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論文題目	EFFECT OF CLIMATE CHANGE ON PRECIPITATION IN NEPAL AND KANSAI AREA IN JAPAN, AND ON WATER QUALITY OF OSAKA BAY AREA （気候変動がネパールと日本の関西地区における降雨および大阪湾水質へ及ぼす影響）		

（論文内容の要旨）

Climate change driven by anthropogenic activities is likely to increase the temperature and alter the amounts, duration, frequency, and intensity of precipitation. Many studies have reported that climate change directly or indirectly influences water quality, especially the release of nutrients in lakes and sea. This research aims to assess the changes in extreme precipitation indices in Nepal and Kansai region in Japan. Also, it assesses the impact of precipitation indices in sea water nutrient concentration in Osaka Bay.

Chapter 1 Introduction

Chapter 1 presents the overview of the precipitation indices across globe, Nepal, and Japan and its effect on water quality, specifically on Osaka Bay in the past and present. It also discusses research problem statements, scope and research objectives, and outline of the dissertation.

Chapter 2 Materials and methodology

Chapter 2 presents the materials, methodologies, and description of the study area. The extreme precipitation indices in Nepal and Kansai region of Japan were assessed using ETCCDI's indices. The effect of extreme precipitation indices on water quality of the Osaka Bay, Japan was then analyzed. The water quality prediction in the Osaka Bay was also carried out using EFDC water quality model.

Chapter 3 Extreme precipitation indices in Nepal

Chapter 3 analyses the extreme precipitation indices in Nepal from 1976-2015. The spatial distributions of changes of mean annual values of different extreme precipitation indices attributed between two periods T1 (1976-1995) and T2 (1996-2015) with respect to the corresponding values during period T1 are analyzed. The rising trend was observed for R20 (Annual count of days when PRCP>=20mm) and R50 (Annual count of days when PRCP>=50 mm) during those periods, which leads to a risk of torrential floods in the low elevated regions and landslides in the high elevated regions. The quantitative change analysis of the precipitation indices in the two periods showed a higher shift in CDD (Consecutive Dry Days) values (14.8%) and a lesser shift in R10 (Annual count of days when PRCP>=10mm) values (0.6%). This variation concludes that T2 is comparatively drier and has a risk of flash floods.

Chapter 4 Extreme precipitation indices in Kansai, Japan

Chapter 4 discusses the extreme precipitation indices in Kansai region, Japan. In a longer timescale (1971-2015), CDD, R10, and R20 showed a gentle trend while other indices show upward trend. We observed a noticeable increasing shift of CDD in four prefectures namely, Hyogo, Kyoto, Shiga, and Nara. The higher variability of CDD is observed in 1986, 2000 and 2011. In contrast, CWD (Consecutive wet days) showed increasing trend in T1 and decreasing in T2. The spatial heterogeneity in rainfall indices were observed in the Kansai region showing a higher extremity in the urbanized prefectures like Osaka and Kyoto and lesser variation in rainfall extremes in less urbanized prefectures.

Chapter 5 Comparison of precipitation indices distribution between Nepal and the Kansai region in Japan

Chapter 5 assesses the comparison of precipitation indices distribution between Nepal and Kansai region. Both the area lies in the northern latitudes. The annual precipitation in Nepal and Kansai is almost congruent (1700 mm per year). Both the study area behaved similar tendency of PRCPTOT (Annual total wet-day precipitation) in time T1 and T2. Higher amount of precipitation is observed in time T2 compared to time T1 which signifies that floods are the main environmental challenges in both the study area. Further, the spatial and temporal trend of CDD showed reduced number of dry days in time T2 compared to time T1 lower being in the urban areas.

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Chapter 6 Water quality in Osaka Bay

Chapter 6 discusses about the water quality conditions in the Osaka Bay. Fluctuations in the salinity is observed over the temporal period. The temporal distribution of nitrite showed a gentle decreasing trend in 2007 (0.48 mg/L) and reduced drastically beyond. Similarly, the nitrate concentration reduced gradually from 1994 to 2015. The concentration of nutrients is higher near to the shoreline. The observed value of pH in the bay area showed that the water is alkaline (>7) in nature and fluctuate mostly between 8.1 and 8.2. During 2007 and 2009, the alkalinity in all the stations showed increasing nature.

Chapter 7 Effect of precipitation indices to water quality of Osaka Bay

Chapter 7 shows the interrelationship between extreme precipitation indices and water quality nutrients in the Osaka Bay. Salinity concentration descends with increase in total precipitation in the bay area. Further reduction in salinity and nitrogen nutrients is attenuated by increase in R95PTOT (Annual total precipitation when Daily Precipitation>95th percentile) and R99PTOT (Annual total precipitation when Daily Precipitation>99th percentile) in land surface. In contrast, the temporal variation of salinity against R95PTOT and R99PTOT did not show increasing or decreasing tendency with increase or decrease in rainfall indices till 2010. The increase in Rx1day (Yearly maximum one-day precipitation) has resulted in reduced concentration of both salinity and DIN (Dissolved Inorganic Nitrogen) concentration after 2010. But the temporal distribution of salinity and DIN is fluctuating between 1994 and 2009. Higher amount of 1 day precipitation in 2004 and lower amount in 2002 resulted in low and high concentration of salinity and DIN, respectively.

Chapter 8 Prediction of water quality of Osaka Bay

Chapter 8 explains the numerical model that was applied to Osaka Bay, Japan for the prediction of water quality. In this study, salinity, temperature, different forms of nitrogen, DO, pH are simulated using 3D hydrodynamic model. Environmental Fluid Dynamics Code (EFDC) is a public domain, open source, surface water modeling system. The model can simulate the vertical stratification of temperature and salinity near the mouth of rivers. It was found that the freshwater plays major role in stratification and net flushing of the Osaka Bay. Although small individually, the ungauged streams and surface runoff can be a significant portion of the total inflow and affect salinity distribution significantly.

Chapter 9 Conclusions

Chapter 9 concludes the research from each preceding chapters. The results of this study imply that only rainfall is not the driving factors that control the water quality concentration in the bay area. There exist other controlling factors such as anthropogenic activities, management practices and policies and that fluctuate the nutrient concentration in the bay area.