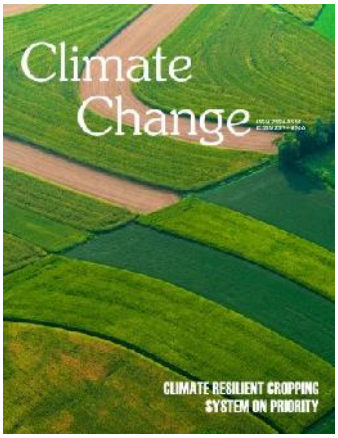
Volume 1, Number 4, Pages 249-530 1, October 2015

Climate Change

About the Cover



Global warming and climate change have already set in and even the semi-literate farmers are being able to realise that the weather conditions are becoming abnormal. Last year, there was a delay in monsoon and several states in the country particularly Maharashtra, had to encounter severe drought. Subsequently, unexpected hail storms and heavy rains during spring season caused extensive damage to standing crops. This year again, the rainfall is expected to be below normal. Apart from the volume, timely distribution of rainfall will also affect agricultural production. This phenomenon is likely to continue. As the food security of 1.2 billion people is threatened by erratic monsoon, there is an urgency to prepare a climate resilient cropping system on priority. Supply of safe drinking water is another serious problem related to climate change (Ref: Narayan G Hegde. Climate resilient agriculture for food security. *Climate Change*, 2015, 1(4), 260-261); (Image: http://cdn.lightgalleries.net/).

COMMUNICATIONS

"Food security and climate change" - opening remarks

Kirit N Shelat

Objective is to ensure food and nutrition security, worldwide. Need to make sure that enough food is accessible to everyone, everywhere, physically and economically. Between now and 2050, the world's population will increase by one-third. Most of the additional 2 billion people will live in developing countries and more people will be living in cities. FAO estimates that production will have to increase by 60 percent by 2050 to satisfy the expected demands for food and feed.

Climate Change, 2015, 1(4), 249-257

Role of Public Governance in Arena of Climate Change and Food Security

Devi Prasad Juvvadi

Climate change, explored in various settings, is adding a new layer of complexity for food security from governance perspective. Changes in production capacity, seasonality, the availability of suitable land and access to water, are all intertwined with issues of governance. It is a fact that the climate is changing and, given the levels of greenhouse gases already in atmosphere, will continue to do so. Extreme weather events, such as high temperatures, droughts and floods, are already more frequent and severe, and have dire social, economic and ecological consequences.

Climate Change, 2015, 1(4), 258-259

Climate resilient agriculture for food security

Narayan G Hegde

Global warming and climate change have already set in and even the semi-literate farmers are being able to realise that the weather conditions are becoming abnormal. Last year, there was a delay in monsoon and several states in the country particularly Maharashtra, had to encounter severe drought. Subsequently, unexpected hail storms and heavy rains during spring season caused extensive damage to standing crops. This year again, the rainfall is expected to be below normal. Apart from the volume, timely distribution of rainfall will also affect agricultural production. This phenomenon is likely to continue. As the food security of 1.2 billion people is threatened by erratic monsoon, there is an urgency to prepare a climate resilient cropping system on priority. Supply of safe drinking water is another serious problem related to climate change.

Climate Change, 2015, 1(4), 260-261

Ensuring food security and effective climate Change mitigation through intensive community LED NRM interventions in the tribal regions of Western India

Kanhaiya Choudhary

65 Local rivers and rivulets have been made perennial and 5 more are in the process of becoming perennial. Floriculture on small piece of land means surety for about 10 fold income compared to traditional crop. The tribal youth giving up government job opted for Self Employment in Dairy. He earns Rs.40,000/- per month. More than 10,000 households having Vermicompost units economizing on the use of fertilizer and cost of cultivation.

Climate Change, 2015, 1(4), 262-291

PRESENTATIONS

Sustainable Food Value Chain

Kirit Shelat

The application of the sustainable and inclusive food value chain approach directly links to Climate Smart Agriculture. Value is captured and determined by consumers when they buy the product, which trickles down to production and support provider levels. In developing countries middle- man-traders who also act as a wholesaler / take away major portion of income – difference between price paid to farmer and market price paid by consumers.

Climate Change, 2015, 1(4), 292-350

Food Security in Volatile Climate: Role of Weather Index Insurance

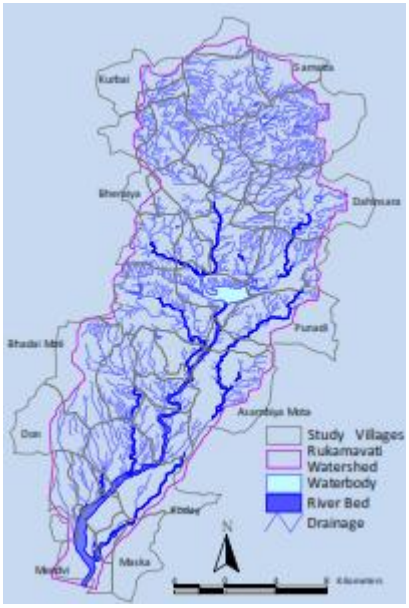
Piyush Kumar Singh

Food security exists when all people at all times have physical or economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The impacts of a given weather event differ according to the specific agricultural system, variable water balances, type of soil and crop, and availability of other risk management tools. In India, weather index insurance was introduced to farmers in 2003. In 2007, the national government adopted it as an alternative to crop-yield index insurance. By 2012, up to 12 million farmers, growing 40 different crops over 15 million hectares, were insured against weather-related losses.

Climate Change, 2015, 1(4), 351-371

Food Security through Climate Resilient Agriculture Rukmavati River Basin

Kantisen Shroff



It is a process of coordinating conservation, management and development of water, land and related resources across sectors within a given river basin. It ensures Economic, Social and Environmental sustainability and ensures Food, Water & Energy security along with good quality of life with objective to provide sustainable livelihood. Crop suitability maps through GIS matrix which will help in conserve more resources and better land utilization. Agriculture productivity improvement – soil & water management, good agricultural practices. Agricultural produce value addition through cluster based promotion of warehousing, processing and market linkage.

Climate Change, 2015, 1(4), 372-385

PERSPECTIVES

Climate change - Research, Mitigation and Adaptive Opportunities for Indian Agriculture

Shankar MA, Prasanna Kumar MK, Thimmegowda MN, Shivaramu HS

Climate change is looming large on the globe. Food security is one of the key issues that inevitably needs to be resolved under the specters of climate change, particularly in the fragile ecosystems. Never before in the history has Indian agriculture been as vulnerable and uncertainty ridden as it is today. A glimpse of the dynamics of Indian agriculture reveals that it has systematically deviated away from its base, that is, the environment—the prop that nourishes all biological resources. Today's agriculture is valued against the prices it fetches from the market, especially the global market. Its contribution to human health and welfare, ecological integrity, resilience of nature, etc. are grossly neglected. The agriculture had begun going anti-nature since the inception of the green revolution, which was implemented on high yielding varieties, monocultures, indiscriminate applications of chemical fertilizers and pesticides and over-exploitation of water resources for irrigation. The Green Revolution turned ghastly for small and marginal farmers as well as for the agroecosystems it operated.

Climate Change, 2015, 1(4), 386-390

Reforming Agricultural Extension to Meet Climate Change Risks

Pathak AR

Climate change refers to any change in climate overtime, whether due to natural variability or as a result of human activity (inter-governmental panel on climate change, IPCC, 2001). It can also be seen as change in climate which is attributed directly or indirectly to human activities that alter the composition of the global atmosphere and which are in addition to natural variability observed over comparable time periods (IPCC, 2007). Climate change has become a global issue in recent times manifesting in variations of different climate parameters including cloud cover, precipitation, temperature ranges, sea levels and vapour pressure (Ozor and Nnaji 2011). The variations in climate parameters affect different sectors of the economy such as agriculture, health, water resources, energy etc. The main cause of climate change has been attributed to anthropogenic (human) activities. For example, the increased industrialization in the developed nations has led to the introduction of large quantities of greenhouse gases (GHGs), including carbon (IV) oxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) into the atmosphere. These GHGs are the primary causes of global warming (IPCC, 2007). The global increases in CO_2 concentration are due primarily to fossil fuel use and land use change, while those of CH_4 and N_2O are primarily due to agriculture (IPCC, 2007). Agriculture is, therefore, the main culprit of climate change producing significant effects through the production and release of GHGs.

Climate Change, 2015, 1(4), 391-396

ANALYSIS

Economic and environmental benefits of roof insulation in composite climate of India

Hemant Kumar Singh, Ravi Prakash, Shukla KK

From the view point of energy conservation in the built environment, thermal insulation is the most common and effective technique. In India, most of the air conditioned residential buildings have either little or no insulation at all. In this study, optimum insulation thickness (OIT) for extruded polystyrene insulation (XPS) material employed on reinforced cement concrete are determined for composite climatic zones of India. Additionally life cycle savings and payback period are calculated by using life cycle cost concepts. In the present study, a commonly used indoor design temperature (IDT) interval of 23 - 27°C is considered. For this range of IDT, OIT of XPS ranges from 0.025 to 0.042 m. Further, life cycle savings for the OIT varies from 240.0 to 663.0 Rs per m^2 of roof area, and payback period ranges from 2.2 to 3.2 years. Further carbon emissions are also estimated and by applying OIT on un-insulated roof, CO_2 reduction of around 65 - 76% is observed, depending on the IDT. It is observed that determining optimum thickness of insulation material for roof is very significant for reducing the operational energy demand in the building sector.

Climate Change, 2015, 1(4), 397-403

GIS: an effective tool to develop resilience to climate change

Neha Singla, Ankit Rattan, Navrit Bhandari

Average temperature of the our planet has risen by 1.4°F over the past century. This rise in global temperatures have been accompanied by changes in weather and climate in the form of changes in rainfall, floods, droughts, or intense rain, as well as more frequent and severe heat waves. The greenhouse gases are essential for living but its content in atmosphere is being altered by human activities which results in Global Warming. Researchers, approach creators, designers, engineers, and numerous others have utilized Geographic Information System (GIS) innovation to better comprehend this intricate circumstance. Various GIS applications are being adopted for floodplain mapping, warning

response and preparedness, damage computations and ecosystem restoration, prediction of time based loss of glacial covers and resultant rise in sea level. Satellite remote sensing used with GIS has provided major advances in understanding the climate system and its changes, by quantifying processes and spatio-temporal states of the atmosphere, land and oceans. The paper shall focus on outlining the various GIS applications which can be put to various uses. Evaluation of large data at global and regional levels through GIS can readily help the decision makers to visually understand the consequences of climate change and work towards developing a resilient system. The strategy involved in adaptation and resillience can prove to be essential in counteracting against climate change.

Climate Change, 2015, 1(4), 404-410

Nonlinear time series analysis of rainfall over central Indian region using CMIP5 based climate model

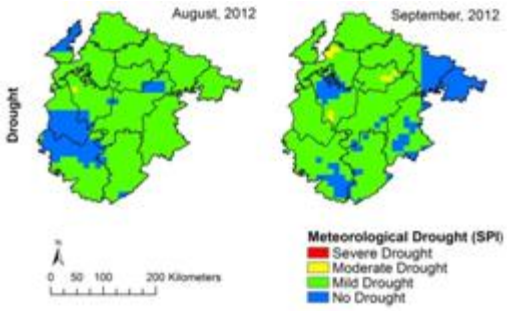
Anurag Tiwari, Ashok Kumar Mittal, Suneet Dwivedi, Uday Pratap Singh

In present study, nonlinear time series analysis is employed to examine the predictability and existence of chaos in the Indian Summer Monsoon Rainfall (ISMR) over central Indian region using Intergovernmental Panel on the Climate Change (IPCC) Coupled Model Inter-comparision Project 5 (CMIP5) models and observations from the India Meteorological Department (1901-2006) for central Indian region. The climate projections under different Representative Concentration Pathways (RCPs) namely, RCP 2.6, 4.5, and 8.5 are used. The model data of 146 years (1860-2005) of historical simulation and 295 years (2006-2300) of future projections from the CMIP5 models under RCP 2.6, 4.5, and 8.5 scenarios are taken. The techniques of correlation dimension and largest Lyapunov exponents are used to quantify chaos and estimate predictability of the ISMR. The Grassberger-Procaccia algorithm is employed in calculating the correlation dimension which gives minimum number of variables required to model the dynamics of system. The average divergence rate of nearby orbits is given by the largest Lyapunov exponent. Presence of chaos is evident by the fractal value of correlation dimension and positive largest Lyapunov exponent for all the data sets. Predictability is calculated for each scenario using largest Lyapunov exponent.

Climate Change, 2015, 1(4), 411-417

Evaluation of the meteorological drought over the Bundelkhand region using geo-spatial techniques

Kundu A, Denis DM, Patel NR



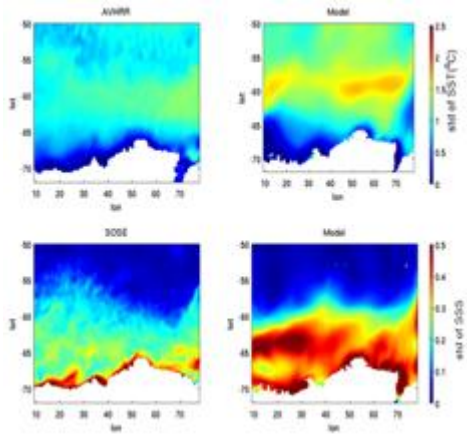
Drought is a climate based natural hazard occurs in almost all climatic zones irrespective of high or low rainfall areas. Generally, drought is considered as a dry weather condition that lasts over several weeks to months, with no or little rainfall. It happens due to imbalance in water availability. There are several types of drought that can be defined from various perspectives such as agricultural, hydrological, meteorological and socio-economical. Meteorological drought generally defined as a condition, where the annual precipitation is less than the normal for a prolonged period (month, season or year) over an area. Among the several proposed meteorological drought indices, the Standardized Precipitation Index (SPI) is a popular drought index, solely based on precipitation and it measures how much precipitation for a given period of time has deviated from historically observed precipitation of an area. Technically, SPI represents the number of standard deviation of the

observed value deviated from the long-term mean, for a normally distributed random variable i.e. Z-variate. SPI can estimate the drought features with different time scales (1, 3, 6, 9, 12, 24 and 48 months), it has been broadly applied to analyze different aspects of droughts. Normally, the ''drought'' part of the SPI range is arbitrary split into moderately dry (-1.0 > SPI > -1.49), severely dry (-1.5 > SPI > -1.99) and extremely dry conditions (SPI < -2.0). The present study attempts to assess the meteorological drought response to extreme climate condition. Long-term rainfall data (2002-2013) have been taken for Standardized Precipitation Index (SPI) analysis. A detailed spatio-temporal analysis of drought dynamics was carried out using the SPI, which revealed the occurrence of a severe drought in Bundelkhand region during several years.

Climate Change, 2015, 1(4), 418-424

Southern ocean sea-ice variability around the Indian Antarctic stations in the context of climate change using ocean sea-ice modelling

Anurag Kumar, Suneet Dwivedi

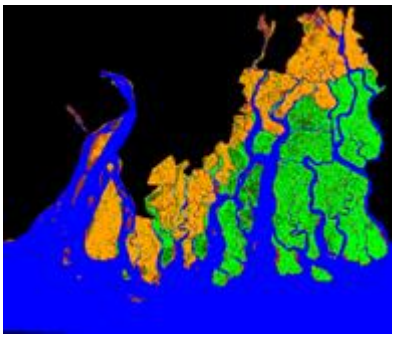


The role of sea-ice physics on ocean state estimate in the Southern Ocean (SO) region [9^0E-78^0E and 50^0S-72^0S] is demonstrated using ocean sea-ice modeling. It is shown that the sea-ice plays an important role in seasonal variability of the salinity and temperature. The sea surface temperature (SST) and sea surface salinity (SSS) around the Indian Antarctic stations is computed and their seasonal variability is studied during 2008-2012. The model simulated values agree well with the observations during ice-melting and ice-formation stages. According to the formation and melting of sea ice, we divided the study domain into ice-affected (above 65^0S) and ice-free (below 65^0S) zones. During the formation of ice July-August-September (JAS), the seasonal SSS remains high (low) inthe ice-affected zone (ice-free zone) whereas a low SST is noted during the same time period. The area-averaged temporal variation of SST and SSS with the available satellite/reanalysis data is also investigated. Apart from this special emphasis is given to see the temperature and salinity variation with depth.

Climate Change, 2015, 1(4), 425-431

Climate change and its impact on the ecological system of the Indian Sundarban region

Guha P, Aitch P, Bhandari G



The Sundarban is a part of the Ganga-Brahmaputra-Meghna delta spanning across an area of about 25,500 Km^2 over southern Bangladesh and West Bengal out of which about 9,630 km^2 forms Indian Sundarban Delta (ISD). This region is within the Central Asian shorebird flyway and the only mangrove wetland tiger habitat in the world. Here intricate estuarine and coastal processes are influenced by the dynamic interface amongst adjacent marine, terrestrial and meteorological systems. Economically and naturally the ISD is of extreme importance to the entire coastal region of West Bengal and also to the entire metro city of Kolkata by providing livelihood and acting as a barrier to the natural coastal disasters. With the advent of time the Sundarban Delta is threatened by the changing climatic condition. On the basis of the available climatological data it indicates that disturbance in the rainfall and temperature pattern has emerged as the major climatic and social threatening issues. Such changes have also accounted for the change in the green coverage of the region leading to the disturbance in the

ecological balance of ISD. This influences the agriculture and livelihood of the population of the area. The present study demonstrates the potentiality of Secondary data for monitoring the climate change in the region by analysing the rainfall and temperature patterns. Since such kind of changes stand as a testimony for the past and present coastal climatology, so the inferences drawn thereon were considered as benchmark tool for climate analysis. Satellite images have been utilized for the subsequent analysis of the land use mapping with special emphasis on mangrove characterisation. A proper correlation model was also attempted between climatic parameters and vegetation coverage to estimate the ecological disasters due to climatic variations. Such estimation may play a vital role towards developing a sustainable management option to protect the mangrove region along with the associated eco-system balancing the socio-economic condition of the region.

Climate Change, 2015, 1(4), 432-438

Teleconnections of monsoon with ENSO, IOD and IMI from ECMWF model with reference to climate change: a statistical approach

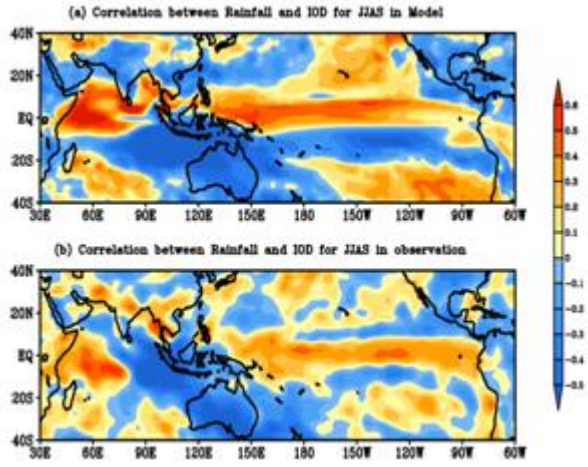
Nishant Mishra, Shailendra Rai

The European Centre for Medium-Range Weather Forecasts (ECMWF) System 3 coupled data for the time domain 1961-2007 is used in this study. We tried to investigate the observed teleconnections of ISMR with ENSO, IOD and IMI and its predictability from the ECMWF System 3 coupled model. It is observed that the model is better in predicting the observed teleconnections pattern of ISMR with ENSO and IOD for the time domain 1997-07 as compared to 1961-1996. The anomaly correlation skill of model produced JJAS precipitation with respect to IMD observation was found to be 0.37 and 0.51 for the time domain 1961-1996 and 1997-2007 respectively. This improvement in the prediction skill of ISMR can be attributed to the better prediction of teleconnections patterns of ISMR with ENSO and IOD for the time domain 1997-07 by the coupled model. Indian Monsoon Index (IMI) is also supposed to represent the dominant mode of interannual variability of ISMR. Thus in order to understand the effects of various factors on ISMR and the change of predictability of ISMR by the coupled model, we applied multiple linear regression model considering Nino3.4, IOD and IMI indices as explanatory variables and the ISMR index as dependent variable. We found that the Nino3.4 Index alone is unable to produce the ISMR index. Moreover, reproduction of ISMR index through linear models not only stabilizes the teleconnections patterns of ISMR with Nino3.4 and IOD for almost the entire domain of our study but also anomaly correlation skill for ISMR is improved during the time domain 1961-1996 although the anomaly correlation skill remains the same during the time domain 1997-2007.

Climate Change, 2015, 1(4), 439-446

Seasonal prediction of ISMR and relationship with EL-NINO and IOD in ECMWF system 4 coupled model

Dhruva Kumar Pandey, Shailendra Rai, Shahi NK, Nishant Mishra



This study evaluates various probable factors that govern the predictability of Indian summer monsoon rainfall (ISMR) and their teleconnections with ISMR. Furthermore, extensive analysis has been performed to evaluate factors leading to the predictability aspects of the ISMR using European Centre for Medium-Range Weather Forecasts (ECMWF) System 4 coupled model for the time domain 1982-2013. It is found that the ECMWF system 4 has well captured the latitudinal variation of rainfall along with sun movement and the spatial climatology of precipitation with respect to observation. The signal to Noise ratio shows that the predictability of the ISMR is better for the oceans as compared to land points of India especially over the central India where the value of signal is least. The prediction of teleconnections between Sea surface temperature anomaly and the ISMR is realistically represented in the system 4. It is found that the system 4 is able to capture the teleconnections of El Nino Southern Oscillation (ENSO) with ISMR is realistically well as compared to Indian Ocean Dipole(IOD) for the time domain of 1982-2013. In case of 1997 El-Nino, the warming over the equatorial pacific ocean is well captured by system 4 but the prediction of rainfall over the land points of India is poor as compared to observation. The rainfall prediction of this year is poor in system 4 because it is unable to captured the IOD event of this year. A dichotomous forecast skill measure is also performed by calculating predictive skill measures like accuracy, bias, probability of detection (POD), false alarm ration (FAR), probability of false detection (POFD), threat score (TS), equivalent

threat score (ETS) and Heidke skill score (HSS) for model produced ISMR, Nino 3.4 and IOD from system 4. This dichotomous forecast skill shows that the model is better in prediction of ISMR and Nino 3.4 as compared to IOD.

Climate Change, 2015, 1(4), 447-455

Can every farm get water? The present crisis and the roadmap towards the solution

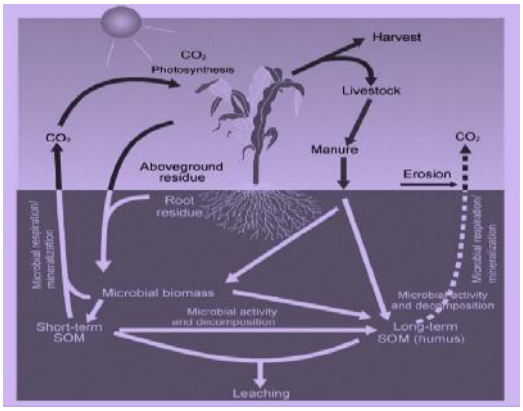
Vivek P Kapadia

Recently an announcement has been made in India – "Water to Every Farm" which sounds beautiful but can it come true easily in the given situation? Does India have really geared up for the same? How can the gap between the attractive slogan and the present scenario be bridged up is of great concern. Many examples of mismanagement in various parts of the word are eye-opener. In India, out of 20 major basins 14 are water stressed at present and the situation is worsening fast. Water stress is increasing day by day and inequitus in distribution of water amongst various user groups is also increasing which has started taking serious stance in the form of social unrest in many parts of India. On the other hand water related legislations and administrative setups are based on fragmented controls in India. Executive machinery being helpless in want of legislative and administrative edge has to witness the sparrow's fall especially in the water sector. Water conflicts as a product of water stress have now gone to the extent of becoming a challenge against the solidarity of the nation which is of prime importance and also a prerequisite for a prosperous nation, especially when the global systems before they could prove their worth have started crumbling. The paper gives an analysis of the present scenario including the factors working in the background and focusses on the roadmap towards a better organized water sector to ensure ensuing corrections in other sectors like agriculture, industries, infrastructure, social services, etc. The paper is in the context that proper distribution of resources – especially the water – is the key to sustainable development of India, perhaps with no alternative model.

Climate Change, 2015, 1(4), 456-462

Soil carbon sequestration enhancement techniques: an emergent technology to mitigate climate change

Kumari P, Nema AK



The purpose of this paper is to review the various techniques and methodologies related to increase the residence time of carbon in soil by enhancing carbon intake rate and reducing the soil respiration rate. The uptake and loss of carbon by land plants and soils were closely balanced before human intervention but due to ignorance of various factors according to Schlesinger (1997) the global flux of CO2 from soil has become approximately $75*10^{15}$gC/yr, roughly 2.5 times larger than the total Net Primary Productivity (NPP) of carbon in soil. Through this paper it is tried to make people aware and encourage to minimize the gap of intake and release of carbon by soil and utilize its huge potential of carbon sequestration via adopting various techniques and proper land management practices, in this way we could not only offset the CO2 concentration in atmosphere but will also increase the soil fertility, water retention capacity and crop productivity.

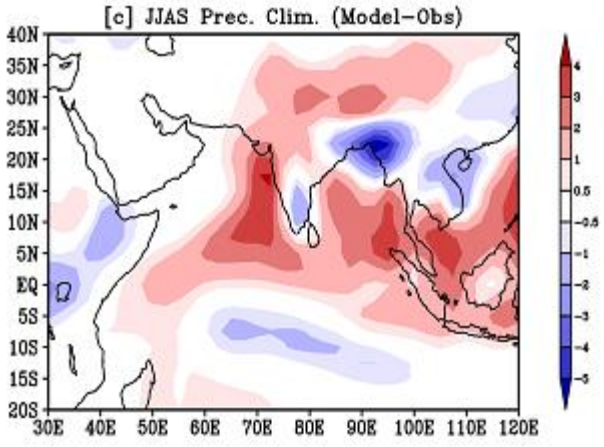
Climate Change, 2015, 1(4), 463-468

Seasonal prediction skill of Indian summer monsoon rainfall in ECMWF system 4 model

Namendra Kumar Shahi, Shailendra Rai, Dhruva Kumar Pandey, Nishant Mishra

This study evaluates the seasonal prediction skill for the summer monsoon rainfall (JJAS) over India from European Centre for Medium-Range Weather Forecasts (ECMWF) System 4 Model for the time domain of 1982-2013. The model overestimates the precipitation over the Indian Ocean, maritime continent, west-coast and some part of the Indian land point and underestimates the precipitation over the northeastern part of India. The cold bias of SST is found over the Arabian Sea including Western Ghats, Bay of Bengal and southern Indian Ocean region (65°E-115°E, 20°S-12°S). The equatorial western and equatorial southern eastern Indian Ocean is warm-biased area. The model shows robust prediction skill of precipitation for the Indian summer monsoon region (ISMR; 50°E-110°E, 10°S-35°N) as the correlation coefficients (CC) between the observation and model is found to be +0.74 but the model failed to show significant predication skill of precipitation over the IMR region (CC=+0.29). We have also observed that the model is able to capture the inter-annual variability of precipitation over the IMR and ISMR region with lower magnitude as compared to the observation.The prediction skill of SST indices of Indian and Pacific Ocean is reasonably good. The model is able to capture the strong El-Niño (1982, 1997) and La-Niña (1988, 2010) events with high skill. The model is also able to simulate

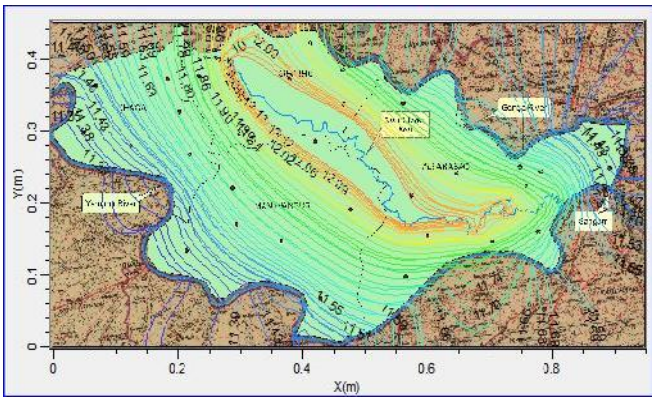
the TNI and EMI index with the interannual CC between the observed and model is +0.89 and +0.89 respectively. We have found that the significant relationship of the ISMR with Niño indices and EMI, while the relationship of the IOD with IMR and ISMR is insignificant. We have also found that the model overestimates the effect of SST indices on the IMR but is in good agreement with the observation for the ISMR.



Climate Change, 2015, 1(4), 469-475

Groundwater flow modeling in a part of Ganga-Yamuna Interfluve region

Prabhakar Shukla, Raj Mohan Singh



Groundwater is the main source of water supply and irrigation in the Ganga-Yamuna interfluve region. Heavy withdrawal of groundwater has set a declining trend of water table over the decade. The groundwater withdrawal is continuously on the rise resulting in overexploitation and also quality deterioration. Therefore, proper groundwater system modeling and management is imperative. Groundwater flow modelling has been performed in this work to simulate the groundwater flow system in a part of Ganga-Yamuna interfluve region of eastern Uttar Pradesh, India. Groundwater simulation model Visual MODFLOW has been utilized to simulate the flow processes in the study area. The model simulates groundwater flow over an area of about 1908.95 km^2. The horizontal flows and recharge from rainfall were considered with proper boundary conditions. Visual MODFLOW was calibrated and validated for water level data available for 8 years (2005 to 2013) under steady and transient conditions. Aquifer parameters (hydraulic conductivity and storativity) are tuned and optimized using PEST (Parameter Estimation) analysis. Calibrated and validated model was further employed to predict the groundwater levels under possible changes in recharge and pumping up to 2020. Results obtained from the study reveals the composite dynamics of rainfall, groundwater recharge, groundwater level and pumping in the study area.

Climate Change, 2015, 1(4), 476-482

Role of air pollutants emitted from coal power plant and meteorology in climate change

Ganesh Chandra Kisku, Markandeya

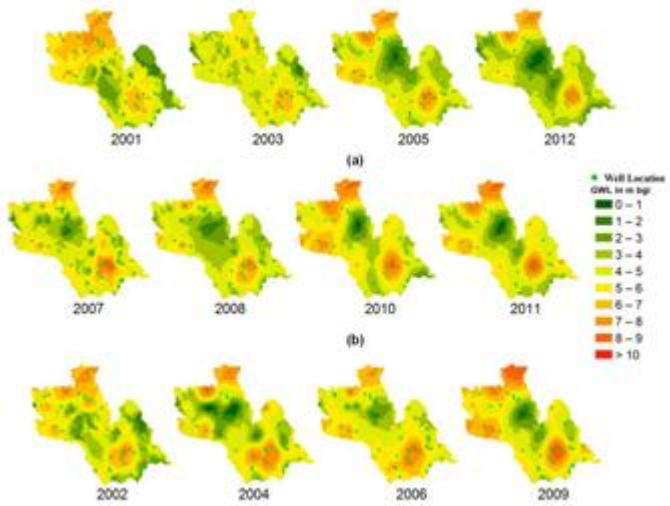
Coal, a fossil fuel is the largest source of energy for the generation of electricity in India. The total of 301.56 billion tonnes of coal reserves is estimated by the Geological Survey of India as of April 1st, 2014. It was mined at 229 million tonnes in year 2013, ranking 4th largest coal producing nation in the world. India consumed about 700 million tonnes of coal in 2013, out of which 324 million tonnes were used for power generation which is 3rd largest nation in the world. Power is considered to be a core industry as it facilitates development across various sectors of the Indian economy, such as manufacturing, agriculture, commercial enterprises and railways. The monthly mean temperature and relative

humidity varied from 6.9 to 47.7°C with an average of 37.4°C and 16.5 to 99.0% with an average of 97.5% during the study period. The concentrations of particulate matter, SO_2, NOx, CO and Pb were found 179, 360, 237, 218 and 1.21 mg/Nm^3 in Captive Power, CP-unit-I and 215, 355, 241, 210 and 1.17 mg/Nm^3 in CP-unit-II respectively while Hg concentration in CP-unit-I 0.94 and in CP-unit-II 1.13 (μg/m3) respectively. Keeping in view of climate change; the most important parameter is CO_2 in the flue gas of a power plant. The percentage of CO_2 ranged in between 11.45 to 13.67%. Meteorological conditions play a crucial role in determining the concentrations of the pollutants by affecting both directly and indirectly the emissions, transport, formation and deposition of air pollutants. Atmospheric stability determines the extent to which vertical motions mix up the pollution in the upper atmosphere, although a major chunk of pollution build up at the ground surface. Our study concluded that coal power plant is one of the key players which govern the local as well as global climate change.

Climate Change, 2015, 1(4), 483-490

Effect of global climate change on groundwater resources using geostatistics and linear regression method

Chandan Kumar Singh, Yashwant B Katpatal



Groundwater is one of the important natural resources useful for irrigation, drinking, industries etc. Groundwater usage is increasing day by day and to prepare the long term management strategy for groundwater development, it is important to understand the past groundwater level scenario. Global climate change has large impact on the natural resources and it is necessary to quantify its effects. The objective of the present study is to analyze spatial and temporal variability in the groundwater and rainfall with respect to climate change over Wainganga Sub-basin. Groundwater level data has been obtained from 41 observation wells of Wainganga sub-basin Nagpur District, Maharashtra, India. Linear regression and geostatistical method were used to analyze the spatial and temporal variation of groundwater within the basin. Groundwater level trends and rainfall were observed from 1990 to 2012 within Wainganga sub-basin and it is found that the groundwater levels may be correlated with the climate varaiability. Groundwater level trends were also analysed for La Nina and El Nino years for past 22 years using geostatistics tool within Geographical Information System (GIS) environment. Study also identifies sub-watersheds which were observed to be more affected by climate change within Wainganga sub-basin and necessary measures are suggested depending upon the severity.

Climate Change, 2015, 1(4), 491-497

Climate change and social justice

Amruta Smit Thakkar

Climate change is an issue of social justice, particularly for developing countries like India. Being a developing country, while formulating the policies and implementation strategies for adaption and mitigation of climate change, we must not divert our developmental goals such as health, poverty, energy access and education. To overcome the problems of climate change both developing and developed countries need to work together and developed countries need to take initiatives to support developing countries to reduce the GHG emission at the same time achieve the desired development. Support in terms of fiancé, transfer of low carbon technologies etc. Responding to climate change will require the integration of adaptation into all aspects of policy development and planning for poverty reduction. This paper analyses the major international developments related to climate change and Indian perspective as a developing country focusing to the measures for mitigating climate change and social justice. Social justice in the International as well as National context important issue of uniformity in distribution of energy consumption/emission per capita is discussed in the paper.

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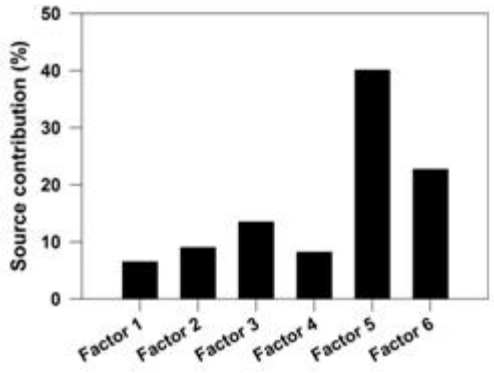
Wintertime source-apportionment of PM_1 from Kanpur in the Indo-Gangetic plain

Prashant Rajput, Anil Mandaria, Lokesh Kachawa, Dharmendra Kumar Singh, Amit Kumar Singh, Tarun Gupta



In today's scenario of increasing anthropogenic emissions, arising due to development in urban and rural areas, it has been widely realized to assess the atmospheric impact of various sources. In this context, we investigated the source contribution of ambient fine-mode aerosols (PM_1; n = 51) during wintertime (mid of November 2009 to February 2010) over Kanpur site in the Indo-Gangetic Plain (IGP). PM_1 mass concentration centers at 113 µg m^{-3}. The high loading of fine-mode aerosols is attributable to source strength and shallower planetary boundary layer. In PM_1 a total of 20 chemical constituents have been measured that include trace metals (Pb, Cd, Se, V, Cr), major elements (Fe, Mg, Ca, Na and K) and water-soluble inorganic species (NH_4^+, NO_3^-, Cl^- and SO_4^{2-}). A recent version of positive matrix factorization (PMF 5.0) was utilized to quantify the contribution of fine-mode aerosols from various sources. This study reveals that nearly 80% of the fine-mode aerosols over Kanpur region are contributed by fossil-fuel sources that include point and mobile sources (vehicular and industrial emissions). However, the contribution from biomass burning emission is about 20%. One of the most interesting features of our study relates to the observation that secondary sources (contributing 40% of PM_1 loading) are predominantly formed from vehicular emission sources (fossil-fuel combustion). Thus, our study highlights the high concentration of PM_1 loading and atmospheric fog prevalent during wintertime in the IGP can have severe impact over the human health.

Climate Change, 2015, 1(4), 503-507

Impact of climate change on water resources

Saumya Singh, Srivastava RK

In many developing countries, there is a problem of water crisis. Climate change is adversely affecting the water cycle and in turn affecting water management. Increasing population, urbanization and climate change will put much pressure on water resources in future. Therefore, integrated water management will be required for sustainable management of water resource. Water is a key parameter affected by climate change and its management is important and therefore this paper aims to raise the understanding of the links between climate change and freshwater resources, in a manner that would help in taking decisions on water resource management. As there is a link between water resources and other sectors, therefore it can be said that water resource will inevitable affect other sectors too.

Climate Change, 2015, 1(4), 508-513

PROCEEDINGS OF NCCSD

Summary Proceedings and Recommendations: National Workshop on Food Security and Climate Change Anand Agricultural University Anand, Gujarat

NCCSD, AAU, IFPRI

The rising atmospheric temperature, widening variability in monsoons, and increasing frequency of floods and droughts in recent past are the major challenges today. The ensuing climate change has started showing its impact on agricultural productivity and is posing a threat to the food and nutritional security globally and more so for a developing economy like India. Over the years, the importance of understanding the impact of climate change on agriculture has been often underestimated. It is time to divert efforts to develop agricultural policies by factoring climate change. Considering the importance of food security for the country, the National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD) in collaboration with Anand Agricultural University, Anand, and the International Food Policy Research Institute (IFPRI), New Delhi, organized a one-day international workshop on Food Security and Climate Change on June 2, 2015 at Anand Agricultural University, Anand, Gujarat. The aim of the conference was to understand the impact of climate change on agriculture, enlist the efforts needed to combat this change and develop a road map to achieve food and nutritional security under the climate change scenario. The workshop started with the welcome words by Dr V V Sadamate, former advisor (agriculture), Planning Commission. He mentioned that household income security should be the major concern in our efforts towards achieving food security.

Climate Change, 2015, 1(4), 514-530