

INTERNATIONAL SEMINAR ON
LAND AND WATER ISSUES IN SOUTH EAST ASIA:
STATUS, CHALLENGES AND OPPORTUNITIES

18 - 20 JANUARY, 2018

AT TEZPUR, ASSAM

ABSTRACTS

Sponsored by

NORTH EASTERN COUNCIL

Ministry of Development for North Eastern Region

Government of India

Shillong, Meghalaya



Organized by

**NORTH EASTERN REGIONAL INSTITUTE OF WATER AND
LAND MANAGEMENT (NERIWALM)**

**An Institute under the Ministry of Water Resources, River Development and Ganga Rejuvenation,
Government of India**

(Registered under the Societies Registration Act, 1860)

DOLABARI, TEZPUR – 784027, Assam, India

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Tezpur , Assam, India

FOREWORD

North Eastern Regional Institute of Water and land Management, an institute under the Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India was established in 1989. The mandate of the Institute is to provide capacity building, education and research support in land water management and eco restoration to regional, national and international stakeholders having similar agro ecological situation.

The Institute on the occasion of completion of 28 years in land and water management sector considers it as a responsibility to expand its expertise to other agro ecologically similar region. The North Eastern region of India which is culturally a part of the Southeast Asian countries is dominated by agro based economy. The vast diversity of natural resources, water being one of them has scope for improvement to a great extent by proper land and water management. However the mountain ecosystems of the region are among the most diverse and vulnerable on earth. Steep hillsides terraced with paddy fields provide a living for mountain farmers. In the higher peaks shifting cultivation is for livelihood. With the increase of population the circle of shifting cultivation practiced decreases causing more pressure on land and environmental degradation. On the other hand, heavy rainfall with fragile landscape cause landslides and loss of top soil in the hills and flood in the plains. This calls for a comprehensive strategy for the development of the region.

The Southeast Asian countries have experienced dynamic economic development in recent years by promoting agriculture sector, industrial development and management of natural resources. The economic development is also posing for drastic changes in ecological sustainability. New thoughts, discussion, inspiration and planning is required to understand how to harness the vast land and water resources while managing in a sustainable manner, how to create societies in which diverse peoples, culture and religion coexist in harmony and how to make communities participate effectively so that they feel a sense of belongingness in the development programmes taken up in the region.

*To create a platform and discuss important issues and draw attention of international , national and regional concerned , the seminar on **Land and Water Issues in South East Asia: Status, Challenges and Opportunities** has been conceived. The seminar is intended to identify status, challenges and opportunities of land and water resources and adopt an integrated management approach to conserve our scarce water resources, manage flood, increase water use efficiency, increase water quality as well as restore the fragile ecosystem for reducing poverty by sustainable economic development.*

For fruitful and detail discussions on the seminar topic the following themes were identified and requested for technical papers.

- 1. Water Resources and Flood Management: Policies and Practices**
- 2. Irrigation Water Use efficiency**
- 3. Social Aspects of Land and Water Management**
- 4. Natural Resource Management**
- 5. Ground Water, Water Quality, Eco Restoration**

The institute is heartily thankful to the authors who have responded our request to submit technical papers. Altogether sixty-one technical papers were received and the abstracts of it are included in the pre-seminar proceedings.

We acknowledge North Eastern Council, Shillong for accepting the International seminar proposal and financially supporting and cooperation in organising the Seminar.

The institute is thankful to all the Technical Directors of the specific themes for accepting our request to extend their technical guidance for the Seminar.

The invited speakers both from India and abroad are thankful for contributing technical papers and cooperation to make a fruitful discussion for sustainable development of the South East Asian countries.

The institute is thankful to all the authors of the technical papers for their valuable contribution. Hope the Seminar will benefit the participants in achieving their higher goals.

The abstracts of the technical papers has been compiled themewise for handy reference as pre-seminar proceedings. Deliberations during the technical sessions, suggestions and recommendations emerging from the technical sessions will be published as post - seminar proceedings. Hope that participants, sponsorer, organising institute and other national and international organisations will benefit from the outcomes of the Seminar discussion.

*(Pankaj Barua)
Director*

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THEME - 1

WATER RESOURCES AND FLOOD MANAGEMENT:
POLICIES AND PRACTICES

WRFM- 01

**IDENTIFICATION OF METEOROLOGICAL DROUGHT TRENDS FOR AGRO-CLIMATIC
ZONES OF ASSAM**

Lamneithem Hangshing, P.P. Dabral

ABSTRACT

Standardized Precipitation Index (SPI) was estimated using monthly rainfall of 113 years (1901-2013) at a time scale of 1, 3, 6 and 12 months for the six agro-climatic zones of Assam. For detection of any significant changes in frequency of drought occurrences, trend analysis was performed on SPI-1, SPI-3, SPI-6 and SPI-12-time series using MK trend test and Sen's slope approach. Trend was analyzed for four different time periods: (1) long term trend was computed for the complete 113 years' time series (1901-2013); (2) short term trend was computed for three cases: 43 years (1901-1943), 35 years (1944-1978) and 35 years (1979-2013) for the six agro climatic zones, viz. Barrack valley zones, Central Brahmaputra valley, Upper Brahmaputra valley, North Bank Plains, Lower Brahmaputra valley and hill zone. Results of the study helped in determining the increase or decrease in the number of drought occurrence in the study area.

Keywords: *Meteorological drought; Standardised Precipitation Index; Trend; Frequency analysis*

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WRFM- 02

**FUTURE CHANGES IN TEMPERATURE USING THE STATISTICAL DOWNSCALING
MODEL (SDSM) IN AN EASTERN HIMALAYAN CATCHMENT OF INDIA**

S. Rajkumari¹, V. V.Zaphu², A. Bandyopadhyay³, A. Bhadra³

ABSTRACT

The General Circulation Models (GCMs) represent an important tool for studying climate; however, they do not give a realistic description of the local climate in general. It is therefore, common to downscale the results from the GCMs through either a nested high-resolution regional climate model (RCM) or statistical downscaling. Statistical Downscaling Model (SDSM) provides cheap, computationally undemanding and readily transferable climate change scenarios for individual sites at daily time-scales using grid resolution of GCM output. SDSM is a hybrid between a multi-linear regression method and a stochastic weather generator. In this study, SDSM 4.2.9 was used for generating future climatic outputs for Nuranang watershed located at Tawang district of Arunachal Pradesh. The model was calibrated and validated using the temperature (maximum and minimum) and predictors obtained from the National Centre for Environmental Prediction (NCEP) reanalysis data set. The future climate scenarios were obtained using the predictors from Hadley Centre Coupled Model version 3 (HadCM3) experiment under A2 and B2 scenarios. Performance of the model was evaluated through standard indices. The results showed that the downscaling model was capable of reproducing the daily temperature series at local scale for the selected catchment. The annually averaged projected change of T_{max} and T_{min} in the future periods (2011–2040) 2020s, (2041–2070)2050s and (2071–2097) 2080s from the baseline period (1979–2009) showed an increased change in temperature in the future periods under A2 and B2 scenarios. For T_{max} , under A2 scenario, the projected change in temperature was predicted to increase with 1.03 °C, 2.05 °C and 3.44 °C for the future periods of 2020s, 2050s and 2080s respectively while under B2 scenario, the projected change in temperature was predicted to increase with 0.92 °C, 1.69 °C and 2.13 °C in 2020s, 2050s and 2080s respectively. For T_{min} , under A2 scenario, the projected change in temperature was predicted to increase with 1.20 °C, 2.59 °C and 3.97 °C in 2020s, 2050s and 2080s respectively while under B2 scenario, the projected change in temperature was predicted to increase with 1.11 °C, 1.79 °C and 2.92 °C in 2020s, 2050s and 2080s respectively.

Keywords: *General climate model (GCM), SDSM, maximum temperature, minimum temperature, NCEP, HadCM3, statistical downscaling.*

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WRFM- 03

VALIDATION OF DEVELOPED STAGE-DISCHARGE RATING CURVE OF NURANANG RIVER UNDER HISTORICAL AND PROJECTED CLIMATIC SCENARIOS

P. Mishra¹, Grace, N.¹, R. Dui², Arishinaro², L. Ete², A. Bhadra³, A. Bandyopadhyay³

ABSTRACT

Measurement of discharge at any point on stream plays an important role in planning and management of water resources of the basin. In Hydrology, rating curve is discharge versus stage plot for a given point on stream usually at gauging site, which is used for estimating discharge from observed stage data. In the present study, rating curve for Nuranang river of Arunachal Pradesh was generated and validated based on historical data; further discharge value estimated using developed rating curve was compared with projected discharge under RCP 4.5 and RCP 8.5 climatic scenarios for the year 2016. The stage and discharge data for Nuranang river from 2000-2011 measured at CWC discharge site at Jang, Tawang district were collected from CWC office, Itanagar. Daily precipitation, maximum temperature, and minimum temperature data for future years for different CMIP5 (Coupled Model Intercomparison Project Phase 5) models were downloaded from CORDEX South Asia website. Observed stage for the year 2016 was taken from Digital Water Level Recorder (DWLR), installed at the outlet of Nuranang catchment since April 2015. For generating rating curve, the time series data of the stage (m) and the corresponding discharge (m³/s) were plotted against each other and the best fit line showed the rating curve. The regression equation of the best fit line is the equation for obtaining discharge from stage. RHESSys, a GIS-based, hydro-ecological model was used to generate future stream-flow using projected data from CORDEX. The regression equation between stage and discharge was generated and the regression coefficient (R²) of the equation was found to be 0.7525 which showed a good relation between the stage and discharge. Generated regression equation was used to obtain discharge from stage data and was validated with observed discharge values of historical period which were not used for the calibration purpose. The observed and generated discharge values were found very much comparable with R² value of 0.895. Total discharge obtained at the basin outlet for 2016, using the measured stage and developed rating curve was found to be in good agreement with the discharge simulated using RHESSYS model under projected climatic scenarios.

Keywords: *Rating curve, RCP scenarios, CMIP5 models, CORDEX, RHESSys*

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WRFM- 04

**DEVELOPMENT OF WATER RESOURCES FOR IRRIGATION AND HYDROPOWER IN
NORTH EASTERN OF INDIA**

Uzzal Mani Hazarika¹, Ch. Victoria Devi², Amulya Chandra Debnath³

ABSTRACT

North-Eastern region of India, consisting of eight states, accounts for about 35% of total water resources of the country whereas its geographical area is only 8% of the country. Rainfall of the region is high, which ranges from a minimum of 1000 mm to maximum of 11000 mm. Cherrapunji-Mawphlang belt having rainfall over 11000mm annually, is the highest in the world. The major river basins of the region are Brahmaputra basin, Barak basin, Gumti basin and Imphal basin. Out of these, Brahmaputra basin alone constitutes about 33% of the country's total surface water potential. Annual flow of Brahmaputra and Barak rivers, before entering into Bangladesh are 537.2 BCM and 14.08 BCM respectively which are the highest among all river basins in the country. The Ultimate Irrigation Potential (UIP) of the region is 4316 thousand hectares. Irrigation Potential Created (IPC) through major, medium and minor irrigation schemes of NE are 1433.2 thousand hectare, which is only 33% of Ultimate Irrigation Potential of the region. Percentage of net irrigated area over net sown area for rest of the country is 44.88 percent. Hydropower potential of this region is 63257 MW, out of which only 1911 MW has been harnessed so far, which is only 3.02% of total hydropower potential of the region. Per capita availability of water in the region is highest in the country. However, its harnessing is very limited, which is even less than 5 percent of the existing potential. In spite of all these vast water resources potential of NE region, development of both irrigation and hydropower potential is very meager. The region is also facing severe problem of floods drainage congestion and erosion of the riverbanks.

This paper reviews status of development of water resources for irrigation and hydropower of the region. Some views and suggestions for improvement of water resources are also indicated.

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WRFM- 05

**TREND OF RAINFALL IN RELATION TO CHANGE IN NORTH BANK PLAIN ZONE OF
ASSAM**

D. Saikia, R.R. Changmai , P. Neog

ABSTRACT

One of the best ways of understanding how climate of a place may change in future is the trend analysis of past climatological data of sufficient duration, which would reflect natural climatic variability as well as long-term impacts of climate change in that place. In present study, behaviour of annual, seasonal and monthly rainfall was studied by subjecting them to non-parametric Mann-Kendall test to detect the plausible positive or negative trends and increasing or decreasing slope of trends in the time series was determined by using Sen's slope method for the four stations located at the different places in North Bank Plain Zone of Assam. The daily time series rainfall data for the period Lakhimpur (1984-2016), Biswanath Chariali (1971-2016), Balipara (1980-2016), Thakurbari (1986-2013) were analyzed statistically for each station separately. The results of Mann-Kendall test showed decreasing trend in annual rainfall in Lakhimpur and Biswanath Chariali, however, no trend in rainfall was observed in Balipara and Thakurbari over the respective periods. In case of Lakhimpur, decreasing trends of rainfall were observed in the monsoon and winter season with slope magnitude of -0.267 mm/yr and -2.345 mm/yr respectively. In case of Biswanath Chariali, decreasing trend of rainfall was observed in the post-monsoon with slope magnitude of -2.304mm/yr, respectively. Though not significant, coherent decreasing trends in monthly rainfall were observed for different months in all four locations of the zone. The significant decreasing trends of annual and seasonal rainfall and coherent decrease in trends of monthly rainfall reflected to the changing rainfall behaviour interms rainfall fluctuations with large amplitudes and increasing frequency of dry spells and flash floods in the recent years for the zone. The increasing rainfall fluctuation has been becoming the major weather risk and a serious concern for the rainfed rice based cropping system of the zone.

Keywords: *Climate change; Mann-Kendall; Rainfall; Seasonal; Trend analysis*

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WRFM- 06

**DEMAND SUPPLY BASED SOURCE COMPETENCE ASSESSMENT FOR Harsi COMPLEX
RESERVOIR SYSTEM OF MADHYA PRADESH**

R.K. Jaiswal¹, R.V. Galkate¹, T.R. Nayak¹, T. Thomas¹,
J.K. Jain², S. Das², B. Baghel²,

ABSTRACT

The estimates of the magnitude and duration of water deficit/surplus are of vital importance for planning crop, additional irrigation water supplies and water management practices in order to promote crop production both in irrigated and rain-fed areas. The irrigation requirements depend on several factors like type of crop, soil, meteorological conditions, rainfall, land grading and levelling, water conveyance and distribution, timely supply of water in right quantities, method of water application, adequate inputs and agronomic technique, drainage etc. In the present study, the irrigation water demands of Harsi command under variable climatic and efficiencies conditions have been computed using Cropwat software. Harsi reservoir receives water from its own catchment, Madikheda dam through Mohini pickup weir make 427 Mm³ firm availability of water in the system. The source competence analysis under variable scenarios has been carried out taking care of all demand and supplies under variable climatic, crops and efficiency conditions. The present cropping pattern (PCP) of Harsi command consists of total irrigable area of 53518 ha with 23482 ha paddy in kharif, 25223 ha wheat in rabi and 4453 ha sugarcane as annual crop. After modification and construction of high level canals in the command, the designed cropping pattern (DCP) increases to 62675 ha. The crop water requirements for six different scenarios each for design (DCP-1 to DCP-6) and present cropping patterns (PCP-1 to PCP-6) compared with firm water availability in the system to ascertain competence of source to fulfil demands. The gross water requirement for present cropping pattern vary between 433.97 Mm³ in dry rainfall year with 80% conveyance and 75% application efficiency (PCP-5) to 349.23 Mm³ in dry rainfall year with 80% conveyance and 75% application efficiency (PCP-2) and similar demands for designed cropping pattern may vary between 432.52 Mm³ to 361.71 Mm³. The water requirement computed for commands of different water user associations (WUAs) will be helpful to manage available water in more judicious manner.

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WRFM- 07

**WATER RESOURCES MANAGEMENT PRACTICES OF OLD VAIGAI SYSTEM
IN TAMIL NADU**

Er. S.J. Sivakumar¹, Er. K.S. Abdul Rashid², Er.P. Jegan³

ABSTRACT

Vaigai River Basin is the second largest basin in Tamil Nadu State. The basin lies between 9°15' to 10°20' N Latitude and 77°10' to 79°15' E Longitude. The total basin area is 7393 KM². The Length of Vaigai basin is 250 KM and width varies from 6 to 50 KM. Vaigai is the main river and it originates from Varushanad area in eastern side of Western Ghats. The Vaigai basin consists two Irrigation systems namely old vaigai system (Vaigai old Anicut system) and Periyar System (Periyar Main Canal System). This paper focuses on the development of old vaigai system and Water Resources Management Practices adopted in Old Vaigai System

Vaigai is not an abundant flowing river, even in favourable seasons. The flow in the river is intermittent and seasonal. The irrigation was carried out by diverting the river water through stream channels from the river storing the river water in tanks. There are 374 tanks and total culturable command area (CCA) of them is 1, 36,109 Acres. But the tanks were inadequately filled by the periodical rains and are always liable to fail at the moment of the farmer's greatest need.

In order to secure constant supply of water in this river various irrigation structures were constructed starting from Periyar Dam in 1896 and Peranai Regulator, the first trans-basin transfer in South Asia. Another one major addition is Vaigai Dam constructed in the year 1958 with a capacity of 185 Mm³.

Although the construction of Reservoirs has ensured supply of Water to the tanks, problems aroused due to inadequate carrying capacity of old spring channels in changed hydrology of basin. Two major regulators Virahanur and Parthibanur were constructed in the downstream of Vaigai Dam. The Regulators divert the waters into Right and Left main canals which feed the chain of tanks.

In order to give equitable distribution of water number of Pickup weirs were constructed along the entire river course. The detailed paper will present the various Water Resources Management Practices which has been adopted along with the development of basin to ensure optimum utilization of water in the basin.

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**DESIGN FLOOD ESTIMATION FOR GAUGED AND UNGAUGED CATCHMENTS OF THE
WESTERN HIMALAYAS ZONE 7**

Chanchala¹

ABSTRACT

Hydropower projects are economically the most viable for producing power in hilly regions of the Himalayas. For planning, development and operation of different types of water resources schemes including the hydropower projects, applications of new and advanced methodologies of prediction of floods of various return periods for ungauged, poorly gauged and gauged catchments is of a great importance.

For this purpose, method of L-moments approach holds a great potential. In this paper, annual maximum peak flow data of 9 stream flow gauging sites of the western Himalayan zone 7 are screened using the discordancy measure (D_i) and homogeneity of the region is tested employing the heterogeneity measure (H). Robust frequency distribution is identified based on L-moment ratio diagram. For prediction of floods of gauged catchments, a regional flood frequency relationship is developed based on the robust frequency distribution. For ungauged catchments, the developed relationship is coupled with a regional relationship between mean annual peak flood and catchment area. For a hydraulic structure planned within the river (or dam or barrage) or on an adjoining area (like flood control embankments), due consideration should be given to the design of the structure so as to prevent it from collapsing and causing further damage by the force of water released from behind the structure.

Hydrological study plays a very vital role in all stages of a water resources development project starting from planning, execution and operation of the project. The study related to safety of project in extreme flood event is very crucial and need to be carried out at regular intervals. The design flood for a hydraulic structure may be defined as the maximum flood that any structure can safely pass. The design flood is assigned with non-exceedance probability, which is generally expressed in terms of the return period.

Hence an estimate of flood flow is required for the design of hydraulic structures, as a higher value would result in an increase in the cost of hydraulic structures, while an under-estimated value can place the structure and population involved at some risk.

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CHARACTERISTICS OF DAILY EXTREME TEMPERATURES AND PRECIPITATION OVER STATIONS OF HUMID NORTH-EAST INDIA

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ABSTRACT

It's a known fact that climate change will bring about increases in the occurrence of weather extreme events such as increased temperature, droughts and floods. Northeast India is one such region which receives much rainfall than all the India average and also the summer monsoon temperatures are high which cause flooding, drought, damage crops and bring life to standstill. Based on the daily precipitation, maximum and minimum temperature data from two stations in the humid North-East India, this study examined the characteristics of daily extreme precipitation and temperature in Imphal and Shillong for the period from 1985 to 2003. The daily records of precipitation, maximum and minimum temperature data were collected from ICAR Manipur and Meghalaya. Six extreme temperature indices and four extreme precipitation indices out of 27 extreme indices recommended by the Expert Team on Climate Change Detection and Indices (ETCCDI) were applied. Trends in the daily precipitation and temperature extreme indices were also identified using a non-parametric Mann–Kendall test, while the significance of trend at 90% confidence level was estimated using Sen's slope estimator. The results of the analysis indicated significant increase in the consecutive dry days (CDD) and coldest day (TXn) at Shillong; warmest night (TNx) at Imphal and coldest night (TNn) at both the stations considered for the present study. The warmest night (TNx) at Shillong was found to be decreasing significantly. The non-significant warming (cooling) of warmest day (TXx) was observed in Imphal (Shillong). Although the wet day precipitation (PRCPTOT) was also found to decrease in both the stations but was not significant. The study also reveals that the number of summer days (SU25) and tropical nights (TR20) were highest in the year 1999 and 1995 for both the stations. The consecutive dry days, CDD exhibits an increasing non-significant trend in Imphal while there was no change in Shillong. The 1-day maximum precipitation shows non-significant decreasing (increasing) trend in Imphal (Shillong).

Keywords: *Extreme Precipitation and Temperature Indices, ETCCDI, daily precipitation, daily temperature, trend in extreme indices, North-Eastern region of India.*

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WRFM- 10

**METEOROLOGY DROUGHT CHARACTERIZATION OF STATIONS OF HUMID
NORTHEAST INDIA USING SPI**

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ABSTRACT

Drought is a natural phenomenon affecting various aspects of life and their impact generally spans a long period of time. Lack of understanding of the drought is the main reason for its adverse impacts. So therefore it is important to assess and characterize the drought for the future management. A study was carried out for the characterization of meteorological droughts for two stations viz. Imphal and Shillong of Northeastern India using Standardized Precipitation Index (SPI). The analysis has been carried out at different time scales viz. 1-monthly, 3-monthly, 6-monthly, 12-monthly, 24-monthly and at seasonal scale for the period between 1985 and 2010. From the study it was found out that, for Shillong, the years 1991, 2003 and 2008 were found to be moderately dry ($-1.5 < \text{SPI} < -1.0$) while the years 1989 and 2006 were observed to be severely dry ($-2 < \text{SPI} < -1.5$). In case of Imphal, the year 2008 was moderately dry while the years of 1992, 2006 and 2009 were found to be severely dry. Seasonal analysis illustrated that the monsoon season (June-September) of the same years were affected with severe meteorological drought. The second half of the year in 1994 for Imphal and the years 1990 and 2006 for Shillong also showed severe dry period. This is significant as this period contains maximum of the monsoon rains. The months from April to June in 1998 showed extremely dry condition ($\text{SPI} < -2.0$) at Shillong. However, the study did not find any such instances for Imphal at the same time scale. SPI values at monthly time scale showed many instances which ranges between moderate and severe drought for both the places, however, the month of September in 2002 at Shillong was found extremely dry. The present study suggests that in future these two stations may face water scarcity problem and the planners have to prepare a detailed plan to mitigate the drought that may caused due to deficient rains specially during monsoon season.

Keywords: *meteorological droughts, SPI, time scale, monsoon season*

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WRFM- 11

**GEOSPATIAL ASSESSMENT OF CHANNEL MIGRATION OF RIVER BRAHMAPUTRA
ALONG THE MAJULI ISLAND OF ASSAM**

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ABSTRACT

The Majuli island has been suffering heavy erosion through ages whether it is bank line or surface soil erosion. The Brahmaputra and Subansiri Rivers are the main cause of the depletion of this island since they change their course after every flood event since the plains of the Assam suffer from heavy rains during monsoon. These rivers transport a huge amount of sediment throughout its journey. After a flood event these sediments deposit at the banks of the river. But the river also erodes the surface picking up a lot of sediments from the area. So, the process of erosion and deposition continues every year. In the present study, changes in the scenario of Majuli Island and channel migration pattern of Brahmaputra along the island over a span of 40 years has been studied from 1976 to 2017. It has observed that the deposition is prominent at the right bank on the right but gradually erosion invades the middle part. Therefore, the river is found to be widening in the middle. This has in turn reduced the land surface of the island, creating a negative impact on the ecosystem. Therefore the major ports i.e. Nimatighat and kamalabari ports are shifting from its initial positions towards south and north respectively. About 18 villages are highly susceptible to the erosion problems. Bankline erosion is a major cause of soil erosion and this has in turn reduced the land surface of the island due to which Majuli has been shrinking and sinking over the years.

Keywords: *Bankline erosion, remote sensing and GIS, Majuli Island, Brahmaputra.*

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WRFM-12

**EXPANDING THE CBFM KNOWLEDGE BASE - A TOOL FOR DISASTER MITIGATION
IN FLOOD RISK MANAGEMENT**

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ABSTRACT

Community based Flood Risk Management (CBFRM) requires knowledge about exposures; vulnerabilities; and preparedness and response options. Exposures and vulnerabilities are site-specific, while response options comprise general and site-specific measures. All will evolve in the course of time, affected by flood protection measures, bank erosion, changed land use, infrastructural development, new cultivation systems and climate change.

The Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program (AIFRERMIP) is presently producing a wealth of knowledge relevant to CBFM, including (but not limited to) pilot village surveys and numerical modeling. Much of this knowledge is useful also for other purposes than the one for which it is produced. Knowledge management and information flows are important because they extend the value of the generated knowledge, at a marginal extra cost.

Knowledge about the flood exposure is needed not only for CBFM, but also for land use planning, development of cultivation systems, and design of buildings and infrastructure.

Vulnerabilities of the AIFRERMIP pilot villages have been or are being mapped by a participatory process involving the village disaster management committees (VDMCs). They reflect present conditions and are likely to change in the course of time, so the knowledge produced must be re-visited from time to time (including after major floods).

Information flows follow a hub-and-spoke pattern, with the 'hubs' undertaking data compilation and relay at the village, district and state level, respectively. Much (but not all) information flows about vulnerability goes mainly from the household and village level to the district and state level, with lateral knowledge-sharing at each level. Information about preparedness and response options proceeds as a two-way process.

Much of this knowledge serves important social, economic and environmental purposes that reach far beyond CBFM. Sharing the knowledge must be maintained on a routine basis. This is being piloted already, but there may be a need of fine-tuning and consolidation of practical modalities with moderate resource requirements.

This paper discusses some opportunities for expansion of the CBFM knowledge base in connection with ongoing and planned AIFRERMIP activities. The objective is to fully activate (and possibly expand) the generated benefits.

Key words: *CBFRM, AIFRERMIP, VDMC, Vulnerabilities, pilot village, hubs, preparedness.*

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WRFM-13

**LAND AND WATER ISSUES IN BHUTAN: STATUS, CHALLENGES
AND OPPORTUNITIES**

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ABSTRACT

Bhutan's finest attribute lies in its diverse presence of flora and fauna. It is currently a cradle for excellent water resources and food production. With 58 percent of population depending on agriculture, the land use for the agriculture sector amounts to 2.93%. Water and land symbiotically exist in nature and contribute to functioning of the diverse ecosystem that the country holds. Although Bhutan has been acclaimed for its extensive water resources, there has been acute scarcity of the very resource to population of both rural and urban areas. This issue has been a rising concern in today's time. With issues of both land and water, Bhutan still strives to achieve sustainability of water resources and land which also is a part of the pillars of the Gross National Happiness. With such challenges related to water and land, the country grants a big opportunity for accommodations to be implemented as a measure to conquer the issues. This paper discloses the concern for scarcity of water in the country and the challenges faced to counteract the issue. It also unfolds the current status of land use and discloses the issues faced in administrating the challenges in the Himalayan Kingdom of Bhutan.

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WRFM- 14

THE ISSUE OF UNUSUAL TURBIDITY OF WATER OF THE RIVER SIANG

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ABSTRACT

The water of the River Siang became highly turbid from the last week of November 2017. This created a lot of commotion in the Brahmaputra valley. This made the water of River Brahmaputra highly turbid even near Guwahati. Analysis of the flowing water at different sections of the River Siang also proves increase in turbidity with presence of significantly large concentration of suspended sediment. However, water quality analysis of the River Siang conducted during one-month period indicates decline in turbidity with respect to time. These are largely thought to be a fallout of avalanche or landslide in the upper reaches. Analysis of sediments of the terraces of the River Siang in the past conducted by many scientists also substantiates such theory. The Siang River have several precedence of unusually high flow of water and sediment during the Holocene. The present problem is throwing a perception of occurrence of impending unusually high flood, prompting the authorities to increase disaster preparedness in identified disaster prone areas. A review of the situation with respect to Geomorphology of the River Siang is presented in this paper.

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THEME - 2

IRRIGATION WATER USE EFFICIENCY

PIM EXPERIENCE IN GUJARAT STATE: OVERVIEW

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ABSTRACT

State has rainfall varies windily from year to year and area to area. Annual rain fall in South Gujarat is @ 2000 mm while in Kachchh it is @ 200 mm. Sometimes floods and draught both occur in the different areas of State in the same year, as in case year 2017. Therefore state's challenge is how best to conserve control and deliver enough water to meet various water needs. The state adopted an integrated approach for efficient and sustainable water resources development and management this includes.

- Water conservation – Check Dam, Deepening of ponds etc.
- Micro irrigation- Drip, Sprinkler etc.
- Interlinking of rivers and inter basin transfer of water
- Strengthening and up grading existing canal system
- Salinity ingress prevention – tidal regulator/bandaras, recharges wells, spreading channels
- Participatory irrigation Management (PIM)

Concept of PIM in state evolved from 1987 which includes enactment of the “Gujarat Water Users Participatory Irrigation Management Act- 2007” and Notification of “Gujarat Water Users Participatory Irrigation Management Rules-2012 “

Achievement of PIM in Gujarat (Ending Sept. 2017)

Sl. No	Name of Organisation	No of WUAs Registration	Area of WUA registered	No of WUAs handed over	Area of WUA handed over in Ha.
1	Water Resources Department	2500	7,72,299	1822	5,60,581
2	Sardar Sarovar Project	2330	9,45,462	938	3,83,353

Participatory irrigation management in canal irrigation systems has been a positive experience in Gujarat. There is a need to further scale up these initiatives to benefit a larger number of people. Some issues that need to be considered by Gujarat for strengthening community involvement in irrigation systems.

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IWUE- 02

**WATER USE EFFICIENCY – A CASE STUDY ON WATER SCARCE IRRIGATION SYSTEM
OF TAMIL NADU**

Er. A. Meenakshi Sundara Arasu ¹, Ms T. Jonna Dorthy ¹, Er. K. S. Abdul Rashid ¹,
Dr. V. Geethalakshmi ², Dr. A. Lakshmanan ³

ABSTRACT

Ponnanai dam has been constructed across Ponnanai river, a tributary to Cauvery at longitude 78° 16'20" E and Latitude 10° 34'55" N in Manapparai Taluk in Trichy district during the period 1970-74. Ponnanai River originates from Kadavur hills and after running for 32km towards east, it reaches the Koraiyar River on its right near its confluence with Cauvery.

Ponnanai is a water starving system. The hydrology of the Ponnanai Reservoir system was studied in a detailed manner and the rainfall, inflow, outflow, releases from the reservoir, cultivation details etc were collected and analyzed and found that:

- Out of 39 years, 11 years experienced normal rainfall, 12 years had excess rainfall and 13 years received deficit rainfall. Worst drought hit was experienced during 1980, 1990, 2000 to 2003, 2006, 2012 and 2013.
- The inflow into the reservoir was studied and it clearly established that the inflow into the reservoir after 2000 is poor and from 2000 to 2012, only in one year the reservoir has reached its full reservoir level.
- The South West monsoon is having a declining trend and especially after 2000, the contribution of South West Monsoon to agricultural activities has considerably reducing.
- The North East Monsoon at the same time is having an upward trend there by contributing to the agricultural activities.

This called for conservation of water and hence six Field efficiency studies have been conducted in the basin in different fields for paddy crop.

The paper discusses the different trials carried out in the fields, the observations taken on the plant phenology, water delivered to the crops, the benefit - cost of farming, Data on activities carried out during cultivation, fertilizer applied, cost of human resources, details on pest and diseases, challenges met and above all the Water Productivity of Ponnanai System. The paper also outlines the pitfalls in the system, both structural and non-structural and the measures to be taken to make it more efficiently functional.

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IWUE- 03

**ROTATIONAL WATER SUPPLY POLICY OF PARAMBIKULAM ALIYAR PROJECT IN
TAMIL NADU**

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ABSTRACT

Parambikulam Aliyar Project (PAP) successfully accomplishes the diversion and integration of 8 west flowing rivers in the Anaimalai Hills of Western Ghats for the benefit of the drought prone areas in the Coimbatore and Tirupur districts of Tamil Nadu State and stabilizing the existing irrigation system in Chittoorpuzha basin of Kerala State. Dams on the 8 rivers with inter connecting tunnels have been constructed at various elevations ranging between elevation + 3800 feet and + 1050ft. This difference of elevation has made it possible to the development of hydro-electric power.

In a sense this project is a symbol of Inter-State Co-operation of the two neighborly States of Kerala and Tamil Nadu. An agreement in this regard was signed by the two states in 1969 and also in the year 1970. The main components of this project are 8 Dams, 4 Power Houses, 6 Main Tunnels and 7 irrigation Canals.

The agreement between the State of Tamil Nadu and Kerala provides for the diversion of 30.5 Thousand Million Cubic feet of water for Tamil Nadu when all the aspects of the agreement completed.

The Command Area originally contemplated under the Parambikulam Aliyar system was about 1.01 Lakh ha. There has been lot of representations for extension of irrigation facilities under the scheme to the adjacent dry lands.

The Command Area has been extended by another 0.73 Lakh ha by means of an Extension of Ayacut scheme for relieving the drought prone condition of Coimbatore District and Tirupur District

The irrigation facilities to the dry areas adjoining the existing Command Areas expanded to the extent possible by providing irrigation supplies in alternative years. The entire command area is divided into 4 zones. Two zones will get water in a year subject to normal monsoon conditions.

Due to irrigation in alternative years, the ground water table in the locality is bound to rise up resulting in good yield in the wells, which can be used for drinking purposes and for cultivation of lands during non-irrigation years. This paper will discuss in detail about the Rotational Water Supply Policy adopted in PAP System and its impacts.

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IWUE- 04

IRRIGATION WATER USE EFFICIENCY – KRISHNAGIRI RESERVOIR PROJECT IN TAMIL NADU – A CASE STUDY

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Dr. R. Prakash, Research Associate, Er. S. J. Sivakumar, Assistant Professor

ABSTRACT

Tamil Nadu is situated at the southern part of India. The State of Tamil Nadu has 4 % of country's land area and 3 % of water resources of the country which have to be optimally used to feed a population of 72.1 million which is 6 % of national population (2011 census). Tamil Nadu is water starved state.

The Krishnagiri reservoir project is a medium irrigation project lying in the Pennaiyar basin which is an interstate basin. The annual mean rainfall is about 880mm. The main crops cultivated in the command area are paddy, coconut, jasmine; groundnut etc., the designed cultivable command area under the project is 3467 Ha.

Agro-economic Performance: The cropped area has considerably increased from what was planned originally. The originally planned area is 3603.65 Ha (for single crop), while the gross area cultivated after the project is 6090 Ha. After the construction of the project, there is a crop diversification to a measurable extent. They grow Jasmine, Turmeric, Sugarcane, Betel vine, Fodder Cholan, Ragi etc., occupying 27 percent of the gross command area.

Socio-Economic Impacts: The labour force is inadequate for farm employment and roughly 1/3 of irrigated farm labour force is coming from outside the command area which is an indirect benefit.

Environmental Impacts: water is alkaline in nature, mildly saline hard water with high alkalinity values. The urbanization and industrial growth affecting the water quality in downstream

Water Use Efficiency: The various aspects of the project was studied in detail the average reservoir efficiency works out to 79.71 %.(1973 to 2012). The average main canal efficiency is 83.22%. The distribution cum on-farm efficiency is 73.22%. The overall project irrigation efficiency is 44 %.

Conclusion

To increase the Water Use Efficiency by 20%. The lesser Distribution cum on farm efficiency is the major reason for the low Project Water Use Efficiency. Hence in order to build the Capacity of the farmers training programme and awareness programme on modern technolgis, Micro Irrigation and Water Saving techniques are to be organised and Lining & Rehabilitation of convergence system.

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IWUE- 05

**IMPACT OF CLIMATE CHANGE ON REFERENCE EVAPOTRANSPIRATION (ET_o) AND
CROP WATER REQUIREMENT IN BARAK VALLEY, ASSAM, INDIA**

Kuldeep Deka^{1*}, Laxmi Narayan Sethi², Sudipto Sarakar², and Avinash Kumar³

ABSTRACT

Reference evapotranspiration is the key hydrological factor capable of affecting hydrology cycle and water requirement of crops. Barak Valley of Assam is recognized as one of the climate susceptible regions due to its unique geographical location, hydrological regime and topography in north east of India. So, the present study was carried out to analyse the trends of climatic parameter for 10 years' duration (2006–2015) of Cachar districts and also the reference evapotranspiration (ET_o) of Hailakandi, Karimganj and Cachar districts of Barak Valley, Assam. Crop coefficients (K_c) of selected crops (Chili, Green bean, Cabbage, Onion, Tomato and Capsicum) were established to determine crop water requirement (ET_c). Probability and correlation analysis were also carried out, between evapotranspiration (mm/day) and four climatic parameters such as mean temperature ($^{\circ}C$), sunshine duration (hours), wind velocity (m/sec) and relative humidity. It was observed that Karimganj district has highest evapotranspiration during Summer (March, April, May) and Rabi (October, November, December, January, February) season. However, Cachar district has highest evapotranspiration in Kharif (June, July, August, September) season. Among the climatic parameters temperature was found to have most significant impact on ET_o and the regression coefficient (R value) is noted 0.7 following by sunshine duration with regression coefficient (R value) 0.56. Noteworthy The minimum ET_o noted (by using Hargraves method) in the month of December (3.84 mm/day - 4.04 mm/day) and maximum noted in April (5.83 mm/day - 6.54 mm/day). Vulnerability and adaptation assessments of climate change, reference evapotranspiration and crop water requirement could be the alternative to prioritize adaptation of integrated water resources management and crop planning.

Keywords: *Barak Valley, ET_o , K_c , ET_c , Hargraves method, probability analysis, regression coefficient*

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IWUE- 06

MANAGING THE WATER FOR SUSTAINABLE CROP PRODUCTION IN ASSAM

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ABSTRACT

Water is one of the important natural resources for survival of mankind. The ecosystem of any place is linked with water. It also determines the food, nutritional and livelihood security of human population. As all these security are of great concern today, importance of water has been increased tremendously across the globe. Assam located in the North Eastern Region (NER) of our country with an area of 78,438 Sq. Km (78.44 lakh ha) accounts for 2.4 per cent of total area of the country. The state is very rich in water resources with high annual average rainfall of about 2250mm. There are also large numbers of river and other water bodies as well as ground water. Two river systems viz. Brahmaputra and Barak have 73 and 11 tributaries respectively. About 8251 Sq. Km which is 10.5% of total geographical area of the state is occupied by surface water bodies comprising 6503 Sq. Km by the river system and 1748 Sq. Km by natural wetlands. In the entire state rivers and canal run about 4820 Km which is 2.47% of the country and 23.09% of the NER. The state also accounts for 1.35% (1.35 lakh ha) of the total water bodies (73.59 lakh ha) of the country and 23.98% of the NER (5.63 lakh ha). The major water bodies found in the state is flood plain lakes and derelict water bodies followed by tanks, lakes and ponds, and reservoirs. The ultimate irrigation potential (UIP) of the state through major, medium and minor irrigation schemes including ground water as estimated by central water commission, Govt. of India (2008) accounts for 2.05% of the country and 66.44% of the NER's UIP.

In case of ground water resource, the entire Brahmaputra valley covering more than 70% of total geographical area of the state contains prolific aquifer system with water table lying at shallow depth. Similarly, the Barak valley also has good potentiality for the development of ground water. The net annual availability of ground water in the state has been accounted for 25.79 BCM which is 6.48% of the country's figure of 398.16 BCM. The annual replenishable ground water for the state is 28.52 BCM as against 432.72 BCM at the national level. The ground water draft in the state is very poor (3.49 BCM) resulting only 13.53% of stage of ground water development. Thus, the state accounts for 22.4 BCM availability of ground water for future use.

High water resources in the state though being considered as a strength for achieving higher crop yield, not being able to utilize for the purpose of crop production has been recognized as an important issue. This could be understood by the lesser area under irrigation which is only about 20 % on gross cropped area basis. The water productivity for the state is also very low i.e. only 0.29 Kg/m³ for food production in comparison to the 1.01 Kg/m³ in Punjab.

The approaches for proper utilization of water resources in the state which need to address mainly are harvesting of rain water and its recycling, ground water recharging for future utilization, regulated use of shallow/deep tube wells, water

quality management for irrigation , implementation of the concept of common irrigation and drainage canal, restoration and renovation of village community tank, promotion of multiple use of water concept, precise use of irrigation water, optimum irrigation scheduling, enhancing application efficiency with minimum water losses during conveyance, proper selection of crop(s) and cropping pattern(s), participatory water management and increasing water literacy etc. While in utilizing the water for agricultural purposes, the important approaches perhaps to be considered are technological. All India Co-ordinated Irrigation Water Management, Jorhat Centre under Assam Agricultural University has developed different technologies for the state. Adoption of different such technologies in concerted manner will help in improvement of agricultural water productivity and sustainable food security of the state.

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METHANE MITIGATION FROM RICE FIELD THROUGH WATER MANAGEMENT

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ABSTRACT

Carbon dioxide (CO₂), Methane (CH₄) and nitrous oxide (N₂O) are the most important greenhouse gases (GHGs). Mostly, Agriculture accounts for approximately 50% and 60% of global anthropogenic greenhouse gas emissions specially CH₄ and N₂O, respectively (Smith *et al.*, 2007). Rice fields have received increasing global concerns for their contribution of approximately 4.4–19.2% of total global anthropogenic CH₄ emissions (Houghton, 1997). Rice fields submerged with water are considered to be one of the major sources of CH₄ emission from soils. Methane is produced in soil during microbial decomposition of organic matter under anaerobic conditions. Indian rice fields emit 3.37 million tons of methane and out of these; 1.84MTs is the contribution of irrigated rice fields. There are several factors or otherwise mitigating options of methane emission including water management, organic amendments, fertilization, and the use of appropriate rice cultivars. Under the water management option, strategies for significantly reduction of methane emissions from rice field may be mid-season drainage or alternate wetting and drying, intermittent irrigation or pre-harvest field drying. Draining water from rice field can prevent the development of anaerobic environments for the methanogenic bacteria in the soil and can considerably reduce CH₄ emissions from rice field. The alternate wetting and drying reduced annual greenhouse gas emission by 57–74% (Gabriel *et. al.*, 2016). U.S. studies revealed that precisely maintained alternate wetting and drying (AWD) coupled with dry seeding could reduce emissions by 90 percent.

Key words: *Rice, Greenhouse gas, Alternate wetting drying*

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IWUE- 08

**SPRING WATER MANAGEMENT FOR FULFILLING THE REQUIREMENT OF
IRRIGATION AND DOMESTIC PURPOSE IN SIKKIM, INDIA**

Prem Ranjan^{1*}, Pema T Lepcha², P K Pandey³, Manjeet Prem⁴

ABSTACT

Sikkim is one of the North-Eastern hilly states of India. This hilly state is blessed with adequately high rainfall, but the received rainfall drains away through the steep terrain in the deep valleys, so water conservation is a challenge. The rainfall patterns are changed due to the climate change and now rains coming in short period and extreme weather events becoming more frequent the percolation of water underground is further reduced. After rainfall, spring is the main water resource of this hilly state. Springs are natural way out of hilly aquifer/groundwater. The livelihood of Sikkim is fully depending on spring water for domestic and irrigation supply. The impact of climate change and deforestation/change in land use affect the discharging patterns of the springs. It is observed that the water stress is increased after withdrawal of monsoon. The springs are dried, and its discharge rates are decreased in the lean period. It is also observed that the traditional water supply system consisting of pipe network and roof tank of the houses continually overflowing in the available period. The spring water management is necessary for fulfilling the irrigation and domestic requirement in a lean period. So, an awareness program for the local livelihoods and development of water storage structures, the harvest of rainwater for the recharge of springs, artificial recharge of natural lakes and ponds, rooftop spring/rainwater harvesting.

Keywords: *Lean Period, Roof Top Harvesting, Spring Water Management, Water Scarcity*

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IWUE- 09

**DEVELOPMENT OF INFILTRATION CHARACTERISTIC CURVES FOR DIFFERENT
LANDUSE AND SOIL TYPES UNDER KULSI RIVER BASIN**

S.R. Kumar

ABSTRACT

Infiltration, defined as the entry of water from the surface into the soil profile, is an important component of hydrologic cycle and one of the thrust areas in hydrology. The infiltration characteristics of the soils greatly influence the hydrologic response of a watershed. An understanding of infiltration and factors affecting it is important to the determination of surface runoff as well as subsurface movement and storage of water within the watershed. From agricultural practices point of view also infiltration characteristics of soils of crop fields is equally important. Since the availability of soil moisture can be estimated quantitatively from infiltration modeling, the irrigation requirement for crops can be easily estimated. Infiltration is one of the basic parameter for developing an integrated crop, soil and water management practices and also an integral part of the rainfall-runoff process.

Infiltration is considered as an important process in the management of water resources. Knowledge of infiltration is needed to model, evaluate and design management technologies to conserve soil and water resources. Such results have also vital applications in agriculture and hydrological modeling. Infiltration rates widely vary in different landuse and soil types under different hydro climatic environments. In the present study, field infiltration tests were carried out using double ring cylinder infiltrometer to represent different soil-vegetation-landuse complexes. Results were analyzed and typical infiltration curves were developed for different landuse and soil types. The results show large variation of infiltration rates depending upon various landuse and soil types. From the study it is found that the steady infiltration rates decrease in order of mixed forest land having silty loam soil, river bank with silty loam soil, teak forest grown upon loamy sand soil, bamboo forest land having silty loam soil, shrub land of silty loam soil, harvested agricultural field having silty loam soil texture, grassy land with silt to silty loam soil and barren land with silty loam soil. Soil samples of infiltration testing locations were classified according to USDA soil textural classification.

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IWUE- 10

WATER USE EFFICIENCY IN FARM SECTOR-HOW TO PLUG THE HOLES?

Pradip K. Bora

ABSTRACT

Disproportionate demand to the available fresh water resources has been looming large over the human civilization. The development-energy-water nexus has smothered the sustainability of countries like India which are on the cross roads of economical progress. The developing countries usually have higher water footprint on every commodity that it produces due to poor technology implementation. This leads to a dismal efficiency of resource utilization. Indian farm sector has been identified as one of areas where there is a room for improvement. The level of water application efficiency in farm sector of India is reported to be very less and about 30-35%. Choosing suitable intervention from the technological basket, the efficiency can be easily enhanced by more than 15%. Increase of efficiency will translate into saving of water which is synonymous to creation of resources. In this paper, it was tried to analyse the issues of poor water use efficiencies in various sectors and their future scenarios. It was also synthesised the strategies and technological options to plug the holes for improving the precious fresh water in search of sustainable development.

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THEME - 3

**SOCIAL ASPECTS OF LAND AND WATER
MANAGEMENT**

SALWM- 01

**PERFORMANCE OF IRRIGATION PROJECT: A SOCIO ECONOMIC CASE STUDY OF
KALIABOR LIFT IRRIGATION**

Ch. Victoria Devi¹, U.M.Hazarika², A.C. Debnath³, Pankaj Barua⁴

ABSTRACT

Irrigation development has been taken up rapidly to boost up crop production to meet the ever increasing demand of food grains. But water regarded as free gift of nature has become a precious natural resource due to its increasing demand by various competing sectors such as industry, power, drinking and irrigation. Among the various sectors irrigation consumes highest share of water in India. The increasing population demands for more food production together with rapid industrialization in recent years had resulted in sharp rise in demand of water, while the supply of available fresh water remain the same. This calls for efficient use of fresh water in all sectors especially irrigation which consumes the highest share water. In case of Assam due to occurrence of frequent floods there is recurrent loss of agricultural crops. To provide food security to the increasing population the state develops irrigation projects to supply water for agriculture purpose. One of the irrigation projects is the Kaliabor Lift irrigation project commenced in 1971 with gross command area of 11741 ha and cultivable command area of 8579 ha to supply irrigation water to Nagaon district. The project is located at Hatimura hills in Nagaon district of Assam. There are 7 pumps of 250 HP and 1 standby pump of 200 HP capacity installed in floating barge on the Brahmaputra River to delivered irrigation water in the command area. Under the project there are 16 water users associations formed for involving in participatory irrigation management. The area covered under water users associations is 1574 ha. A study was conducted to examine possibility of performance of the project from socio-economic point of view which was functioning for the last four decades. The study attempts to examine the socio economic status of the farmers, their attitude towards the performance of the irrigation project and suggestion for increasing efficiency of the Kailabor irrigation project.

Key Words: *Irrigation water use efficiency, irrigation management, water users association*

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SALWM- 02

INDIA AND CHINA- A TALK OVER WATER-COOPERATION AND BOND BUILDING

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ABSTRACT

The very controversial and media blitzkrieg of China being starting a longest tunnel project is a major cause of concern amongst the Indian side strategic thinkers. Chinese engineers have submitted plan building a thousand kilometre tunnel, (to be the world's longest); to waters of the Brahmaputra from Tibet to arid Xinjiang. This tunnel carry as much as 10 billion to 15 billion tons of water from the Brahmaputra to the arid Taklamakan district in Xinjiang. Engineers want to divert water from Shangri County in Tibet to the Indian Arunachal Pradesh. Though the Chinese govt. says that environment evaluation has been carried out, yet the nature and scale of the impact remains in the dark. The plan was submitted to the Chinese govt. in March itself but hence being approved now, the South China morning post thus reported on Monday, 30th October, 2017. Past diversion proposals were scrapped because of high cost of environmental situations and technical constraints. The tunnel is likely to be another source of tensions between India and China as the plan, if approved, would have huge ramifications for states along the eastern corridor as well as Bangladesh.

The Yarlung Tsangpo future zone, the young mountain and the young river system as it flows from the third pole to the valley agrarian culture of the Brahmaputra valley. Use of making a long tunnel to divert Yarlung Tsangpo/Brahmaputra's water is a disturbing piece of news. Though the Chinese Govt. though denies the report, but this is the natural behaviour of the Chinese and the way they operate though diverting water in a sustained activity for a while. However, the real story never appears the like the facts is. The Chinese basically are making a demonstrative tunnel in Yunnan province what will be the main project they are working on. Chinese's first project was however was to divert water from the 'Great Bend', but the heights were a serious obstacle. They however, did build five (5) dams there including the Southern Tibet, the swathe, comprising of about 3/3.5 miles high. A nomadic tribe used to live there. Oxygen decreases every 10,000 ft. So there is serious oxygen problem for people who are not adapted to this height. So China cannot make California or Las Vegas there. Their aim is to take water through the Yunnan tunnel. This controversial project can be compared with the notorious 'South China Sea' project of China. It is a natural phenomenon that geography does not create any barrier and knows no bounds. But when people use it for their own strategic wins then this very geography can be the biggest decisive factor of division.

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SALWM- 03
CHALLENGES AND OPPORTUNITIES OF JUTE FARMING FROM GROWERS
PERSPECTIVE: A STUDY IN ASSAM

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ABSTRACT

Jute is one of the major cash crops, mainly cultivated by the marginal and small farmers in Assam. The state ranked third in terms of its production as well as acreage in India after west-Bengal and Bihar. In this era of growing environmental awareness, natural fibers are regaining its acceptance among environment conscious consumers across the world. In spite of such a promising situation, farmers express apathy towards cultivating the fiber crop due to various agro-economic and agro-ecological constraints in the region. This paper is an attempt to discuss the agro economic challenges faced by the jute growers in the process of production as well as marketing of the crop in the region. Analyzing the feasibility of Diversified Jute Products (DJP) and its ecological importance in the contemporary era is another dimension of the paper. The study is based on both primary as well as secondary data. Multistage sampling procedure has been followed and farmer's responses were obtained through a structured schedule. 1050 Jute growers were interviewed irrespective of the farm size across the state. It was observed that due to increasing cost of production, scarcity of labor, scarcity of irrigation and retting water, jute becomes the least preferred crop among the farmers. Absence of appropriate marketing structure is another major constraint can be attributed to the cause of declining Jute acreage in Assam. However, diversified Jute products can be viable option for revitalization of Jute economy and promotion of sustainable livelihood among the growers in the region.

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SALWM- 04

**TOWARDS A MORE SUSTAINABLE USE OF RAMSAR LOKTAK LAKE OF MANIPUR,
INDIA: AN ECONOMIC APPROACH**

K. Gyanendra Singh¹

ABSTRACT

Wetlands are an important resource for the sustenance of societal livelihood. They provide diverse goods and services, which have got immense social, cultural and economic value. However, these often get ignored in the conventional policy framework mainly due to the intangible nature of the same. Loktak Lake, a Ramsar site, is one of the examples for such case.

Loktak Lake is considered as the lifeline of the state of Manipur due to its importance in the socio-economic and cultural life of the people. It is the largest natural freshwater lake in the north-eastern region of India. *Keibul Lamjao National Park*, the World's only floating national park, is a part of Loktak Lake, which is the natural habitat of the endangered Manipur brow antlered deer '*Sangai*'. The Lake attracts numerous migratory birds during winter season. Many local communities depend on the Lake for their livelihood in the form of the source of food, income, and cultural needs. They largely depend on the Lake for fish, cultivation, water, etc. It is also a major source of power generation in the state. However, the Lake is currently threatened with severe issues of siltation, eutrophication, pollution, indiscriminate fishing and excessive proliferation of Phumdis, etc.

In the present study, we employ discrete choice experiments to estimate the economic values of changes in several ecological, social and economic goods and services provided by Loktak Lake as perceived by its important stakeholders. Random parameter logit model with socioeconomic interactions is estimated to identify the stakeholders' preferences for the improvement in the selected wetland attributes. The results reveal that there exists heterogeneity in significant scale across stakeholder preferences. On average, however, they perceive positive and significant values from the improved conservation and management of Loktak Lake.

Keywords: *Wetlands, Choice Experiments, Loktak Lake, Conservation, Degradation*

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SALWM- 05

**WATER HARVESTING AND DIVERSION BASED IRRIGATION IN BAKSA DISTRICT OF
ASSAM**

Puspadhar Das, Amiya Kumar Roy

ABSTRACT

Moisture content of soil at various growth stages of crop is an important factor in crop productivity. Farming practice in Baksa district is mostly rainfed and receives more than 1700 mm annual rainfall. The temporal and spatial distribution of rainfall is skewed and rainfall has become erratic and unpredictable, affecting the timeline of agricultural operations, as a consequence of which agricultural productivity is not optimum, causing farmers' distress. The traditional *dong bandh* system prevalent in Indo Bhutan border is a system through which water is regulated and distributed for domestic and agricultural use and this has successfully been running for over a century.

Traditional *dongs*, water reservoirs existed and even the homestead gardens had drains that used to hold and regulate water. But many of them have vanished. It is of utmost necessity that these water holding and regulating structures be developed so that surface run-off is minimized. This will help in several aspects: help reserve water for future use, reduce silts to the river, reduce erosion of fertile land, reduce leaching of valuable minerals, develop aquaculture, etc. If surface run-off can be reduced and water can be held for a longer time in the northern bank of Brahmaputra, it will also have a far reaching impact on flood as many places are flooded during heavy rain spells due to lack of *in situ* water reserving facilities. At the same, this has far reaching consequences as it entails changing land terrain, land holding patterns, reconstruction of old canals, *go-bats*. This may also need land acquisition and eviction as many reservoirs, agricultural drainage, etc. are encroached upon or may need new construction or rework of existing assets.

This paper attempts to study the agricultural system based on rain water harvesting and diversion based irrigation system and how this method can help farmers cope with the adverse effects of climatic changes by adopting diversified cropping and multiple cropping patterns.

SALWM- 06

**NEW ROLE OF WATER AND LAND MANAGEMENT INSTITUTE, WALMI,
AURANGABAD FOR REORIENTING EXISTING WATER SECTOR EMPLOYEES IN
MAHARASHTRA**

Dr. Rajesh Puranik

ABSTRACT

National Water Mission goals for improving water use efficiency and reducing the gap between irrigation potential created and its utilization is well known to all. Efforts are being made to achieve these goals at all levels. Introduction of PMKSY alongwith slogan of “Har Khet Ko Panni” and “more crop per drop” are the classic examples of these efforts. While on the other hand ever increasing population is continued to be dependent on limited water and land resources coupled with reducing availability of water for irrigation purposes owing to other competing reasons like increase in living standards, industrialization etc. Thus availability of water in right time, right quantities and at right place is essential for sustainable development particularly in agriculture sector. Perhaps the last alternative available for supporting food demands will be to increase the productivity i.e. agricultural production per unit of land. Maharashtra Management of Irrigation System for Farmers (MMISF) Act was enacted in the year 2005 and its Rules in the year 2006 basically for 289 irrigation project selected under Maharashtra Water Sector Improvement Programme. Within the framework of this project responsibility of training and capacity building activities of various stakeholders was assigned to WALMI Aurangabad which includes the Water Users Associations. Training and capacity building is the prime function of WALMI, but apart from this institute has also provided strong technical back up to WRD.

WALMI Aurangabad was assigned a role of training of Water sector employees including Water Users Association under Participatory Irrigation Management in Maharashtra. Under Maharashtra Water Sector Improvement Project (MWSIP) strengthening and capacity building of WALMI was taken up as one of the component of the project. WALMI, Aurangabad in association with Water Resources Department has demonstrated a unique and continual effort of delivering the training capacity building programme for Water Users Associations in Maharashtra under MWSIP. In MWSIP phase I (2005-2013), about 23,789 staff and farmers benefitted by participating in a total of 315 training courses conducted by WALMI. The efforts of WALMI are step forward in achieving the objective of improving water use efficiency in command area of irrigation project besides providing a functional irrigation system to benefit the rural people. WALMI is continuing its function to train the WRD engineers, representatives of WUAs, strengthening the processes of PIM, and supporting enactment of MMISF Act 2005. Overall performance of WALMI can be assessed from its cumulative achievement of training and act as a vibrant institution in the field of water and land management. GOI, MOWR, RD & GR New Delhi selected WALMI Aurangabad as pilot project under Water Education programmes.

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EXPANDING HORIZON OF WOMEN IN AGRICULTURE AND WATER MANAGEMENT

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ABSTRACT

Agriculture which is the primary source of many industries is a dominant sector for generating employment in rural India. It is an informal sector where large women are engaged. Through socialization women learn agricultural activities for helping the family and also earning income. Their role varies from landless labourer, cultivator and supervise in agriculture depending upon region, community, caste, class and cropping patterns. Poor households require the greater involvement of women in income generating activities than financially stable ones. Such women get work in agriculture because it is the one of the sectors where education and qualification is not required. Sometimes women's efforts are non-monetised although they contribute their labour. There is a need to recognise their contributions in agriculture. Women being involved in agriculture they can become a good partner in water management either in irrigation or domestic sector. The National Water Policy specifically emphasise states for representation of women in water management. Some states like Madhya Pradesh, Andhra Pradesh, Gujarat and Meghalaya involve women in water management but many states in India are still lacking in expanding the horizon to the women. This paper attempts to highlight women's role in agriculture, government policies for empowering women in water management, capacity building, strategies and way forward for more women participation in making better irrigation efficiency and agricultural growth.

Keywords: *Women, agriculture, water, management, empowering, capacity building*

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THEME - 4

NATURAL RESOURCE MANAGEMENT

NRM- 01

EFFECT OF SOIL TEST CROP RESPONSE (STCR) FERTILIZER PRESCRIPTIONS AND INTEGRATED PLANT NUTRIENT SUPPLY (IPNS) ON YIELD PERFORMANCE OF TORIA

Bikram Borkotoki¹, K.N. Das², Prabal Saikia¹, Anjali Basumatary²

ABSTRACT

An On Farm Trial (OFT) was conducted at farmers' field of Dokhin Kulabali Village of Lakhimpur district of Assam, India during Rabi 2015-16 under All India Coordinated Research Project on Soil Test Crop Response (STCR) to find out the effect of STCR equation based fertilizer prescriptions and STCR prescriptions combined with Integrated Plant Nutrient Supply (IPNS) on yield performance of normal and late sown toria varieties viz. TS-38 and Jeuti (JT-90-1), respectively with the following treatments viz. T₁: Farmers' practice (100% Recommended Dose of Chemical Fertilizers (RDF) and manures), T₂: STCR- Inorganic and T₃: STCR-IPNS. Area under each treatment was 0.07 ha with five replications having one replication per farmer for each variety arranged in Randomized Block Design. A total of 10 farmers were involved in the study covering an area of 2.1 ha. Initial soil properties and organic manures were analyzed for calculating the fertilizer prescriptions for STCR and STCR-IPNS. Fields of the adjacent farmers were selected for the OFT to minimize the soil fertility differences within replications. Variety TS-38 was sown on 14th Nov, 2015 while variety JT-90-1 was sown on 25th Nov, 2015. In both the varieties, STCR-IPNS gave significantly higher yield over STCR-inorganic and farmers' practice and only STCR-IPNS could achieve the targeted yield in and around of 12 q/ha with highest B:C ratios. Conversely, STCR-inorganic and farmers' practice could not produce the targeted yield and found statistically at par. However, B:C ratio in STCR-Inorganic was higher than farmers' practice because Farm Yard Manure (FYM) @ 2 t/ha was also applied in farmers' practice along with RDF unlike STCR-Inorganic applications. The study reveals that STCR prescriptions coupled with IPNS is the best for achieving the targeted yield with higher benefit: cost ratios in both normal and late sown toria.

Key words: *STCR, IPNS and Toria*

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NRM- 02

WEED CONTROL FOR ORGANIC CROP PRODUCTION

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ABSTRACT

Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and good quality of life for all involved. One of the major drawbacks in intensive agriculture is the rampant use of synthetic herbicides for control of weeds. This has caused an evolution of the pest and weeds species and thereby, made them increasingly immune to chemicals. There lies the importance of weed control by organic methods. The primary weed control strategies for organic systems are mechanical, biological and cultural weed control. Devi and Singh (2016) reported that the lowest number of weed population (17.08 m²) was observed from hand weeding treatment which was at par with cross ploughing twice and cross ploughing thrice but significantly lower as compare to without cross ploughing. Bhuiyan *et al.* (2009) reported that higher rates of rice bran application produced lower number of weeds and weed weight. Stale seedbeds coupled with one hand weeding at 60 DAS and hand weeding twice (30 and 60 DAS) were the best treatments for weed control in organic garden pea (Gopinath *et al.*, 2009). The modern concept of flame cultivation uses the heat of a flame to destroy undesirable plants without burning. Stepanovik *et al.* (2014) reported that banded flaming followed by aggressive cultivation applied twice in the season provided the best weed control (97% and 94% WCE at 7 DAT and 28 DAT, respectively) and crop yields (7.8 t/ha), suggesting that flaming and cultivation can be a very effective tool for managing weeds. Golzardi *et al.* (2015) concluded that use of thin plastic for soil solarization as a method of weed control in fallow period or before planting is recommended. Also, to prevent weed growth and significant effect in elimination of weeds keeping polyethylene plastic sheet at least 4 weeks is recommended. Control of *P. hysterophorus* by *Zygogramma bicolorata* and *E. Crassipes* by *Neochetina eichhorniae* are examples of biological weed control. Arif *et al.* (2015) reported that allelopathic effect of two sprays of sorghum+ sunflower+ brassica each at 18 l ha⁻¹ at 25 and 40 DAS inhibited the total weed density by 55-59, 55-56 and 48-59% recorded at 40, 65 and 90 DAS, respectively followed by two sprays of sorghum+sunflower+brassica each at 20 l ha⁻¹ at 25 and 40 DAS controlling the weeds by 38-48%. The use of cowpea as an intercrop leads to a considerable reduction in weed biomass (about 46% at a density of 30 plants m⁻²) (Jamshidi *et al.*, 2013). Mathukia *et al.*, (2015) reported that pearl millet + blackgram (1:1) intercropping significantly reduced density of monocot (13.88 m⁻²), dicot (9.13 m⁻²) and sedge (8.81 m⁻²) weeds and dry weight of weeds (196 kg ha⁻¹) as compared to sole cropping, however it was found to be at par with pearl millet + greengram (1:1)

intercropping in case of dicot weed count. Organic Materials Review Institute (OMRI) in May, 2014 listed certain herbicides for use in organic production with product name such as all down, corn gluten meal, mantran II, ground force, herbicidal soap and xpress.

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NRM- 03

MAPPING OF SOIL FERTILITY STATUS OF JORHAT DISTRICT, ASSAM

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ABSTRACT

The management of soil fertility for maintaining soil health and sustaining crop production poses a great challenge in paddy growing areas of Assam. Continuous mono-cropping of paddy in these soils without proper fertility management has led to decline in fertility status. To address this problem in Jorhat district, geo-referenced surface soil (0 – 15 cm) samples were collected from farmer fields of each block of Jorhat district at 2.5 km grid and at random keeping in view the equal distribution of sampling sites. Average 361 samples were collected from each block amounting to total 2166 samples for the district. They were analyzed for pH, OC, available (Av) N, P, K, S, Zn and B following standard methods. The status of pH was dominantly extremely acidic (< 4.5) covering 58.96 per cent of the cultivated area. Organic carbon of the soils of the district was mostly medium (0.50-0.75 %) and very high (> 1.0 per cent) covering 34.32 and 18.17 per cent of land. Among the macro nutrients Av N, Av P and Av K were dominantly medium and occupied 58.5, 48.9 and 22.19 per cent land, respectively. Sulphur status of the soils was dominantly high occupying 38.43 per cent of the land. The micronutrient Av zinc and boron of the soils were sufficient covering 98.9 and 66.9 per cent of the cultivated soils of Jorhat. The geo-referenced soil fertility maps developed for blocks of Jorhat district will be useful for precise recommendation of fertilizers for different crops to all the farmers of Jorhat district which will subsequently increase crop yield, sustain soil health and check environmental pollution. The mapped data on fertility status can be used by different stake holders engaged in formulating policy guidelines for the planners, administrators on allocation, distribution of required plant nutrient carriers.

Key words: *soil fertility maps, soil fertility status, soil health, Jorhat district, Assam*

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NRM- 04

**DISTRIBUTION OF SOIL CARBON STOCK WITH RESPECT TO LAND USE SCENARIO IN
JORHAT DISTRICT, ASSAM**

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ABSTRACT

Studies on carbon sequestration potential, as a means to mitigate global warming, is an emerging science in the world. Land use systems have a tremendous influence on the carbon sequestration potential. The present investigation was carried out in four agro-ecological situations within Jorhat District, Assam, viz., High land, Humid alluvial flood free, Humid alluvial flood prone and Char areas. A total of 5 land use types (paddy cultivation, forest, bamboo, tea and homestead garden) had been considered. Bamboo cultivation showed highest soil organic carbon (1.36%) and followed by forest (1.35%); homestead garden contained highest total soil carbon (7.90%) followed by forest (5.75%). A total of 28116.11 ha (10.11%) of total area showed total soil carbon at 850°C in the range of 5.43-5.53 per cent. Density of soil organic carbon (Walkley and Black), soil organic carbon at 430°C and total soil carbon at 850°C were in general highest in forest followed by bamboo and tea cultivation in all the agro-ecological situations in the district. Amongst the four situations, highland contained the highest carbon density followed by humid alluvial flood free and flood prone situation with char areas showing the least. It is observed that the soils of the district still contain very less amount of carbon stock, indicating a huge potential for carbon stock below ground.

Key words: *Soil carbon stock, land use system, agro-ecological situations, Jorhat district*

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NRM- 05

**WATER USE STUDIES IN LATE SOWN RAPESEED (*BRASSICA CAMPESTRIS* VAR.
TORIA) AS INFLUENCED BY IRRIGATION SCHEDULE AND FERTILIZER LEVELS**

Pompy Deka, K. Pathak, A. Sarma

ABSTRACT

A field experiment was conducted to study the water requirement of late sown rapeseed at Instructional-cum-Research Farm of Assam Agricultural University, Jorhat during *rabi* season of 2014-2015. The experiment was laid out in a factorial randomized block design with three replications. The treatments consisted of four irrigation schedules *viz.*, I₀ - rainfed, I₁- 6 cm irrigation at pre flowering stage [25 days after sowing (DAS)], I₂- 6 cm irrigation at siliqua formation stage (50 DAS), I₃ - 6 cm Irrigation at 25 DAS and 50 DAS, and three fertilizers levels *viz* F₁- 45-30-30, F₂ - 60-40-40 and F₃ - 75-50-50 N-P₂O₅-K₂O kg ha⁻¹. The soil of the experimental site was sandy clay loam in texture having available N, P₂O₅ and K₂O 259.5, 11.2 and 114.7 kg ha⁻¹, respectively with pH 5.8 and organic carbon 6.8 g kg⁻¹. The rapeseed variety "JT-90-1" was sown on 15th December, 2014 in lines at 30 cm apart with seed to seed distance of 10 cm and harvested on 11th March, 2015. The results of the experiment revealed that two irrigations, one each at pre-flowering- and siliqua formation stage recorded higher seed (9.55 q ha⁻¹) and Stover yield (20.59 q ha⁻¹) as compared to other irrigation schedules. Among the fertilizer levels, application of 75-50-50 N-P₂O₅-K₂O kg ha⁻¹ being *at par* with 60-40-40 N-P₂O₅-K₂O kg ha⁻¹ recorded the highest seed (8.72 q ha⁻¹) and Stover yield (19.06 q ha⁻¹). The value of consumptive use were higher for application of two irrigations one each at pre-flowering and siliqua formation stage (213.11 mm) and at application of 75-50-50 N-P₂O₅-K₂O kg ha⁻¹ (187.11 mm). However, the highest water use efficiency (WUE) was recorded under rainfed condition (50.11 kg ha-cm⁻¹) and at application of 60-40-40 N-P₂O₅-K₂O kg ha⁻¹ (47.47 kg ha-cm⁻¹). In terms of economics, two irrigations, one each at pre-flowering- and siliqua formation stage recorded the highest benefit:cost ratio (1.90) and in case of fertilizers levels, 60-40-40 N-P₂O₅-K₂O kg ha⁻¹ recorded the highest benefit: cost ratio (1.77).

Key words: *Rapeseed, Consumptive use, Water-use-efficiency*

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NRM- 06

**INTEGRATED SULPHUR MANAGEMENT IN RAPESEED-BLACKGRAM SEQUENCE
IN AN INCEPTISOLS OF ASSAM**

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ABSTRACT

A field experiment was conducted during 2012-15 to assess the direct effect of sulphur alone and in different combination with farmyard manure, bio fertilizer and lime on soil fertility status, crop yields and uptake of nutrients by the crops under rapeseed-blackgram sequence. Integrated use of sulphur nutrient management significantly influenced both the crop yield over application of sulphur alone. Among the different treatment combinations, application of 30 kg S ha⁻¹ along with 50% recommended dose of NPK, lime and FYM produced the highest crop yields and uptake of N, P, K and S for both rapeseed and blackgram crop. Organic carbon and available nutrient status were found to be higher in treatments receiving integrated application of sulfur along with farmyard manure, lime and bio fertilizer in different treatment combination over application of sulphur alone.

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NRM- 07

**MEETING HIGH WATER USE EFFICIENCY IN WINTER POTATO UNDER MID HILLS OF
MEGHALAYA**

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ABSTRACT

This paper deals with the strategy of irrigation scheduling that enhances the water use efficiency in winter Potato (*Solanum tuberosum L.*) (Variety: KufriMegha). Under a real time based irrigation scheduling, *i.e.*, ratio of depth of irrigation water (IW) to cumulative pan evaporation (CPE) an agronomic experiment with potato was taken up under mid hills of Meghalaya during the winter season of 2016-17. The trial was laid out with three different irrigation scheduling, *viz.*, IW: CPE- 0.75 (I₁), IW: CPE- 1.00 (I₂) and IW: CPE- 1.25 (I₃); and replicated thrice. Irrigation water through micro sprinkler was followed to water the plants at regular intervals. Results indicated that the irrigation scheduled at IW: CPE-1.25 (51.77 kg ha⁻¹mm⁻¹) showed maximum field water use efficiency (WUE) over IW: CPE-1.00 (50.35 kg ha⁻¹mm⁻¹) and IW: CPE- 0.75 (48.18 kg ha⁻¹ mm⁻¹). The recorded maximum tuber yield was 17.07 t ha⁻¹ (I₃) over other two scheduled irrigation levels.

Key words: *Irrigation scheduling; IW: CPE ratio; micro-sprinkler; North East India; Potato and WUE*

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NRM- 08

**MANAGEMENT OF SEASONAL DROUGHT IN SALI RICE GROWN WITH INCREASING
RAINFALL VARIABILITY IN NORTH BANK PLAIN ZONE OF ASSAM, INDIA**

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ABSTRACT

The intermittent dry spells during growing season of winter or *Salirice*, cultivated in the North Bank Plain Zone (NBPZ) of Assam, India, is the major weather risk causing widespread damage to crop. Yield reduction in *Salirice* was observed up to 100% due to seasonal drought, particularly when cultivated on uplands and medium lands of the zone. In the present study, the trend and variability of rainfall of Lakhimpur district of Assam was studied to understand the observed abnormalities in distribution of rainfall and increasing the frequency of extreme events like dry spells, flash flood etc which has been impacting and going to be impacted the *Sali* rice, the major crop of the area. The seasonal and annual rainfall was verified with Mann-Kendall trend test and Sen.'s slope estimator for the period of 1984 to 2016 and a significant decreasing trend of annual and seasonal rainfall with slope magnitude of -15.09 mm/yr and -29.03 mm/yr was identified in monsoon season and annual rainfall as a whole, respectively. A significant and positive trend of coefficient variation of monthly rainfall for a 10 year moving period was observed in the month June, September and October with higher R² values of 0.63, 0.59 and 0.50, respectively. Decrease in rainfall during monsoon season and increase in variability of rainfall explaining the recent rainfall fluctuations with large amplitudes and increasing frequency of intermittent dry spells and flash floods which are likely to aggravate in future. In the study, a parallel on-farm study was also undertaken in Chamua village (27°02'18" N, 93°52'46" E and 83 to 90 m) in NBPZ, covering 132 ha involving 120 farmers, with an aim to identify climate resilient technologies to cope with seasonal drought in *Salirice* by introduction of short and medium-duration varieties of *Salirice* and manipulation of sowing time using rainwater harvested during pre-monsoon season. Except in 2012, *Salirice* in all other years was affected due to delayed onset of monsoon, and/or mid-season/ terminal drought coinciding with tillering, panicle initiation and grain-filling stages of crop. Improved short-duration varieties such as *Dishang*, *Luit*, *Lachit* and *Kolong* and medium-duration varieties such as *Mahsuri*, *Basundhra* and *Moniram* when evaluated under upland and medium land situations, performed consistently better than the traditional or long-duration improved varieties. As against the average rice grain yield of 1500 kg/ha and 2250 kg/ha of the traditional varieties, improved short and medium gave 3195 kg/ha and 3947.4 kg/ha under upland and medium land situation, respectively. Though intermittent dry spells did not affect long duration varieties of rice cultivated in clay loam textured soil with poor drainage under low land situation, grain yield of these cultivars reduced substantially (42.0 per cent) when

sowing was delayed beyond 3rd week of June. Moreover, impact of late sowing further amplified if delayed sowing was followed by exposure of these cultivars to mid season or/and terminal dry spells. The exceptionally high reduction of grain yield of *Ranjit* (1050 Kg/ha) during 2011, when sowing was delayed beyond 3rd week June could be justified with the added impact of exposure of this varieties to mid season and terminal dry spells tillering to grain filling stages of the variety. Thus, it can be concluded that intermittent dry spell can be effectively managed by replacing long duration or traditional rice cultivars with short and medium duration improved varieties for well drained upland and moderately well drained medium land situation, respectively. Moreover, decreasing yield of long duration varieties in delayed sown condition could be ameliorate by sowing within third week of June which was possible sowing these varieties by using harvested rain water during pre-monsoon season in the region.

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NRM- 09

**DEVELOPMENT OF LAND RESOURCES INVENTORY FOR A WATERSHED IN
BUNDELKHAND REGION, INDIA**

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ABSTRACT

Land Resources Inventory (LRI) is a compilation and description of the existing natural resources data, and indicates potentials and constraints for developing a site-specific resource conservation plan. A study was carried out for Kathan river watershed in Madhya Pradesh, Bundelkhand Region, India to characterize the natural resources like soil, water, and land. The study involved assessment of the suitability of land for major crops and delineation of homogenous areas in form of land management units based on soil-site characteristics. The analysis included interpretation of climatic data, soil data, assessment of crop water requirements, number of irrigations, depth of irrigation, and establishment of watershed level digital land resources database in a GIS framework. The suitability and limitations of land for selected kharif and rabi crops were presented in the form of thematic layers. Further, land management units of the watershed were suggested for the identified crops covering aspects such as crop rotation, intercrops, and suitable interventions for improving the land productivity. The study concluded that LRI provides detailed analysis of natural resources, which is important for watershed planning process. Further, LRI-based natural resource conservation plan provides a scientific tool to educate people and stakeholders on the watershed conditions and to identify specific actions needed to improve water management in the study area.

Keywords: *Watershed, Land Resources Inventory, Kathan River, Land Suitability*

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NRM- 10

CHARACTERIZATION OF RICE GROWING SOILS OF RAIDANGJURI GP FOR CROP SUITABILITY

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ABSTRACT

The potential and problems of land and soil, the two most important renewable and dynamic natural resources, need to be characterized for optimize their use on sustainable basis. This investigation was carried out to characterize the paddy growing soils of Raidangjuri *Gaon Pnachayat* (GP) of Titabor block, Jorhat district, Assam to evaluate its potential and problems for growing different crops. Because though rice is the most dominant crop in Assam, its productivity (1.35 t/ha) is far below the national average of 2 t/ha and farmers are not economically benefitted presently by cultivating rice. A semi-detailed soil survey was carried out in a cluster of nine villages of the GP with the help of Topographical sheet No 83J/3 at 1:50,000 scale and geo-coded IRS LISS-III image. Based on soil and site characteristics, the soils were grouped into eight different soil series viz. Raidangjuri (P1), Matikhula (P2), Sukanjun (P3), Annapurna (P4), Torani (P5), Nagabat (P6), Miri gaon (P7) and Kakodanga (P8) and were assessed for crop suitability following procedures of Sys *et al* (1993). The colour of the soils had hue ranged from 10 YR to 2.5 Y with dominant chroma of 1 which indicated the process gleization and aquic moisture regime. A wide variation in texture of the soils was found that ranged from clay to sand and soils had massive to sub angular blocky structure. Clay skins were present on ped faces in B horizons of P1 and P3 soils. Organic matter content was higher in the surface horizons (0.99 to 2.60 %) and decreased regularly with depth in all the profiles. The surface and subsurface soils were very strongly acidic (pH 4.9-5.6) to medium acidic (pH 5.2-6.5), respectively. The CEC of the soils was low (4.3-11.5 cmol (p⁺) kg⁻¹) with Ca²⁺ and Al³⁺ was the most dominant exchangeable basic and acid cation. Soils were only moderately suitable (S2) for rice cultivation. Rapeseed, sesame, potato, tomato, cabbage, French bean and pea were potentially moderately suitable for most of the soils. The Annapurna (P4) and Torani (P5) series were potentially highly suitable (S1) for rapeseed and potato.

Key words: *Rice growing soils, semi-detailed survey, soil-site characteristics, soil series, crop suitability, Raidangjury GP, Assam*

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NRM- 11

**INFLUENCE OF GENOTYPES AND ESTABLISHMENT METHODS ON WATER USE OF
RICE (*Oryza sativa* L.)**

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ABSTRACT

A field experiment was conducted to study the water use of rice genotypes under System of rice intensification (SRI) and conventional method of establishment at Instructional-cum-Research Farm of Assam Agricultural University, Jorhat during 2013-2014. The experiment was laid out in a split plot design with four replications. The treatments consisted of two different method of establishment viz., System of Rice Intensification (SRI) and conventional method of transplanting in main plot and six different rice genotypes involving four hybrids viz., DRRH2(V₁), Arize6444(V₂), PAC837(V₃), NK5251(V₄) and two high yielding varieties (HYVs) viz., Kanaklata(V₅) and Joymati (V₆) in sub plots. The soil of the experimental plot was sandy loam, acidic in reaction (pH 6.1), medium in organic carbon content (0.62%), medium in available N (294.09kg ha⁻¹) and K₂O(139.01 kg ha⁻¹) and low in available P₂O₅(20.11 kg ha⁻¹). The result of the experiment revealed that among the all growth stages, higher relative leaf water content (RLWC) of 84.30% was recorded at 60 days after transplanting (DAT) in SRI method. The higher water -use -efficiency (60.24%), lower water requirement, higher grain (14.9%) and straw (30.77%) yield were recorded under the SRI method of establishment as compared to conventional method. Among different rice genotypes the highest relative leaf water content was recorded in hybrid PAC 837 at 30 and 90DAT. The highest water use efficiency (51.16kg/ha-cm) was recorded in rice hybrid PAC 837 which was 12.27% more over other hybrids and 30.31% over HYVs. The highest grain yield was recorded in rice hybrid PAC837 (52.67q/ha) which was 12.66% and 28.43% more than average yield of other hybrids and HYVs, respectively.

Key words: *Rice, SRI, Water-use-efficiency*

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NRM- 12

BIOCHAR: SUSTAINABLE OPTION FOR RAINFED WHEAT CULTIVATION

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ABSTRACT

Water management in agricultural land is one of the sustainable options for higher crop yield as well as for the enhancing soil quality and biological properties. However, in rainfed system, fertilization, tillage, and residue-management practices are the major ways to enhance crop productivity and C sequestration. Water availability increase plant biomass production, photosynthesis, and crop yield and thus sequester large amount of CO₂ in plant biomass which contributes to the SOC pool. Thus, the present study evaluated the effects of organic amendments (vermicompost and biochar) on wheat productivity, grain and soil quality under rainfed condition in the inceptisols of northeast India. Eight fertilizer treatments combining recommended doses of inorganic NPK, 50% recommended N and organic amendments were laid in randomized block design. Conjoint application of organic and inorganic fertilizers caused significant improvement in plant growth leading to increased wheat yield. Application of biochar improved production of wheat root biomass while, relative growth rate and nitrate reductase activity were significantly ($P \leq 0.01$) higher in vermicompost amended plots. Biochar application (5 t ha⁻¹) with 40 kg ha⁻¹ (50 % of recommended) inorganic N fertilizers for two consecutive years resulted higher rate of increase of wheat grain yield compared to vermicompost. Also, both vermicompost and biochar showed equal potentiality to uphold soil enzymes (urease, phosphatase and dehydrogenase). Biochar application significantly increased the SOC content and also showed lesser accumulation of soil N compared to vermicompost. Thus, we can conclude that biochar not only can mitigate the adverse effect of water deficit environment by increasing the water availability for plant uptake but also can aid sustainably in increasing C sequestration and soil fertility under rainfed wheat cultivation.

Key words: *Biochar, inceptisols, vermicompost, rainfed, wheat yield*

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NRM- 13

INCREASING CLIMATE UNCERTAINTY AND HILL AGRICULTURE OF NORTH EAST INDIA

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ABSTRACT

The world community has taken climate change in a very serious way and consensus resolutions are being taken up by the countries to tackle it through various short and long term adaptation and mitigation measures. Though climate change is a natural phenomenon, but the present rapid phase of change is mostly attributed to the GHG emissions from various anthropogenic activities, including agriculture. IPCC has targeted to limit the rise in global warming below 2°C by 2100 under scenario of RCP 2.6, provided stringent measures to be adopted globally to reduce the emissions. In agriculture sector, the rainfed agriculture is more vulnerable to climate change than the irrigated one. Because of rain dependency, rainfed agriculture is facing maximum damage from the seasonal extreme weather events like floods and droughts, which is already making livelihood from agricultural activities a tough choice. In North East India evidences of climate change is already recorded in ample and from study it was found that the hills are more vulnerable to the adverse affects than the plains. Besides, resource poorness, poor adaptive capacity and lack of appropriate technologies have already brought about a big question of survival and food security in front of the hill farmers. To overcome the situation the FAO recently presented “Agro ecological” approach of farming in COP 23 (November 2017). The FAO emphasized that Agro ecology should be the way to produce enough food for growing population, while protecting natural resources and livelihood and responding to climate change. The integrated farming system (IFS) is a kind of ‘Agro ecological approach’ which has different complementary components, ensures judicious application of natural resources, soil health restoration and bio-resource flow. There by it generates round the year employment to the farming family and guarantee food and nutritional security to a great extent. This is, therefore, considered as one of the most climate resilient and sustainable technologies as in case of failure of one of the components, the others perform to ensure security to the livelihood.

Key words: *Climate change, Integrated farming system, Agro ecological approach, North East India, Hill agriculture*

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NRM- 14

**GROWTH AND YIELD RESPONSES OF FRENCH BEAN-RICE CULTIVATION IN
TRADITIONAL AND ALDER-BASED *JHUM* AGRO-ECOSYSTEM**

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ABSTRACT

Shifting cultivation or *Jhum* cultivation (slash and burn agriculture) is still in vogue in various countries of the world. An area of forest is manually cleared and the cut vegetation debris burned for agriculture. After a short cropping on the hill slope for a year or two are followed by abandoning the land as fallow for some years for regeneration of natural vegetation (fallow phase), then the cycle is repeated. At least 10-20 years fallow lengths are necessary to prevent soil erosion, loss of soil fertility and water balance, and allow forest regeneration to conserve biodiversity and ecosystem stability. However, due to increasing population, the fallow length phase has been compromised 3 to 8 years.

Two *Jhum* agroecosystems i.e. Alder (*Alnus nepalensis* D. Don) tree growing *Jhum* (Atmospheric Nitrogen can be fixed by Frankia with symbiotic relation with this tree) and Traditional *Jhum* (common trees growing) with different *Jhum* fallow lengths of 2, 4 and 8 years has been selected in Kohima, Nagaland. Collection of litters and soil sampling has been done on before and after burning the *Jhum* fallows. After burning, the soils have been collected in the form of bulk for conducting a pot experiment. First, French bean has been cultivated and then rice, with four treatments (five replications) i.e. Control, *Jhum* inhabited microbial consortium (MC), Alder leaf biomass (ABL) and MC+ABL (total pot 120 nos.). Soil and plant samples have been analysed (intermediate and harvesting stage) and Physiological and yield data have been recorded. Among them, combination of microbial consortium and Alder leaf biomass treatment has been found for highest yield in both French bean and rice cropping in 4-year Alder based *Jhum* fallow soil. The respective soil samples have been analysed for physical, biological and chemical properties. Litter, crop biomass and grain samples have been characterized for tissue Nitrogen, Phosphorus and Potassium content and nutrient uptakes. Overall 4-year Alder based *Jhum* fallow soil have been found to be superior in terms of root nodule formation in French bean, higher nutrient mineralization and biological activity. The study of these nutrient cycling and crop yields has been to understand coexistence of forest and sustainable food production in short duration of *Jhum* system and restoring soil health of this south east Asian forest areas.

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CONSERVATION OF AGRICULTURE FOR NATURAL RESOURCE MANAGEMENT

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ABSTRACT

The long term field trails (more than 15 years) were carried out under different resource conservation technologies (RCTs) at research farm of Indian Institute for Farming Systems Research, Modipuram, Meerut (UP) to evaluate the different natural resource management under rice-wheat system. The observation has been recorded for beneficial in terms of soil health, improving soil water ability, moisture conservation, and soil infiltration rate, soil physical parameters as mean clod weight diameters, soil organic carbon and soil microbial carbon. Energy output: input ratio was 24% higher in ZT, 15 to 4% higher in all the methods except DS, CS and BS, where it was 3 to 10% lower, compared to HT (4.73). The water use was 35% lower in bed planting (BP); 3 to 9 per cent lower in all other methods resource conservation technologies except conventional sowing (CS), where it was 3 to 5% higher, compared to hand transplanting (HT) (214 ha-cm). The infiltration rate was maximum in BP (87 mm day⁻¹) and lowest (39 to 43 mm day⁻¹) in the three transplanting methods because of paddling. The zero till drill (ZT), Strip till drill (ST), rotary till drill (RT) and bed planting (BP) of rice saved time (87 to 84%), labour (85 to 81%), diesel (86 to 60%), cost (81 to 63%), energy (86 to 61%) and also irrigation water (8 to 36%) as compared to conventional sowing. The effect of different resource conservation technologies on soil organic carbon (OC), mean weight diameter of aggregates (MWD) and percent change in OC and MWD revealed that there was an improvement in soil properties by the use of these drills. Zero till drilling resulted in maximum moisture content at all the growth stages of crop, minimum cone index and bulk density, and maximum OC and MWD than any other method. Bed planting, and zero and strip till drilling improved soil organic carbon (15-39%) whereas rotary till drilling and conventional sowing reduced OC (2-13%) after fifteen crop cycles. Bed planting, and zero and strip till drilling also improved mean weight diameter of aggregates, MWD (18-72%), whereas rotary till drilling and conventional sowing reduced MWD (13-20%) after fifteen crop cycles. Crop residue recycling and burning improved soil organic carbon, SOC (43 and 11%) whereas retrieval decreased SOC (11%) compared to initial values after fifteen crop cycles. The recycling also improved SOC (22 and 15%) compared to retrieval and burning treatments. Crop residue recycling improved mean weight diameter of aggregates, MWD (15%), whereas retrieval decreased MWD (5%) compared to initial values after fifteen crop cycles.

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NRM- 16

**AN APPROACH FOR ALTERNATIVE LAND MANAGEMENT SYSTEM AND SCOPE OF
WATER HARVESTING IN DORIKA WATERSHED OF ASSAM, INDIA**

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ABSTRACT

The present investigation was undertaken to study the alternative land management system by preparing land use plan for Dorika watershed of Sivasagar District in Assam based on soil site suitability evaluation of crops. The area coverage of this watershed comprises between 26°48' to 27°03' N latitude and 94°27' to 94°52' E longitude. The watershed boundaries were delineated based on Survey of India toposheet (1:50,000) no. 83J/13, 83J/9, 83J/12 and I/8 and R2 L4 MX Remote sensing data. Generally, the soils under this watershed were found to be strongly acidic, high organic carbon content, low in CEC, medium to high base saturation and texture varies from coarse to fine texture. Soil pH, Drainage and nutrient constraints were the limiting factors for potential utilization of the land resources. Soil site suitability of crops was evaluated for crops such as rice, mustard, potato, tea etc. Several crops are recommended depending on their suitability for the post rainy season in the soils which are kept fallow in the present land use system. Rice is the main crop under this watershed and cultivated during the rainy season due to imperfect drainage though the soils are moderately and marginally suitable. In present study, it was observed that low precipitation in early crop growth stage or growing cycle during *rabi* crops is one of the major constraints. To deal with such situations or dry spells, for cultivation of *rabi* crops, it becomes necessary to harvest rainwater in water harvesting structures for life saving or supplementary irrigation. So, harvesting or storing of rainwater appears to be an alternative proposition. On the basis of remote sensing data and ground truth of river water courses, three nos. of water harvesting structures on Dorika river have been proposed. Considering suitability criteria, site specific cropping plan for different seasons were prepared. The study also covers identification of water harvesting structure at suitable sites; out of three feasible water harvesting structure identified, one water harvesting structure could store approximately 11.61 hectare meter of water which can provide life saving irrigation during *rabi* seasons for an area of 193 ha land for potato/ rapeseed, 232.2 ha for cabbage, 77.4 ha for tomato/ direct seeded ahu rice and 50.4 ha for transplanted ahu rice. Results of this study revealed that the study area under rice fallow cropping system could be modified into double cropping system with the use of proper fertility management and life saving irrigation.

Key words: *Land use planning, soil site suitability, watershed, water harvesting structure*

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NRM- 17

**STUDY OF RELATIONSHIPS BETWEEN THE PLANT PHYSIOLOGY AND SOIL MOISTURE
OF LARGE CARDAMOM IN SIKKIM, INDIA**

Deependra Rai

ABSTRACT

Moisture content of required amount in soil is essential for plant growth. Similarly determining the physiological properties of plant related with soil moisture is also one of the important parameters. The present research has carried out to find the relationship between plant physiology and soil moisture content of large cardamom for understanding the growth stage and production value. Large cardamom is one of the major cash crops of Sikkim. For determining plant physiology of large cardamom, estimation of chlorophyll content and stomata index were done. The finding shows that both the stomata index and chlorophyll content of plant is dependent with moisture content. It also indicated that the increase in moisture content increases chlorophyll content and stomata index value. Since, Sikkim having undulating terrain, distribution of rainfall is not uniform throughout the state and most of the people perception is that, state received sufficient amount of rainfall for which there is no need of irrigation requirement.

Keywords: *soil moisture, chlorophyll content, stomata index, soil moisture stress, irrigation requirement*

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NRM- 18

**HOW CAN SUSTAINABLE EXPLORATION AND EXPLOITATION OF WATER FOR
LIVESTOCK FARMING BENEFIT NE REGION?**

Arup Kr. Sharma

ABSTRACT

With the rise of global warming and climate change, water, the buffer of the planet which created life in earth has incredible perspective property of cooling. The article baseline climate, watersheds, water resources and aquatic ecosystems as focus of mystery and mythology, religion and art, science and philosophy and mastery and introspects water led public health as responsible catalyst of human civilization. The plenty or paucity of water has proved many ancient civilizations wiped out in history. The trend of urbanisation followed by expansion of food and industrial activities had given rise to explore land and ground water as source of energy. Rapid expansion and growth of global economy e.g. production and consumption of animal products has put pressure on water use and sustainability. The present article views water crisis is largely a crisis of governance (World Water Development Report 2003) and emphasised crucial need of water resource survey in estimating relevant and reliable statistics for monitoring resource potential and utilisation and strategic planning with centrality in water.

Referring diversified NER blessed with variety in human, plant and animal, it observes mismatched utilisation of resources including man animal conflicts. The organization of NERALM, NE SAC AAU, CAU ICAR, IIT, IIM, empowered NER with capabilities to continuously sample landbase and space base RS images from satellite. With knowledge base economy, sharing of digitized data on land, watershed and climate and epidemiology is a stepping stone. With passage of advancement and challenges, Look East Policy, Act East Policy, Second Green Revolution, Blue as well as White Revolution and Doubling Farm Income etc., the ground truth and space methodological expertise finds further special relevance and potentiality for sustainable eco-friendly precision soil, water, climate, crop, livestock and fish farming, wildlife and forest conservation with balanced food fodder fibre and water consumption to human plant and animal. Thus, the study rationally wraps up that remote NER needs water shed planning for empowering remotely disadvantaged.

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THEME - 5

GROUND WATER, WATER QUALITY AND
ECO-RESTORATION

GWWQER- 01

ECO-RESTORATION OF COALMINE AND OIL AFFECTED ENVIRONMENT

HP Deka Boruah

ABSTRACT

In the recently concluded 7th World Congress on Ecological Restoration, it was disseminated that the world is entering an “Ecological Restoration Era”. The reason behind the declaration was that in the present centuries the Governments across the globe making impressive commitments towards restoration of degraded environment. The strategic momentum of restoration ecology at regional-National and Global level was the resolve taken on the short term action plan on Ecosystem Restoration of the Convention on Biological Diversity, the 2030 United Nations Sustainable Development Goals and the Paris Agreement on Climate Change. In consequence each nation declared their intended commitments towards reduction of global emission on Climate Change. India’s intended declared commitment towards Global Climate Change were 30-35% by 2030 of the GDP and tried to substantiate to its maximum possible extent by restoring the identified forest habitats as well as restoration of degraded environment / industrial wasteland. At local level we are trying to address the possible measures to be adopted for early re-cloth of the coal mine and oil explored affected environment by integrated biotechnological approaches. It was observed that in coal mine environment particularly opencast mining the foremost affect were habitat and landscape alteration. Mining also creates artificial OB dumping grounds and subsidence mining materials. The siltation affect were also evident in the low lying areas. The mine affected substrate loss true soil behaviour with characteristics low pH, above threshold limit of trace and heavy metals; also contaminate neighbouring low lying areas by metal mobilisation. In contrast to coal mine substrate, abandoned drill sites and oil contaminated sites of surface exploration in upper Assam, are filled up with Oil drilling chemicals, sludge and crude oil etc. Here the pH of the soil and water are basic in nature (pH >7.0). Both the cases the microbial activities are low. To revive such coal mine and oil affected environment we have standardise the restoration methodology where both native microbe and plants were utilised. To treat the affected water for safe disposal microbial treatment process were developed where the microbes utilize the oil and transformed to non toxic form. The methods adapted to re-cloth/recover of oil and coalmine degraded environment are sustainable and impact are enormous.

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GWWQER- 02

**FATE OF OVER 480 MILLION INHABITANTS LIVING IN ARSENIC AND
FLUORIDE ENDEMIC INDIAN DISTRICTS: MAGNITUDE, HEALTH, SOCIO-ECONOMIC
EFFECTS AND MITIGATION APPROACHES**

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ABSTRACT

During our last 27 years of field survey in India, we have studied the magnitude of groundwater arsenic and fluoride contamination and its resulting health effects from numerous states. India is the worst ground-water fluoride and arsenic affected country in the world. Fluoride results the most prevalent ground water related diseases in India. Out of a total 29 states in India, groundwater of 20 states is fluoride affected. Total population of fluoride endemic 201 districts of India is 411 million (40% of Indian population) and more than 66 million people are estimated to be suffering from fluorosis including 6 million children below 14 years of age. Fluoride may cause a crippling disease. In 6 states of the Ganga-Brahmaputra Plain (GB-Plain), 70.4 million people are potentially at risk from groundwater arsenic toxicity. Three additional states in the non GB-Plain are mildly arsenic affected. For arsenic with substantial cumulative exposure can aggravate the risk of cancers along with various other diseases. Clinical effects of fluoride includes abnormal tooth enamel in children; adults had joint pain and deformity of the limbs, spine etc. The affected population chronically exposed to arsenic and fluoride from groundwater is in danger and there is no available medicine for those suffering from the toxicity. Arsenic and fluoride safe water and nutritious food are suggested to prevent further aggravation of toxicity. The World Health Organization (WHO) points out that social problems arising from arsenic and fluoride toxicity eventually create pressure on the economy of the affected areas. In arsenic and fluoride affected areas in India, crisis is notal ways having too little safe water to satisfy our need, it is the crisis of managing the water

Keywords: *Magnitude of fluoride and arsenic, contamination, Health effects, Affected children, Social issues, Socio-economic problem, Approaches for mitigation*

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GWWQER- 03

**A LABORATORY SYNTHESIZED MATERIAL OF COMPOSED METALS DISPERSED ON
CARBON SUPPORT AS ADSORBENT FOR REMOVING ARSENIC FROM AQUEOUS
SOLUTION**

Mridul Chetia¹ & Upendra Nath Gupta²

ABSTRACT

Arsenic (As) in drinking water and its related toxicology are serious concerns nowadays. Development of better techniques related to removal of as from drinking water is an urgent need. A laboratory synthesized material of composed metals dispersed on carbon support as adsorbent for arsenic removal from aqueous solution can be considered as a good adsorbent for the removal of toxic Arsenic from water. From Batch experiment it has been observed that 100mg of the synthesized material can remove 82% arsenic from 500ppb stock solution of arsenic when exposed to a time period of 90 minutes at rpm 100 and pH 7.0. Due to easy availability, low cost carbon source and the metals non toxic in nature makes this material as a good adsorbent for arsenic removal from water.

Key Words: *Arsenic, adsorbent, removal, composed metal*

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GWWQER- 04

**GROUND WATER LEVEL AND SURFACE RUNOFF TREND ANALYSIS IN SHIPRA RIVER
BASIN IN MP**

R.V. Galkate¹ & R.K. Jaiswal

ABSTRACT

Shipra is one of the important and sacred rivers in Malwa regions of Madhya Pradesh. The river experiences very high water demand especially during Kumbhmela organized periodically at Ujjain. It is reported that the Shipra River was earlier of perennial nature up to late seventies then it changed its nature and became intermittent. It has risen concerned over urgent action for rejuvenation of Shipra. Present study aims at assessment of declining of flow regime in Shipra River with the help of trend analysis of ground water and surface runoff data. The long term runoff data of Ujjain station from 1985 to 2012 was analyzed to identify long term trend in dependable flow using non-parametric Mann-Kendall test. The ground water data was analyzed to identify trend and attempts were made to find the relation between ground water regimes in Shipra basin with declining river flow in river.

Mann-Kendall test results indicated the declining trend for dependable river flow at various probability levels during the beginning and end of monsoon months at Ujjain however rising trend was evident for very short period during mid monsoon. To compare the results of declining river flow in Shipra with the ground water status of the area in basin a trend analysis of ground water levels data was carried out. For this purpose the observations wells falling in 5 km distance from the river course in upstream area, middle area and downstream area were identified. The groundwater level data of such 15 wells from 1984 to 2014 was analysed to assess the trend in pre-monsoon and post-monsoon period at selected wells in the basin. The results indicated that the ground water levels in the Shipra basin upstream has shown falling trend at all the individual well locations and even when regionalized, the falling trend was observed at upstream area, middle area and downstream area in the basin. Declining of ground water levels was found higher in middle area of the basin where important cities like Indore and Ujjain are located. The trend analysis of ground water and surface runoff in the river basin may be useful to derive information and to formulate strategies for river system rejuvenation and management.

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GWWQER- 05

**REVIEW ON NORMS AVAILABLE FOR EVALUATION OF GROUNDWATER FOR
IRRIGATION PURPOSE**

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ABSTRACT

The water quality used for irrigation is essential for the yield and quantity of crops, maintenance of soil productivity, and protection of the environment. Irrigation with poor quality waters may bring undesirable elements to the soil in excessive quantities affecting its fertility. The long-term application of moderate quality water in poorly drained land may accumulate high quantity of salts in agricultural land which may harm plants' growth and productivity. Water quality is influenced by natural and anthropogenic effects including local climate, geology and irrigation practices. Once undesirable constituents enter the ground, it is difficult to control their dissolution. To cope up with such problems, the information concerning the quality of irrigation water and its effect on soils and crops is necessary. India accounts for 2.2% of the global land and 4% of the world water resources and has 16% of the world's population. Intensive agricultural activities have increased the demand on water resources in India. Therefore, water quality issues and its management need to be given greater attention. Hence, different norms available for evaluating the suitability of groundwater for irrigation purpose on the basis of electrical conductivity (EC), total dissolved salts (TDS), magnesium hazard (MgH), sodium percent (SP), U.S. Salinity Laboratory (USSL) classification, sodium adsorption ratio (SAR), permeability index (PI), residual sodium carbonate (RSC), etc. are reviewed and discussed.

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GWWQER- 06

VARIATION IN GROUNDWATER QUALITY AND ITS MAPPING USING GIS

S.R. Kumar

ABSTRACT

GIS is one of the most important tools for integrating and analyzing spatial information from different sources or disciplines. It helps to integrate, analyze and represent spatial information and database of any resource, which could be easily used for planning of resource development, environmental protection and scientific researches and investigations.

GIS not only provides tools for interpolating measured values of groundwater quality parameters from specific locations, but also enables one to link groundwater quality with landuse, soil characteristics, and other relevant information. In addition, GIS provides sophisticated map-generation capabilities, useful in communicating results of data analysis. GIS can also be used to describe associations between groundwater quality and both geogenic and anthropogenic activities in the world.

The GIS assisted database system could help to apply groundwater management practices such as; proper groundwater resource management in terms of groundwater quality & quantity, integrated management of water, landuse and the environment; to optimize pumping rates with respect to the capacity of the aquifer system, and to prevent groundwater quality deterioration through proper monitoring & evaluation.

In the present study, different water quality maps using GIS have been prepared to check the location specific suitability of groundwater of Tezpur, in Assam valley of Brahmaputra Basin for its drinking, domestic and irrigation purposes. Data for this study is based on the fieldwork. The produced groundwater quality maps could help as information source to researchers, groundwater practitioners and decision makers etc.

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GWWQER- 07

**CLIMATE CHANGE EFFECTS ON GROUNDWATER RECHARGE AND YIELD IN THE
NORTH-WEST REGION OF BANGLADESH**

M. S. Sheik¹ and D. Islam²

ABSTRACT

Over the last three decades, groundwater resources in the northwestern dry Barind region have been excessively exploited to irrigate high water demanding *Boro* rice crop therein. This leads to a declining trend of groundwater level (GWL) in the region and many past studies reported that recent annual drops in GWL are not being naturally replenished. Therefore, a research study was conducted in three selected sites of Barind region namely, Bagmara, Mohadevpur and Nachole upazila to estimate recharge potentials and safe yields of the underneath aquifers; and, to project the likely impacts of climate change on recharge to those aquifers. Two different recharge estimating approaches (i) GWL fluctuation and (ii) soil moisture accounting method embedded in the Hydrologic Modelling System (HEC-HMS) model were employed in this study.

It was found that rainfall is strongly correlated with groundwater recharge estimated by both GWL fluctuation (correlation coefficient = 0.61) and HEC-HMS (correlation coefficient = 0.83) models. The studied aquifers are mainly get recharged during June – October and about 23 – 70% of annual rainfall can be converted into groundwater recharge. Safe yield analysis shows that both unconfined Mohadevpur and Bagmara aquifers are no longer suitable for further exploitation whereas the confined aquifer underneath Nachole upazila has still the potentiality to provide useable groundwater. The build HEC-HMS model was run with future climate forcing's generated by the two Global Climate Models (GCM), GFDL-CM3 and MIROC-EMS, participated in the latest IPCC's CMIP5 project. Compared to the baseline period (1981 – 2000), an increased mean monthly rainfall (up to 60 mm per month) was projected during June – August in the future 2021 – 2040 period. Moreover, the studied areas are projected to experience consistent increased temperature for all calendar months (maximum increase 2.9 °C). Projected increasing rainfall and decreasing evapotranspiration altogether increase groundwater recharge (maximum 90 mm per month) of the aquifers for the future 2021 – 2040 period. Such blessing impacts of climate change will help conserve the country's groundwater resources.

GWWQER- 08
A STUDY ON QUALITY OF BRAHMAPUTRA RIVER WATER AT TEZPUR

Sanjib Gohain

ABSTRACT

Living organisms, more specifically human beings are one most important part of the ecosystem that carries the tag of being most intellectual, interacts with the environment with the pen in their dairies. Humans make use of developed science and technology to exploit the environment for obtaining food, water, fuel, medicines, building materials and many other things for their benefit. They are always so obsessed and possessed of industrial growth and making life easier that many times it has touched ground water and has undergone many ramifications and diversions in quality concern. Thus in the present study an attempt was made to check the quality of the Brahmaputra river water when it pass by Tezpur. Water sample was collected from the river bank near Agnigarh at Tezpur and tested against seven parameters viz. Alkanity, Chloride (Cl), Fluoride, Total Hardness, Iron (Fe), pH value and Turbidity. The result signifies that water is more turbid with all above parameters normal as per limits of BIS.

Keywords: *Alkanity, Total Hardness, Chloride, Fluoride, Iron, pH, Turbidity, BIS*

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GWWQER- 09

**GROUNDWATER ASSESSMENT, DEVELOPMENT AND MANAGEMENT IN THE
STATE OF TRIPURA**

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ABSTRACT

Tripura is the one of seven sisters in the North-eastern part of India. Its Geographical area is 10,491.69 sq.km and area covered by hilly terrain is 5960 Sq. Km. There are 10 major rained perennial rivers present in the state. The average annual rainfall in this State is 2116 mm. During summer, the rivers maintain very slender flows, but in rainy season they carry appreciable flows by ephemeral nature flashing directly to Bangladesh. The semi-consolidated Tipam formation consisting of friable sandstone, sandy shale etc. of Tertiary age forms the principal aquifer of the area. Groundwater development in the deeper aquifers has also been established through construction of deep tube wells. State Govt. departments have constructed thousands of deep tube wells. Agartala city is developing and growing with the capacity to become the gateway of North-East to South East Asia through an international link. However, it is already facing some scarcity of water during non-monsoon season. Again demand of irrigation in the agriculture sector is increasing day by day. Groundwater is a replenish-able but finite resource. Groundwater resource comprises of two parts-dynamic which reflects seasonal recharge and discharge of aquifers and static resource below water table. Aside from the aquifers of the active recharge zone which get charged every year and which constitute the dynamic fresh groundwater resource, there are deeper aquifers below the zone of water level fluctuation. These deeper aquifers of passive recharge zone contain vast quantity of water. The water in these aquifers has accumulated over hundreds of years. This water is often called 'static' water though in reality it also flows but very slowly. In Tripura, rainfall is the principal source of recharge, though in some areas return flow from irrigation also contribute significantly to the groundwater recharge. It is utmost important to estimate ground water resources as accurately as possible for planning and sustainable management of this valuable resource. This paper deals with block wise estimation of ground water resources from both shallow and deeper aquifers in Tripura for sustainable management.

Key words: *Tripura, Groundwater, Resources, Aquifers, Sustainability*

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GWWQER- 10

**DUG WELL IRRIGATION – POSSIBILITIES AND IMPACT IN AGRICULTURE OF RI BHOI
DISTRICT, MEGHALAYA, INDIA**

T Chakraborty and S Kent

ABSTRACT

Meghalaya is a small state located in NE India. Meghalaya is basically a hilly state with rolling hill ranges, tablelands and narrow ravines. Meghalaya Plateau is the north-eastern extension of the Indian Peninsular shield. Meghalaya plateau has undergone several geotectonic and structural deformities to attain the present configuration and altitudes of about 150 to 1965 m above Mean Sea Level. RiBhoi district located in the central part of Meghalaya (part of Khasi Hills) lying between E 91°20'30" and E 92°18'00" Longitude and N 25°38' to N 26°06' Latitude, having an area of 2448 sq km, comprises of highly dissected hills and narrow limited valleys with moderate slopes. The district experiences sub-tropical to humid climate. The perusal of the average rainfall distribution pattern in the state indicate that the southern parts of Meghalaya like Mawsynram and Cherrapunjee receives heavy rainfall when compared to northern parts like Byrnihat in RiBhoi district. The district bestowed with the modest average annual rainfall of about 1700 mm, but still faces water scarcity during summer months, as the rivers are seasonal and majority of the springs dry up during summer season. Soil profile is relatively thick in intermontane valleys, gullies and low lying areas. Meghalaya state government is developing surface water resources for minor irrigation schemes. Ground water irrigation is absent in the district. The district is having good ground water reserve but ground water development in the district is very limited. The reasons are lack of reliable information about the availability of ground water resources, poor and marginal farmers, Govt. schemes focussing only in surface water sources etc. To provide vital information about the ground water resources, Central Ground Water Board (CGWB) has recently taken up Aquifer Mapping and Management studies in parts of the district. This study has revealed the presence of prolific deep seated fractured aquifers in the valleys. Though irrigation through bore well is possible but due to terrain conditions, movement of heavy machines, like drilling rigs for construction of bore well, to some small intermountain valleys will be difficult. Under these conditions, to utilize the untapped ground water resources available, to grow the second crop, dug well irrigation will be the key. This paper deals with the possibilities of dug well irrigation and would be impact rural society especially in agriculture sector of the district.

Key words: *Groundwater, Possibility, Dug well, Irrigation, Impact*

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GWWQER- 11

CO-CONTAMINATION PERSPECTIVE OF ARSENIC WITH FLUORIDE AND ASSOCIATED HEALTH RISK IN LAKHIMPUR DISTRICT IN THE UPPER BRAHMAPUTRA FLOODPLAIN

Ritusmita Goswami¹, Ritu Thakur², Manish Kumar¹

ABSTRACT

Arsenic (As) and fluoride (F⁻) are geogenic contaminants and reported to be hazardous for human health. Co-contamination perspective of these two elements is poorly understood. The present study was carried out to understand the co-occurrence of As and F⁻ in the groundwater of Lakhimpur district, Assam, situated in the upper Brahmaputra floodplain. An attempt was made to evaluate the potential processes for As and F⁻ mobilization and enrichment in the groundwater. The future scenario was predicted by calculating saturation index using MINTEQA2. The results showed a wide variation in the concentration of As (0.01-300 µg L⁻¹) and F⁻ (15-660 µg L⁻¹). The occurrence of As and F⁻ was mostly observed in Ca-HCO₃⁻ rich water along with positive correlation between Ca²⁺ and F⁻ (r = 0.4). The initial release of As and F⁻ from the parent rock might be driven by the both natural as well as anthropogenic activities, while their mobilization depends on chemical interactions and individual affinities of the elements within the aquifers. Negative saturation index of various minerals highlight possibility of further release of As and F⁻ into the groundwater. The health risk assessment done by estimating hazard indices (HI) among population groups and genders showed HI >1 for both male and female suggesting that the residents in the study areas might confront more significant adverse non-carcinogenic health impacts along with cancer risk.

Keywords: *Groundwater, Arsenic, Fluoride, Co-occurrence, Saturation Indices, Health Risk*

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GWWQER- 12
SIMULTANEOUS REMOVAL OF TYLOSIN (TY) AND *p*-CRESOL WITH THE HELP OF
RECYCLED MnO_2 AND CABS

Payal Mazumder¹, Jaehong Shim², Ajay Kalamdhad³, Manish Kumar⁴

ABSTRACT

A study was carried out using composite alginate beads (CABs) containing MnO_2 and Activated Carbon (AC) prepared for the removal of veterinary byproducts Tylosin (TY) and *p*-cresol compounds from swine wastewater. CABs were obtained from alginate beads mixed with AC and MnO_2 recovered from battery waste water. Characterization of CABs was carried out using FE-SEM, FTIR and XRD which have shown the morphological properties of CABs and its capacity to remove compounds like TY and *p*-cresol. BET and Langmuir surface area analyses were done to study the surface porosimetry of CABs which showed an increase in the surface area after incorporation of MnO_2 and AC. TY and *p*-cresol removal efficiency of CABs were studied at different pH, temperatures and agitation time to understand their effect on the removal percentage. Removal of TY and *p*-cresol was found to be dependent on the initial concentration of the compounds and the contact time for the reaction. Parameters of kinetic studies suggested that both the TY and *p*-cresol removal followed pseudo-second order kinetics and the adsorption isotherm results were best fitted with Langmuir model. Reusability study of CABs revealed that it possess high reusability capacity even after 5th regeneration cycle which makes it a promising adsorption material for the removal of compounds like TY and *p*-cresol.

Keywords: CABs, MnO_2 , Activated Carbon, Tylosin, *p*-cresol, Adsorption kinetics

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