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Review Article

Climate change and challenges of water and food security

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Abstract

Water and food security are the key challenges under climate change as both are highly vulnerable to continuously changing climatic patterns. Studies have predicted that the average global temperature may increase by 1.4–5.8 °C and there would be substantial reduction in fresh water resources and agricultural yield by the end of the 21st century. Approximately 75% of the Himalayan glaciers are on retreat and will disappear by 2035. Moreover in Africa (Sub-Saharan Africa) by 2050 the rainfall could drop by 10%, which would reduce drainage by 17%. Majority of the fresh water resources has already been depleted and there is reduction in agricultural production globally with escalation in population and food demand. Some of the prominent climate change impacts are, growing deserts, and increase in the magnitude of floods and droughts. An extreme decline in crop yields in arid and semi arid areas globally has caused food shortages and a manifold increase in food inflation. Countries of Africa, Middle East, Arab and Asia have close economic ties with natural resource and climate-dependent sectors such as forestry, agriculture, water, and fisheries. This manuscript highlights groundwater recharge by utilization of wastewater using the Soil Aquifer Treatment (SAT) method in irrigation and the significance and methods of artificial recharge of groundwater. This paper also presents easily and economically feasible options to ensure water and food security under climate change and recommend formation of effective adaptation and mitigation polices and strategies to minimizing the impact of climate change on water resources and irrigation.

Keywords: Climate change; Water security; Food security; Adaptation & mitigation techniques

Contents

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1. Introduction

Water and food scarcity are the biggest problem globally and it severely affects the arid and semiarid regions/countries. Climate change has resulted in increases in globally-averaged mean annual air temperature and variations in regional precipitation and these changes are expected to continue and intensify in the future (Solomon et al., 2007). The impact of climate change on the quantity and quality of groundwater resources is of global importance because 1.5–3 billion people rely on groundwater as a drinking water source (Kundzewicz and Döll, 2009). As per the fourth IPCC assessment report the knowledge of groundwater recharge and of levels in both developed and developing countries is poor. There has been very little research on the impact of climate change on groundwater' (Kundzewicz et al., 2007).

Study of Global Climate Models (GCMs) projects significant changes to regional and globally averaged precipitation and air temperature, and these changes will likely have associated impacts on groundwater recharge (Kurylyk and MacQuarrie, 2013). IPCC report (2008) predicts that the climate change over the next century will affect rainfall pattern, river flows and sea levels all over the world. Studies show that agriculture yield will likely be severely affected over the next hundred years due to unprecedented rates of changes in the climate system (Jarvis et al., 2010; Thornton et al., 2011). In arid and semi-arid areas the expected precipitation decreases over the next century would be 20% or more. The accelerated increase in the greenhouse gases (GHG) concentration in the atmosphere is a major cause for climate change. As per the IPCC (2007) report, the maximum growth in the emission of greenhouse gases (GHG) has occurred between 1970 and 2004, i.e. 145% increase from energy supply sector, 120% from transport, 65% from industry, 40% from change in land use patterns and during this period global population increases by 69%. As per the WMO (2013), the world experienced unprecedented high-impact climate extremes during the 2001–2010 decade that was the warmest since the start of modern measurements in 1850. Moreover, survey of 139 National Meteorological and Hydrological Services and socio-economic data and analysis from several UN agencies and partners conducted by WMO concluded that floods were the most frequently experienced extreme events over the course of the decade. The amount of energy reaching the earth's atmosphere every second on a surface area of one square meter facing the sun during daytime is about 1370 Watts and the amount of energy per square meter per second averaged over the entire planet is one quarter of this (IPCC, 2007A). The global mean temperature has increased by 0.74 °C during (Fig. 1) the last 100 years. Furthermore studies conducted by Indian Space Research Organization (ISRO) after the study of 2190 Himalayan glaciers revealed that approximately 75% of the Himalayan glaciers are on the retreat, with the average shrinkage of 3.75 km during the last 15 years (Misra, 2013). These findings raise serious concerns over the accelerated retreat of glaciers in the Himalayan Mountains because it will increase the variability of water flows to downstream regions and threaten the sustainable water use planning in the world's most populous Ganga Basin. Studies (de Wit and Stankiewicz, 2006; Anthony Nyong, 2005) predict that by the year 2050 the rainfall in Sub-Saharan Africa could drop by 10%, which will cause a major water shortage. This 10%