 Climate Changes and Water Availability Issues

Water scarcity is among the top most concerns of the world (Brown and Halweil 1998). Water is life as plants, animals and humans all depend on the invaluable natural resources. Almost every human activity you can think of involves some use of water (Kingsolver 2010). Water is used in moving waste, cleaning and sanitation, manufacturing, construction and farming (Howard et al. 2003). For many people, water has never been a big problem in their lives. This is because they live in communities that have good water supply systems. They turn on the tap and clean water flows, everyday of the year. This makes it very difficult for people to appreciate how precious water is for. Water covers more than 70% of the earth's surface but less than 3% of it is fresh water (Gleick 2014). Major bulk of fresh water is entrapped to snowfields and glaciers which are not in easy access. The rest of water reserves as seas, oceans cannot be used as fresh water. A tiny fraction (0.014%) is as surface water in the form of rivers, lakes etc. Naturally, the 3% should be enough for all humans and animals on earth, but unfortunately,

Table 2.3 Possible impacts of climate change on water resources (Zimmerman et al. 2008)

Phenomena	Chances or future tendencies	Major effects on water resources
Plain land areas possibly will have long warmer and fewer cold days	Nigh on	Water resources relying on snowmelt will be effected and disrupt the water supplies
Frequency of warmer spells in summer season and heat waves will be increased in most of the land areas	Very well expected	Water requirements will be increased
Occurrence of heavy rainfall happenings will be increased	Almost immediately possible	Deterioration of water quality at surface and groundwater
Many areas possibly will be affected by drought	To be expected	Stress on water resources will very high
Tendency of tropical cyclones may possibly be increased	Probability is high	Power outbreaks and interruption of water supply
Sea levels can be extremely high	Very nearly	Freshwater will reduce due to saltwater invasion

many factors have caused a major upset in the flow and use of fresh water and has caused massive crisis in many regions of the earth.

If climate in a given region were to become warmer and drier, water availability would decrease and water demand would increase, especially demand for irrigation and electric power production, the largest users of water (Schewe et al. 2014). Probable impacts of climate change on water resources are presented in Table 2.3. Lower river flows resulting from drier conditions could affect adversely in stream uses such as hydropower, navigation, aquatic ecosystems, wildlife habitat and recreation. Lower stream flow and lower lake levels could cause new power plants to locate in coastal areas in order to obtain a water source that is reliable and that may be used without violation of thermal restrictions (EPA 1989).

2.3.1 Water Pollution

The air is polluted by burning fossil fuels in industries, power plants, transports etc. (Lee et al. 2014). When sulphur and nitrogen oxides escape to atmosphere these pollute the air and produce toxic clouds. These toxic clouds in turn pollute the land surface in the form of acid rain which ultimately pollutes the river water which now cannot be used for drinking purpose (Lamarque et al. 2013). Industries cause huge water pollution with their activities. These come mainly from sulphur that is a non-metallic substance and is harmful to marine life. Asbestos pollutant has cancer-causing properties. When inhaled, it can cause illnesses such as asbestosis and some types of cancer. Lead and Mercury are metallic elements and can cause environmental and health problems for humans and animals. It is also poisonous. It is usually very hard to clean it up from the environment once it gets into it because it is non-biodegradable (de Vries et al. 2013). Nitrates and Phosphates are found in fertilizers, and are often washed from the soils to nearby water bodies. They can cause eutrophication, which can be very problematic to marine environments. Oils form a thick layer on the water surface because they do not dissolve in water. This can stop marine plants receiving enough light for photosynthesis. It is also harmful to fish and marine birds. A classic example is the BP (British petroleum) oil spill in 2012 which killed thousands of animal species. Routine shipping, run-offs and dumping of oils on the ocean surfaces happen every day. Oil spills make up about 12% of the oil that enters the ocean. Oil spills cause major problems, and can be extremely harmful to local marine wildlife such as fish, birds and sea otters and other aquatic life. Because oil does not dissolve, it stays on the water surface and suffocates fish. Oil also gets caught in the feathers of seabirds, making it difficult for them to fly. Some animals die as a result. A change in the chemical, physical, biological, and radiological quality of water that is injurious to its uses. Thus, the discharge of toxic chemicals from industries or the release of human or livestock waste into a nearby water body is considered pollution.

The contamination of ground water of water bodies like rivers, lakes, wetlands, estuaries, and oceans can threaten the health of humans and aquatic life. Sources of water pollution may be divided into two categories. (i) Point-source pollution, in which contaminants are discharged from a discrete location. Sewage outfalls and oil spills are examples of point-source pollution. (ii) Non-point-source or diffuse pollution, referring to all of the other discharges that deliver contaminants to water bodies. Acid rain and unconfined runoff from agricultural or urban areas falls under this category (Black et al. 2014). The principal contaminants of water include toxic chemicals, nutrients, biodegradable organics, and bacterial and viral pathogens. Water pollution can affect human health when pollutants enter the body either via skin exposure or through the direct consumption of contaminated drinking water and contaminated food. Prime pollutants, including DDT and polychlorinated biphenyls (PCBs), persist in the natural environment and bioaccumulation occurs in the tissues of aquatic organisms (Mckinney et al. 2015). These prolonged and persistent organic pollutants are transferred up the food chain and they can reach levels of concern in fish species that are eaten by humans. Moreover, bacterial and viral pathogens can pose a public health risk for those who drink contaminated water or eat raw shellfish from polluted water bodies.

Contaminants have a significant impact on aquatic ecosystems. Enrichment of water bodies with nutrients (principally nitrogen and phosphorus) can result in the growth of algae and other aquatic plants that shade or clog streams. If wastewater containing biodegradable organic matter is discharged into a stream with inadequate dissolved oxygen, the water downstream of the point of discharge will become anaerobic and will be turbid and dark. Settle able solids will be deposited on the streambed, and anaerobic decomposition will occur. Over the reach of stream where the dissolved-oxygen concentration is zero, a zone of putrefaction will occur with the production of hydrogen sulfide (H_2S), ammonia (NH_3), and other odorous gases. Because many fish species require a minimum of 4–5 mg of dissolved oxygen per liter of water, they will be unable to survive in this portion of the stream. Direct exposures to toxic chemicals are also a health concern for individual aquatic plants and animals. Chemicals such as pesticides are frequently transported to lakes and rivers via runoff, and they can have harmful effects on aquatic life. Toxic chemicals have been shown to reduce the growth, survival, reproductive output, and disease resistance of exposed organisms. These effects can have important consequences for the viability of aquatic populations and communities.

2.3.2 Wastewater Discharges

Wastewater discharges are most commonly controlled through effluent standards and discharge permits. Under this system, discharge permits are issued with limits on the quantity and quality of effluents. Water-quality standards are sets of qualitative and quantitative criteria designed to maintain or enhance the quality of receiving waters. Criteria can be developed and implemented to protect aquatic life against acute and chronic effects and to safeguard humans against deleterious health effects, including cancer.

2.3.3 Water and Flood Issues in Pakistan

The looming threat of water scarcity is an issue that is rarely talked about in Pakistani politics, and yet it constitutes one of the biggest challenges to Pakistan's survival. With a projected population of 263 million in the year 2050 (United Nations 2012), Pakistan needs to put serious thought into how it will provide adequate water for agriculture, industry, and human consumption in the face of rapidly dwindling reserves. The Himalayan glacier, whose ice melt replenishes the Indus River's annual freshwater, is receding by about one meter the approximate equivalent of 3.3 ft per year due to global warming (Simi 2009). This phenomena has had a staggering impact on Pakistan's water availability. In just 1950, Pakistan had around 5,000 m^3 per capita per year of freshwater resources. In 2002, its supplies shrunk to only 1,500 m^3. To put that number in perspective, around 1,000 m^3 is when a country is declared water scarce (Michael 2009).

Unfortunately, Pakistan's water woes do not end with just scarcity. The War on Terror, as well as the 2010 flood, has displaced two million people from Pakistan's countryside, many of whom have flocked to urban centers such as Karachi. As a result, Pakistan must also increase water availability and sanitation in urban centers to accommodate this massive influx of people, in addition to tackling its water scarcity issue. One figure states that around 40–55 million Pakistanis do not have regular access to drinking water and around 630 Pakistani children die each day to the waterborne illness of diarrhea (Michael 2009).

The mismanagement of water will have its biggest impact on Pakistan's agricultural sector. According to the World Bank, 43% of Pakistan's employment is in the agricultural sector (WDI 2013). This prosperous industry relies on the single largest contiguous irrigation system in the world. While this is an impressive feat, Pakistan also fosters one of the lowest crop yields per unit of water in the world. This is alarming because Pakistan uses a whopping 97% of its water resources on its agriculture industry (Simi 2009).

As the previous examples demonstrate, Pakistan's water issues are multi-dimensional. There is no single, all-encompassing problem, but instead multiple, interrelated problems. Therefore, Pakistan needs to completely rethink its entire approach to its water resources. It will take time to implement solutions to these problems, and yet time is in very short supply. It is projected that by about 2035, Pakistan will become water scarce (Simi 2009).

The current status quo is characterized by waste, provincial disputes, corruption, and poor infrastructure. Feisal Khan, Assistant Professor of Economics at Hobart and William Smith Colleges, points out that Pakistan's crop irrigation system is in desperate need of repair. The annual budget for maintenance and repair usually falls well below what is needed. In 2005, the projected budget for repair of Punjab's irrigation infrastructure was estimated at 0.6 billion USD; unfortunately, only 0.2 billion USD was allocated towards maintenance. As such, Pakistan practices a cycle of "Build/Neglect/Rebuild" when it comes to its water infrastructure (Feisal 2009). Currently, around one-third of the water from the irrigation system is lost in delivery due to seepage and malfunctioning watercourses. Still, this number does not seem to faze officials in Islamabad, as Pakistan continues to push for the construction of expensive new dams, such as Diamer Bhasha, instead of renovating its decaying irrigation system (Simi 2009). In fact, there is evidence that dam projects have contributed greatly to waterlogging and soil salinity, making large chunks of agricultural land useless (Kaiser 2009).

Another source of waste comes from farms themselves. Around a quarter of the water delivered from irrigation is wasted from poor farming practices (Simi 2009). Khan blames this on the warabandi system of water management in rural areas. According to this system, each farmer has a specific day to irrigate his or her field. The quantity of water used is irrelevant each farmer pays a flat fee. Although this system was intended to be equitable in the face of water shortages, in reality, farmers who have first access can take a lion's share of the water. Since water is not priced based on usage, there is nothing to discourage waste and overuse. As such, large and powerful farmers have greater access to water from the Indus, which forces small farmers to rely on tube wells to extract groundwater (Feisal 2009). In turn, over-extraction of groundwater negatively affects the salt content of soil, leading to further environmental destruction. This inequality in water distribution also negatively affects crop yields, since small farmers do not have access to adequate water supplies.

Urban areas lack adequate water treatment facilities. As of 2007, only about 7.7% of urban wastewater underwent treatment. Most of the time, household and industrial waste is simply dumped into nearby waterways. This practice has dramatically raised the level of pollution in both groundwater and river systems, and constitutes a major concern for public health.

Lastly, water scarcity has several political implications. Numerous disputes have erupted between Punjab and Sindh over water use and allocation. Although there are provisions within the government which outline the distribution of water between the two provinces, these guidelines are rarely ever met. The current system is particularly hurtful to Sindh, as water from the Indus and its tributaries must pass through Punjab first. Any interference with the Indus River in Punjab adversely affects Sindh. As more and more water is redirected to support Punjab's agricultural industry, there is less water in Sindh for use in consumption, sanitation, and environmental conservation (Feisal 2009). By some accounts, the Sindhi portion of the Indus has shrunk to the size of a mere canal (Michael 2009).

Water pollution is the death of the earth. We should care because a lot of the factors that cause water scarcity are broadening and becoming more complex and uncontrollable. This means if we do nothing in terms of preserving and using it wisely, it is only a matter of time that all regions shall begin to experience water crisis and all the repercussions that come with it. Ozone is a natural gas and is naturally replenished over time. This means if we can do something to balance the natural production with its depletion, there should not be a problem.

Unfortunately, it does not quiet work like that. People ask if we cannot produce our own ozone gas to replenish what is lost in the stratosphere. That's a good question. The sun naturally produces ozone with immense energy and over time. To do the same, we will be looking at using immense energy too, about twice the energy used in the USA. That is just not practical. The only way to do that is to remove the excess chlorine and bromine from the stratosphere. And the only way to do that is to stop making CFCs and several other chemicals. This is why in the 1990s a meeting of the worlds big nations met and agreed to reduce the usage of CFCs and also encouraged other nations to do the same. That was decided in the Montreal Protocol. This is not enough, but at least it was a good starting point. It is always best to talk and discuss problems than to do nothing at all. This is why learning about Ozone depletion, like you are doing, is the most important step towards a safe environment in future.

Finally, Pakistan needs to change its mentality towards conservation. For most of Pakistan's history, the response to water shortages has always been to build dams, redirect rivers, and irrigate the soil. While this may have worked in the past, this engineering-based approach largely ignores the reality that Pakistan is sitting on dwindling reserves. The approach for the coming century must focus on re-education and conservation. Instead of thinking about how and where to build new dams, Pakistan should be thinking about how it can reduce waste in the existing system. Instead of figuring out ways to extract more water from the ground, Pakistan should be figuring out how to recycle its water and make the most of each drop. In a country that has the largest contiguous irrigation system in the world, the main obstacle is not that the system is not large enough, but that it has not been streamlined for efficiency.

2.4 Human Effects on Water Quality and Quantity

Due to human activity, there is a direct impact effect on the hydrologic cycle and the land's physical, chemical, and biological characteristics are changed (Carpenter et al. 2011). Urbanization, transportation, irrigation, deforestation, land drainage, channelization and mining change water ways and also alter water quality parameters by changing the materials with which the water interacts (Peters and Meybeck 2000).

Water quality is not only altered by changes in water ways, but also through the deposition of many substances and wastes to the landscape. Such activities include application of pesticides, herbicides, and fertilizer. These may also leach to the groundwater and surface water from landfills, mine tailings, and irrigated farmland. Table 2.4 keeps valuable information regarding various physical and biological contaminates effecting water quality. The chemical changes are also linked physical processes, but occurs mainly through the addition of wastes gases, liquids, and solids to the earth. Such activities include on land release of industrial effluents or in waterways. Some human-derived substances, including pesticides, microorganic pollutants, nitric acid, and sulfuric acid from fossil fuel combustion, have been traced everywhere. Their occurrence and distribution is due to long-range transport in the atmosphere (Majewski and Capel 1995). Biological modification comprise of forest management, agriculture, and the inclusion of exotic species.

Human direct needs of water also heavily impact hydrologic pathways through the provision of a specified quality water for various activities for human sustainability as farming, Drinking water supplies, electricity generation, cooling towers of the industries. The water quality from urban areas is complex due to the innumerable sources and pathways (Larsen et al. 2009). Artificial drainage channels in urban areas are present in place of natural water ways. Release of untreated waste water directly to earth surface has caused much water pollution, emphasis has been laid on control of leaching the toxic materials (Line et al. 1999).

Table 2.4 Various physical and biological contaminates effecting water quality (Peters and Meybeck 2000)

Sources of contamination	Major issues	Major control factors
Population	Pathogens micro pollutants Eutrophication	Density and various treatment
Water management	Salinization parasites eutrophication	Hydrology and water balance
Land management	Pesticides nutrients physical changes	Agrochemicals, fertilizers cultivation and mining
Atmospheric transport	Micro pollutant radionuclides	Fossil fuel emissions
Global climate changes	Salinization	Fossil fuel emissions and greenhouse gases

The resources used to sustain various standards of humans living are major cause in deterioration of water quality (Moldan et al. 1997). Humans are altering the land to get these resources. Irrigated agriculture alone is responsible for about 75% of the total water withdrawn from surface water and groundwater sources, and more than 90% of this water is consumed and delivered to the atmosphere by evaporation (Cosgrove and Rijsberman 2014). Water quality degradation depends upon climatic characteristics such as amount and timing of rainfall and associated potential evapotranspiration and the various agrochemicals applied to increase yields.

2.5 Conclusion

Climate change mainly creates threats to any of the country's sustainable development. It also effects water resources management and protection. Water scientists have focused their research on establishing sustainable climatic change policies with multi-sectoral coordinating bodies. A large proportion of the world's population is recently suffering from water stress. Rise of global water demand for production of biofuels greatly outweighs greenhouse gases reduction impact of biofuels. Frequent availability of water is considered an important facet of the larger global climate change question. The chapter contributes to an enhanced understanding of present climatic conditions, observed climate trends and climate vulnerability to fresh water availability. Importance of climatic factor in availability of water to raise food and feedstock has been reviewed.

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