

Climate Change

About the Cover



In this study, assessed the spatial-temporal variability of rainfall over the Kalaburgi District of Karnataka, India for the period 1981–2018, using gridded data with 0.5-degree resolution obtained from the National Aeronautics and Space Administration prediction of worldwide energy resource (NASA POWER) project. Trend detection and quantification in the rainfall and index evaluated using the non-parametric Mann–Kendall (MK) test and Sen’s slope estimator. Also, an investigation carried out to know the dry and wet years using Standardized Anomaly Index (SAI). The overall rainfall data and Sen’s estimate showed the decreasing trend in series for the last 38 years. SAI results show shows that 1981, 1995, 1998 and 2005 are incredibly wet years of widespread flooding in the region and 1985, 1999, 2003 and 2016 were found as extreme drought years for 1981 to 2018. In the overall, the spatial distribution analysis results observed the better distribution of rainfall in Aland, Chincholi, Sedam and part of Chittapur with a range from 800 to 900 mm and sparse distribution in the range of 600 to 700 mm over the Afzalpur, Jewargi, and part of Kalaburgi and Chittapur. (Ref: Siddharam, Kambale JB, Basavaraja D, Nemichandrappa M, Dandekar AT. Assessment of long term Spatio-temporal variability and Standardized Anomaly Index of rainfall of Northeastern region, Karnataka, India. *Climate Change*, 2020, 6(21), 1-11).

Assessment of long term Spatio-temporal variability and Standardized Anomaly Index of rainfall of Northeastern region, Karnataka, India

Siddharam, Kambale JB, Basavaraja D, Nemichandrappa M, Dandekar AT

In this study, assessed the spatial-temporal variability of rainfall over the Kalaburgi District of Karnataka, India for the period 1981–2018, using gridded data with 0.5-degree resolution obtained from the National Aeronautics and Space Administration prediction of worldwide energy resource (NASA POWER) project. Trend detection and quantification in the rainfall and index evaluated using the non-parametric Mann–Kendall (MK) test and Sen's slope estimator. Also, an investigation carried out to know the dry and wet years using Standardized Anomaly Index (SAI). The overall rainfall data and Sen's estimate showed the decreasing trend in series for the last 38 years. SAI results show shows that 1981, 1995, 1998 and 2005 are incredibly wet years of widespread flooding in the region and 1985, 1999, 2003 and 2016 were found as extreme drought years for 1981 to 2018. In the overall, the spatial distribution analysis results observed the better distribution of rainfall in Aland, Chincholi, Sedam and part of Chittapur with a range from 800 to 900 mm and sparse distribution in the range of 600 to 700 mm over the Afzalpur, Jewargi, and part of Kalaburgi and Chittapur.

Climate Change, 2020, 6(21), 1-11

Assessment of Temperature and Rainfall Variability over South Eastern Nigeria: Implication to Flooding and Erosion Management

Ajiere Susan, Nwaerema Peace

Rainfall and temperature variability, trends and pattern have posed serious challenges across the globe. Studies have shown that the global climate has varied slowly over the past decades and it is expected that it will continue to vary in future. Therefore, this work examined annual and decadal distribution, pattern, trends, anomalies of rainfall and temperature in South-Eastern Nigeria. The rainfall and temperature data were obtained from Nigerian Meteorological Agency (NIMET) for a period of 30 years for five states of Rivers, Imo, Abia, Cross Rivers and Enugu States respectively. The data were grouped into three decades of (1987-1996), (1997-2006) and (2007-2016) which were analyzed using the descriptive statistics and 3rd order polynomial trend. It was observed that in the first decade (1987-1996) rainfall was high in Rivers and Imo States; and in the second decade (1997-2007) rainfall was high in Abia State and the third decade rainfall was high in Cross River and Enugu States respectively. The mean annual temperature from 1987-2016 had persistent increase in temperature in all the state since 2001 and 2002. The analysis of long time trends in the time series showed notable fluctuations in the pattern of polynomial trend in rainfall and temperature. Abia, Enugu and Cross River States have positive trends while Rivers and Imo states have negative trends in rainfall. Temperature showed positive trend across the states. This shows an evidence of climate variability. The increasing surface air temperature and associated heat enhances spread of diseases and its epidemics as well as sea level rise. However, temperature increase results to flooding and erosion while extreme temperature gives rise to drought in the region. It is therefore recommended for planners to manage agriculture and outbreak of diseases by considering the predictability of temperature and rainfall variability, trends and anomalies for better human comfort and livelihood.

Climate Change, 2020, 6(21), 12-22

Climate Change & Adaptation/Mitigation

Determinants of choice of adaptation to climate change by maize-based farmers in Ekiti state, Nigeria

Arojo OA, Adewuyi SA, Okuneye PA, Bada BS

This study examined the determinants of choice of adaptation strategies to climate change employed by maize-based farmers in Ekiti State, Nigeria. Multistage sampling technique was used to select 172 maize-based farmers for the study. The data were obtained on respondents' socio-economic characteristics, inputs, outputs and climate change adaptation strategies of maize-based farmers using a pre-tested questionnaire. Descriptive statistics, and Tobit regression techniques were used for data analysis. Results revealed that 79.1% of the farmers were male, 89.0% were married and 73.2% had formal education with mean age, farm and household sizes of 47 years, 2.90 hectares and 5 persons respectively. Furthermore, 63.9% had secondary occupation, 25.6% had access to credit, 84.9% had access to extension visits and 67.4% were aware of climate change. Common adaptation strategies used by the farmers were multiple crop type ($\bar{x}$ = 2.40), crop rotation ($\bar{x}$ = 2.26), crop diversification ($\bar{x}$ = 2.16), planting of cover crops ($\bar{x}$ = 2.06) and multiple planting dates ($\bar{x}$ = 2.03). Principal constraints faced by the respondents in adapting to climate change were high costs of improved seeds (90.1%), invasion of farm by Fulani herdsmen (85.5%), lack of timely information on weather conditions (85.4%), inadequate access to institutional facilities (81.9%) and high costs of irrigation facilities (76.2%). Chi-square showed a

significant ($p < 0.01$) association between adaptation strategies used and maize output ($\chi^2 = 208.0$, $df = 11$). Tobit model revealed that sex ($\beta = -0.0945761$), household size ($\beta = -0.0204273$) and income ($\beta = 7.39e-08$) were major determinants of adaptation strategies ($p < 0.10$, $p < 0.10$ and $p < 0.05$ respectively). The study concluded that climate change adaptation strategies affected maize output. The study recommended that the maize-based farmers in the study area should continue to make use of multiple crop type, crop diversification, multiple planting dates, mixed farming, land fragmentation, use of agricultural insurance, crop rotation, planting of cover crops, fertilizer application as climate change adaptation strategies to improve maize output.

Climate Change, 2020, 6(21), 23-35

Climate Change & Environmental Science

Sea surface temperature trends and its relationship with precipitation in the Western and Central Equatorial Africa

Akeem Shola Ayinde, Regina Folorunsho, Adeyemi Ekundayo Oluwaseun

We examine Sea Surface Temperature (SST) trends and its relationship with precipitation in the Western Equatorial Africa (WEA), Central Equatorial Africa (CEA) and Western and Central Equatorial Africa (WCEA) regions. Global Precipitation Climatological Project (GPCP) and revised version 5 of Extended Reconstructed Sea Surface Temperature (ERSSTv5) data from 1979 – 2018 were used for the study. SST show an increasing trend with highest value recorded in 2015. Variations in SST is strongly influence the precipitation in the regions with strong positive Pearson (ρ) and Spearman (r_s) correlation coefficients recorded for WEA ($\rho = 0.627, r_s = 0.627$), CEA ($\rho = 0.501, r_s = 0.565$) and WCEA ($\rho = 0.601, r_s = 0.651$). SST in the equatorial Atlantic respond to both longitudinal and latitudinal changes with decrease trend toward the coast and increase away from the equatorial region before further decrease. This behavior is well translated to the precipitation of the study area where precipitation increases with latitudes and decreases across the longitudes and as it goes further away from the coast. Analysis also show a remarkable seasonal change in SST and precipitation with peak SST and precipitation across the CEA correspond to the lowest SST and precipitation across the WEA and vice versa, for winter and spring respectively. Coastal upwelling is suggested in Republic of Congo, DR Congo and Angola coast with rapid decrease in coastal SST in July, August and September.

Climate Change, 2020, 6(21), 36-51

Climate Change & Agriculture

Prediction of economic loss of rice production due to flood inundation under climate change impacts using a modeling approach: A case study in Ha Tinh Province, Vietnam

Pham Quy Giang

The present study was carried out to predict the economic loss of rice production due to flood inundation under climate change impacts using a modeling approach with a case study of Huong Son District in Ha Tinh Province, Vietnam. Extreme precipitation and its return periods were identified by GEV distribution method using historical daily observations and output of MRI-CGCM3 climate model. The predicted extreme precipitation data was then employed as an input of hydrological models for flood modeling. Finally, a complex approach taking into account depth and duration of inundation and crop calendar was used for the prediction of potential economic loss of rice production. Results of the study show a significant increase in the intensity of extreme precipitation and floods, and the economic loss of rice production would increase significantly as a result of larger, deeper and longer floods. In 2050s, the loss would be 21.02% greater compared to the baseline period. The finding of this study is expected to be valuable scientific information for long-term agricultural planning to tackle with potential flooding threats under climate change impacts.

Climate Change, 2020, 6(21), 52-63

Climate change and crop coefficients of some field crops in Egypt

Samiha Ouda, Tahany Noreldin

Matching water supply and demand are essential for productivity and sustainability in an irrigation scheme. Because Egypt is experiencing water scarcity, knowledge of crop water requirements is crucial for water resources management and planning. Crop water requirements consist of two components, namely evapotranspiration (ET_o) and crop coefficients (K_c). There are several equations exists in the literature to calculate the values of ET_o in a certain region. The values of K_c for a certain crop are; however, vary from one region to another. Therefore, its values presented in the literature are not accurate enough to be used in Egypt. Basic Irrigation Scheduling model (BISm) provides an easy method to determine K_c values for a large number of crops, as affected by the weather in a certain region, irrigation method as well as planting and harvest dates. Thus, the objective of this

chapter was to calculate Kc values for 13 vegetable crops, 14 field crops, and 6 fruit crops. The calculation was done for these crops grown under the weather conditions of the five agro-climatic zones in Egypt.

Climate Change, 2020, 6(21), 64-73

Assessing the Climate Change Impact on Rice and Wheat Production in Uttar Pradesh and Haryana States of India

Ajay Kumar, Jyoti Singh B, Pritee Sharma

This study investigates the impact of climate change on rice and wheat production in Uttar Pradesh and Haryana using a time series analysis. For this, simple production function approach, Cobb–Douglas production function approach and Ricardian multi-regression approach are used. Rice and wheat production as a dependent variable is regressed with different socio-economic and climatic variables such as crop-wise area sown, irrigated area; crop-wise use of fertilizer, tractor, pumpset; literacy rate, forest area, population density; minimum, maximum and mean temperature; and rainfall. Empirical results show that increase in rainfall, maximum and minimum temperature have a negative impact on rice production in Haryana and Uttar Pradesh. Rice and wheat production are negatively affected due to increase in maximum temperature in both the states. Furthermore, climatic factors do not similar impact on rice and wheat production in Uttar Pradesh and Haryana. Moreover, results based on Ricardian model infer that there is non-linear relationship between climatic factors and crop production. It also proves that the impact of climate change on crop production have become more sensitive after 1991 due to changing in non-climatic factors. It is suggested that Ricardian model is found suitable technique to assess the climate change impact on agricultural production system.

Climate Change, 2020, 6(21), 74-93

Changes in the grapevine's growth cycle in Southern Finland in the 2000s – comparison between two first decades

Karvonen Juha

The temperature of Southern Finland has risen faster than ever in the last few decades of a 172-year period. This has made it possible to grow hydride vine varieties and some *Vitis vinifera* varieties. This study evaluated the effects of climate change and growing conditions in the Helsinki region on the growth cycle of *Vitis vinifera* 'Rondo' for two consecutive decades (2000–2009) and (2010–2019). During 2010– 2019, the mean climate temperature had risen by 0.4 °C compared to the mean of 2000– 2009, grape harvesting had been sped up by 6 days and growth cycles had been reduced by 11 days. Changes were statistically significant ($p < 0.05$). There was no significant difference between the mean of the growing seasons and the mean of the bud burst dates. Based on the study, it can be concluded that the appeared rise in annual air temperature significantly accelerated the growth cycle of *Vitis* 'Rondo' in the cool - cold growth zone of Southern Finland.

Climate Change, 2020, 6(21), 94-99

Future Climate Change impacts on Crop Productivity in Coastal Regions of India: A Panel Estimation

Surendra Singh, Alka Singh, Sanatan Nayak

By using large-scale district-level data and the panel-FGLS regression model, the present study attempted to examine and predict climate change impacts on crop yield. A semi-log model was adopted to calculate trends of rainfall and temperatures over 1966–2011. Spatial and temporal analysis of rainfall and temperatures revealed that annual rainfall had been increased in all regions except the central plateau and hills region (i.e., 0.39mm/year). The FGLS- regression results revealed that adverse impacts of climatic factors, i.e., rainfall and temperature were cancel out by adaptation strategies. Without adaptation, projected results revealed that the majority of all crops would be decline in all regional scenarios. In the light of analysed results, regional adaptations are prerequisites for negating adverse impacts of climate change on crop yields.

Climate Change, 2020, 6(21), 100-108

Climate Change & Environmental Science

Evaluation of methane emission distributions in Nigeria using neural network model

Ibeh GF, Udochukwu BC, Ibeh LM, Okoh D

The earth is becoming warmer because of solar energy trapped in the lower atmosphere and less heat radiated into space due to radiative forcing of greenhouse gases. This study assesses the distributions of greenhouse gas (methane) concentration over Nigeria with neural network model. The variation of methane reveals that higher concentration occurs in the South in dry season than the North, while slightly higher concentration occurs in the South in wet season in comparison with the Northern part of Nigeria. In addition, it could be noted that methane concentration covered almost over Nigeria during the wet season. This could imply

influence of weather conditions on methane and several anthropogenic sources of methane during the wet season such as the production of rice, decomposition of some plants, high moisture content etc. The similarity in the estimated and observed signatures shows good performance of the Neural Network model used in this study. The result reveals that the contributions of methane in Nigeria if left unchecked will increase adverse effects on livelihoods, such as crop production, livestock production, fisheries, forestry and post-harvest activities, because the rainfall regimes and patterns will be altered, floods which devastate farmlands would occur. It will also result in increase in temperature and other natural disasters like floods, ocean and storm surges, earth tremors which not only damage Nigerians' livelihood but also cause harm to life and property.

Climate Change, 2020, 6(21), 109-119

Analysis of land use and land cover change in the Sahel: a case study of Yobe State, Nigeria

Jude Nwafor Eze, Patience Chinyelu Onokala

The study analyses the extent of land use and land cover change in the Sahel and the factors influencing the changes. To achieve this, a remote sensing technique was employed. The Landsat Thematic Mapper Image of 1986, Landsat Enhanced Thematic Mapper Image of 2002 and Landsat Enhanced Thematic Mapper Image of 2019 were collected and analysed. Six classes of land use and land cover were obtained using Earth Resource Development Assessment System Imagery 9.1 software. The result shows that there was a decrease in the land area occupied by wetland, shrub-land and water body, while there was an increase in the land area occupied by bare land/dune, settlement and scattered cultivation from the year 1986 to 2019. Increase in bare land/dune, scattered cultivation and settlement were mainly as a result of climate change, overgrazing, a southward movement of dunes from the Sahara desert, increasing farming activities and increasing demand for shelter by the increasing population. The decrease in shrub-land, water body, and wetland was mainly as a result of climate change, increasing deforestation, and increasing use of wetland for farming activities. Based on the results of the analysis, it is recommended that measures should be taken to integrate sustainable land management and climate change adaptation options into the local government plans.

Climate Change, 2020, 6(21), 120-128

Characteristics of temperature and its future scenarios over Nghe An Province of Vietnam in the context of global warming: Implication for Land and Water Management

Pham Quy Giang

The main aim of the present study was to investigate the evolution of temperature during recent decades and its future rise over Nghe An, the largest province in Vietnam, and to draw implications for land and water resources management in the province. An ensemble of Global Climate Models simulation with MAGICC/SCENGEN model and a statistical downscaling method were employed for temperature change prediction. The study found that during the 40 years of observation (1971-2010), annual temperature has increased approximately 0.8 °C, meaning that it has risen 0.2 °C per decade. The province is also predicted to face with a severe warming climate in the future, which could warm as much as 3.9 °C by the end of this century. A warmer climate could lead to a number of issues regarding the variability of land and water resources in the province including the negative change of water cycle; the increase in the frequency and intensity of floods and droughts which could destruct the current land and water systems; degradation of land due to soil erosion which causes the loss of fertile soil; water pollution and water quality deterioration due to the transportation of heavy metals, pollutants, pesticides, and chemical fertilizers during heavier rains, etc. It is recommended that countermeasures should be planned in the framework of watershed management, which is the integrated use and management of land, vegetation and water resources while enhancing livelihoods and maintaining ecosystem services in the province.

Climate Change, 2020, 6(21), 129-140

Climate Change & Policy/ Strategy

The spatial turn in the National Physical Plan (NPP) Malaysia in compare to Germany for better criteria identification on climate change and environmental hazards issues

Kamran Jafarpour Ghalehtimouri, Faizah Binti Che Ros

The National Physical Plan (NPP) is the first national spatial planning draft in Malaysia prepared under Part II B, Section 6B, of the Town and Country Planning (Amendment) Act 2001, (Act A1129). Reviewing the planning system in Malaysia shows constant economic shifts have made planning policies as an uncoordinated way that fails plans to address environmental issues. As a prime example, comparing NPP1, NPP2, and NPP3 shows that there are some significant shifts in planning implementation. Moreover, the economic dimension in NPP3 is stronger than NPP1 and NPP2. In addition, this study aims to show the appropriate application of

spatial planning at the national level. Therefore, comparing spatial planning implementation in Malaysia with Germany provides criteria for effectiveness of spatial planning in the NPP in Malaysia. Comparing spatial planning in Malaysia and Germany showed that in Germany over 72% of the planning system influenced by the spatial theme and economic themes is 22%. However, Malaysia with smaller market size, and less industrialized than Germany over 50% of the National Physical Plan have been economic in the NPP1 and the NPP 2 and spatial and spatial themes have been less than 18% in the NPP1 and NPP 2.

Climate Change, 2020, 6(21), 141-155

Climate Change & Education

Climate change impact on workers' health, safety and productivity

Joshua, OLU, Adeshina Sherif MAJEKODUNMI

Climate change is a global phenomenon which effects continue to generate attention. Workers are exposed to many types of climate change related hazards depending on the type of work, geographic region, season, and duration of work time. This study aim to evaluate the effects of climate change on workers with respect to their health, safety and productivity. In this study, data was collected from a total of 200 respondents who were workers across four occupational sectors: agriculture, fishing, construction and food production using well structured questionnaires. There was significant difference between the perceptions of climate impact among the workers in the four sectors from the model final χ^2 (15, N= 200) = 38.211, p= 0.001 Nagelkerke R^2 = 0.186. There was no significant relationship between low productivity and climate change related hazards in workplace, from Omnibus χ^2 (5, N= 200) = 8.642, p= 0.124. The climate change related hazard affected the health and safety which subsequently result in a low productivity by the workers. Increased ambient temperature has more significant effect on the workers in their workplace environment.

Climate Change, 2020, 6(21), 156-167