International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES),(UGC APPROVED)
Impact Factor: 5.22 (SJIF-2017),e-ISSN:2455-2585
"International Conference on Modern Trends in Civil Engineering"(ICMTCE-2019)
(Towards Sustainable Development Goals)
Volume 5, Special Issue 02, Feb.-2019

IMPLICATIONS OF CLIMATE CHANGE ON SURFACE WATER QUALITY

Poonam Khare[1] and Naveen Shukla[2]

[1]*Department of Geology, J.V. Jain College, Saharanpur, U.P. India*
[2] *U.P. Jal Nigam, Lucknow, U.P. India*

Abstract-Climate change is a serious threat caused by anthropogenic activities like burning of fossil fuels, destroying of rainforests and clearing land forms for agriculture, setting up of industries and other practices. This has resulted in the accumulation of vast amount of greenhouse gases in the atmosphere. Weather and climate pattern are dynamic in nature and with an unaffected increase in human activities one can expect drastic change in the near future, with an increased prevalence of extreme weather schocks.Amongst other, climate change has a major adverse effect on quality of surface water. It reciprocally detirments traditional balance of water bodies and ecosystems, leading to the degradation of water quality. To understand the impact of weather on water quality. We first study the surface water bodies such as river, lakes and streams and secondly the parameters like physical-chemical, biological and micro pollutants are to be considered. Present Paper discusses the impact of climate change on the surface water quality and also focus to understand how droughts and floods coincides with temperature and rainfall

Keywords: Disinfection by product (DBP), Greenhouse gases, water quality, micro pollutants.

INTRODUCTION

Climate change is a 'threat multiplier'and resilience is the answer (Sherri Goodman). Climate change means a rise in the average global temperature, which is due to increase in the green house gases in the atmosphere. There are many gases within the atmosphere, but, Co^2 is a greenhouse gas which is usually derived from human activities. Currently it is 40 % higher than it was when industrialization began in 19^{th} century. Water resource is not only necessary to sustain human life, but also is additionally a key input to several industries like producing and agriculture. Therefore the conservation and best utilization of this scarce resource is very vital for economic development. Water is not only greatly affected by climate change, but it is also a core component of climate. The hydrological cycle include processes like evaporation, condensation precipitation and collection. These processes are undergoing through major shifts as climate change and might have vital implications on the surface water supply for drinking water, rain fed agriculture, groundwater supply, forestry biodiversity and sea level. Surface water is more affected by climate change as compared to ground water . It has been observed that the climate change is not the only factor affecting quality of water. Other factors are land use evolution, deforestation etc. But more often, water pollution is directly associated with human activities of urban, industrial and agricultural origin, and climate change could lead on to degradation of surface water quality.

1. Factors affecting climate change

1.1. Temperature is the main factor affecting almost all physical- chemical equilibriums and biological reactions. The average global temperature should increase between 1.8^0C and 4.0^0C (Bates et al., 2008) during the 21^{st} century.
Rise of atmospheric temperature may have an impact of terrestrial ecosystems and it may also affect water resources and forests. It is pointed out that a temperature rise of 2^0C may cause a large deviation between actual forest distribution and optimum distribution. The amount of agricultural chemicals are expected to rise due to increase in the number of pests, and therefore, there is a fear of increase in the concentration of agricultural chemicals in the water resources.
Floods and droughts will also modify water quality by direct effects of dilution or concentration of dissolved substances. For low river flow rates, the main effect on water quality is temperature increase, concentration increase of dissolved substances in water but concentration decrease of dissolved oxygen (Prathumratana et al.,2008, Van Vliet and Zolsman, 2008)
Solar radiations alters water quality and especially the characteristics of natural organic matter in freshwater systems both by warming and UVB radiations. (Soh et al., 2008)
Production of Trihalomethane occurs due to rise in temperature. It is considered to be largely influenced by temperature alteration. Generally it is produced by reaction between chlorine and organic material. The reaction rate alter the temperature, which increases the production of trihalomethane. Rise in water temperature increases the consumption of residual chlorine. Therefore, more chlorine has to be supplied in the water purification process.
Very high and very low temperatures can result in significant challenges within a lakes or streams and distributing system. Heat waves can encourage algal growth, particularly cyanobacteria, which prefer higher temperatures. Extreme heat and cold also contribute to stratification-destratification within the water supply areas. High temperatures increase the potential for DBPs (Dis-infection by products) formation in the distribution system and nitrification in chloraminated

systems. As air temperatures rise, water temperature and dissolved oxygen in water decreases. Such conditions negatively affect aquatic habitat, which can affect a utility releases and diversions from rivers. Higher winter and summer temperatures are also act as a result of climate change. The warmer weather causes bodies of water to absorb more heat in the summer and release less heat in the winter, resulting in overall hot waters. Warmer waters harm certain fish populations and increase the likelihood of harmful algal blooms and bacteria. It may also increase the survivability and breeding of insects that carry pathogens that create health problems.
Drought coincides with high temperatures. It affect water supplies as well as water quality. Decreased reservoir volumes and lake levels lead to increased inflow from point sources of pollution, including municipal and industrial sewer outflows, mine discharges and thermoelectric power plant return flows. Storm, hurricanes and tornadoes bring heavy rains and strong winds. Alternately extended drought may also be followed by heavy rains that negatively affect turbidity, contaminant concentrations, and organic matter in raw water supplies. If level of water decrease in the water bodies, algal growth can occur in warmer stagnant waters and bottom sediments can become disturbed. If sea level rise due to effects of droughts, it causes saltwater intrusion into drinking water quality.

1.2. Precipitation
Heavy rainfall can mobilize contaminants from a river and lake, disturb sediments in streams and lakes, and result in sewer overflows. The most significant pollutant loads are usually associated with the first flush of rainfall after long dry periods. Apart from heavy rainfall, flooding has its own negative consequences including infrastructure damage and groundwater well contamination.
Increased precipitation, especially in large storm events, can cause river flooding and flash flooding. Flooding results from changes in the land use, undersized sewer and storm water pipes, and extreme precipitation or rapid snowmelt. Because of heavy precipitation, certain health issues will develop. Physical injuries and destruction to property, allergies. Damage to crops and farmland affecting food security and access increased runoff such as sediment, contaminants, nitrate, etc. Sewage overflows, contamination the surface water and waterborne disease outbreaks are from contaminated drinking water

1.3. Less rainfall-Some areas of the country will experience decreased precipitation. This is a result of localized large storm events, which leave some areas of the country drenched and others without any precipitation. An extended period of below-average precipitation can cause a drought, and it can be worsened by high temperatures or short, intense rainfalls that do not allow rainwater to soak into the ground.
Less precipitation causes drought and significant changes in the regional lake water levels. Because of less precipitation, certain problems will arise like reduced soil moisture, groundwater and stream flows, reduced water levels in lakes and wetlands, potential concentration on pollutants, decreased water supply for drinking water,agriculture negative effects to food supply and wildfire dangers. Floods coincides with high rainfall.

1.4. Wind- Water quality can also be affected by strong winds. Large lakes and streams are susceptible to erosion from wind wave action. Together wind, drought and high temperatures can create an ideal situation for algal bloom and associated taste and odor problems, DBP s and filter clogging.

2. Primary parameters affecting climate change are

2.1. pH -In many rivers it has been observed that an average increase in water temperature is 2^0c. When pH of water increases, it shows a decrease in the concentration and a decrease in dissolved oxygen. Increase water temperature have an impact on lakes chemical process, it increases its pH and alkalinity.(senner and Schmidt 1992). Under high temperature dissolved oxygen solubility lowers down. In several lakes in Europe and Northern America, the stratified period is increased by 2-3 weeks and water temperature have risen of 0.2-1.5^{0}c. This has an influence on the thermal stratification (Komatsu et al 2007). It has been observed that the shallow lakes are likely to be most vulnerable to climate change. After temperature have an impact on internal lake processes like diffusion, mineralization and vertical mixing (Malmaeus et al 2006). It is predicted that shallow lakes will experience an increase of temperature during summer (Johnk et al 2008) although deepest lakes are most sensitive to the climate arming on a long period of time due to the greater heat storage capacity and will consequently show higher inter temperature. (Geogg.et al 2007). Whereasman-made lakes respond more directly to the weather variations. (Mooij et al, 2005).

2.2. Dissolved Organic Matter (DOM) affects the functioning of aquatic ecosystems through its influence on acidity, trace metal transport light absorbance and photochemistry and energy and nutrient supply (Evas et al., 2005).The main source of DOM in surface waters is soil leaching (Hejzlar et al., 2003).

2.3.Nutrients in river water affected when droughts occur. An increase of Nitrate mineralization in soil due to an increase in mean soil temperature is expected (Ducharne et al..2007). Droughts increase the soil extractible total organic carbon (TOC) concentration in inter and warming increase extractable nitrate in summer. A moderate increase in soil temperature could lead to a large increase in enzymatic activity. Temperature is positively correlated with nitrification

process. Soil warming increases soil extractable nitrates concentration in summer and autumn (N losses facilitated) and concentration of extractable ammonium in winter.
A winter climate will create indirect impacts on water bodies like an increased nutrient load in surface and groundwater (Van Vliet and Zolsman, 2008). Indeed higher temperature will increase mineralization and release of nitrogen, phosphorous and carbon from soil organic matter. Higher ammonium concentrations could be observed in rivers with a reducing dilution capacity caused by droughts(Zolsman and van Bokhoven 2007).
Increasing temperatures is supposed to decrease nitrate concentrations in lakes with an increase in identification rate and higher N loses in upstream situated soil and surface waters (Mooij et al 2005). Phosphorous increases in the surface layer fueling phytoplankton growth (Jackson et al., 2007).

2.4. Inorganic Micropollutants-Metal concentrations like barium, selenium and nickel were observed in the river. These were found in river as an industrial waste. Sometimes concentrations of lead, chromium, mercury and cadmium are also measured in rivers. It is seen that the concentration of metal are higher during drought period in the rivers.(Zolsman and van Bokhoven,2007).

2.5. Organic micropollutants-Surface water are the main receptors for pesticides contamination from the agricultural use. Bloomfield et al.(2006) observed that changes in rainfall seasonality, intensity and increased air temperatures are the main climate drivers .

2.6. Pathogens- **w**aterborne pathogens could be spread within the freshwater after a contamination by annual or human waste due to heavy rainfall discharge in combined sewer system(CSS). When the flow exceeds the CCS capacity, the sewers overflow directly into the surface water body. (charron et al., 2004). Moreover higher water temperatures will probably lead to pathogen survival increase in the environment.(Hunter 2003). In addition, an increase in temperature threats water quality with regard to waterborne diseases especially cholera disease in Asia (Hunter 2003).Increase in water temperature and nutrient concentration causes massive cyanobacteria bloom in many water bodies (Hunter 2003) Summer heat waves could also boost the cyanobacteria development in lakes (Jhonk et al.,2008).Fishes, green algae and diatoms are often used as water quality indicators. High temperature and low turbulent diffusivities in lakes could suppress the abundance of population of green algae and diatoms.

CONCLUSION

Climate change also impose indirect water quality problems. Changes in temperature and precipitation patterns can increase wildfire, encourage invasive species. In addition, infrastructure damage from floods and power outages increase the difficulty, in maintaining good quality of water supplies.
Climate change implies a predicted increase in the hydrologic cycle speed and intensity. In other words heavy rain, storms, drought, and heat waves can occur more frequently. For eg. if heavy rains that lead to turbidity occur too frequently, rivers and lakes may have little time to recover between events . Alternating events such as drought and heavy rains, can negatively affect water quality because organic material and nutrients build up in the rivers are flushed into downstream, all at once.
The main findings of this study are on Climate change related impacts on the surface water quality. Effects of drought and floods are the two main factors which coincides with temperature and rainfalls. These impacts depend on natural and manmade environment, and the consequences can be different according to the water body type for eg. rivers, lakes, dams, ponds, wetlands etc. For streams, the main parameters affected are DOM and Nutrients meanwhile pathogens and cyanobacteria are more related to the lakes.
Climate change affect water quality and degrade the drinking water quality leading to an increase of risk situations with regard to potential health impact, mainly during extreme meteorological events.
Among water quality parameters, dissolved organic matter, micropollutants and pathogens are susceptible to rise in concentration or as a consequence of temperature increase. Lastly, water borne diseases are potentially highly linked to the climate change impacts but still rarely studied for tropical countries. Eventually, there is a huge need for water quality monitoring and predictive tools to develop.

REFERENCES

Bates BC.Kundzeicz Z, u S Palutikof JP. Climate change and ater.Geneva: Technical Paper of the Intergovernmental panel on Climate change. IPCC Secretariat:2008.
Bloomfield JP, Williams RJ, Gooddy DC, Cape JN, Guha P. Impacts of climate change on
the fate and behaviour of pesticides in surface and groundwater—a UK perspective.
Sci Total Env 2006;369:163–77.
Charron DF, Thomas MK, Waltner-Toews D, Aramini JJ, Edge T, Kent RA, et al. Vulnerability of waterborne diseases to climate change in Canada: a review. J Toxicol
Environ Health Part A 2004;67:1667–77.

Ducharne A, Baubion C, Beaudoin N, Benoit M, Billen G, Brisson N, et al. Long term prospective of the Seine river system: confronting climatic and direct anthropogenic changes. Sci Total Environ 2007;375:292–311.

George G,Hurley M, Hewitt D. The impact of climate change on the physical characteristics of the larger lakes in the English Lake District. FreshwBiol 2007;52:1647–66.

Hejzlar J, Dubrovsky M, Buchtele J, Ružička M. The apparent and potential effects of climate change on the inferred concentration of dissolved organic matter in a temperate stream (the Malše River, South Bohemia). Sci Total Environ 2003;310: 143–52.

Hunter PR. Climate change and waterborne and vector-borne disease. J ApplMicrobiol 2003;94:37S–46S.
Komatsu E, Fukushima T, Harasawa H. A modeling approach to forecast the effect of long-term climate change on lake water quality. Ecol Model 2007;209:351–66.

Malmaeus JM, Blenckner T, Markensten H, Persson I. Lake phosphorus dynamics and climate warming: a mechanistic model approach. Ecol Model 2006;190:1–14.

Mooij WM, Hülsmann S, De SenerpontDomis LN, Nolet BA, Bodelier PLE, Boers PCM, et al. The impact of climate change on lakes in the Netherlands: a review. AquatEcol 2005;39:381–400.

PrathumrstanaL.Sthiannopkao S. Kim K. The relationship of climate and hydrological parameters to surface ater quality in the loer Mekong River.Environ.Int 2008:34:860-6
Sherri Goodman, public policy fellow at the wilson Center environment change and security program, 2018.
Soh YC, Roddick F,VanLeeuen J. The Future of ater in Australia the potential effects of climate change and ozone depletion on Australian ater quality, quantity and treatability, Environmentalist 2008:28:158-165.
Jackson LJ, Lauridsen TL, Søndergaard M, Jeppesen E. A comparison of shallow Danish and Canadian lakes and implications of climate change. FreshwBiol 2007;52: 1782–92.
Jöhnk KD, Huisman J, Sharples J, Sommeijer B, Visser PM, Stroom JM. Summer heatwaves promote blooms of harmful Cyanobacteria. Glob Chang Biol 2008;14: 495–512.
Van Vliet MTZ,Zolsman JJG. Impact of summer drought on ater quality of the Meuse river.jHydrol 2008:353:1-17.
Zwolsman JJG, van Bokhoven AJ. Impact of summer droughts on water quality of the Rhine River—a preview of climate change? Water SciTechnol 2007;56:44–55.