National Seminar
on

Recent Trends in Geospatial Technology for Environment and Health

For Post-graduate Students and Research Scholars

March 24, 2022

Dehradun

ABSTRACT VOLUME

Jointly organised by

Indian Institute of Remote Sensing, &

Indian Society of Remote Sensing - Dehradun Chapter

Hosted by

Indian Institute of Remote Sensing, Indian Space Research Organisation

Department of Space, Govt. of India, Dehradun

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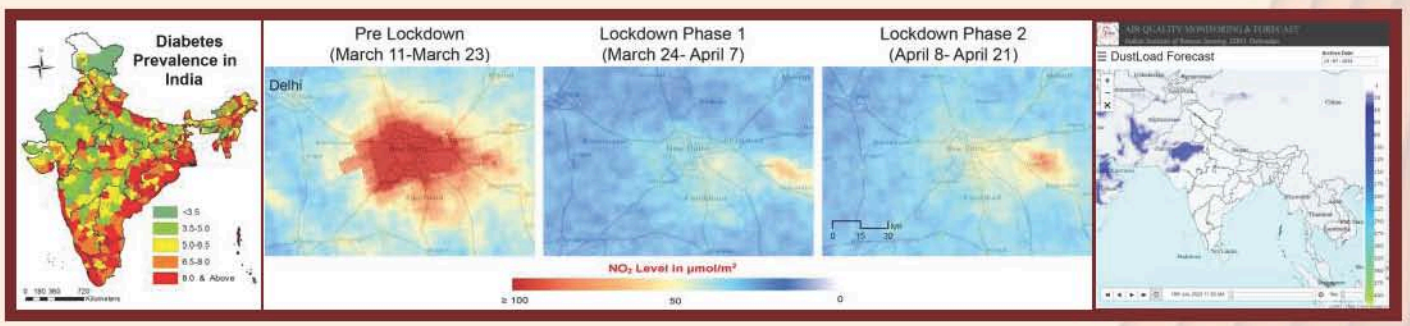

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Indian Institute of Remote Sensing (IIRS)

Indian Society of Remote Sensing-Dehradun Chapter (ISRS-DC)

Dr. Prakash Chauhan

Director, IIRS and CSSTEAP; Chairman, ISRS-DC (2020-22)

FOREWORD

It is with deep satisfaction that I am writing this foreword to the Abstract Volume of the National Seminar for PG students and Research Scholars on ***"Recent Trends in Geospatial Technology for Environment and Health"*** jointly organized by Indian Institute of Remote Sensing (IIRS) and Indian Society of Remote Sensing - Dehradun Chapter (ISRS-DC) on March 24, 2022. It is a unique initiative where the Institute (IIRS) and the society (ISRS-DC) have come together to facilitate the young researchers to share, learn and gain experience in hybrid (online and offline) mode. It has provided a forum where Post Graduate students and Research Scholars will be given an opportunity to share their research work with the peers and furthermore to gain knowledge through interaction with experts in their discipline. The participants would benefit by exposure to opportunities in geospatial technology and applications in the light of new challenges brought about by rapid urbanization, depleting natural resources, climate change, disasters and epidemics.

I am hopeful that the research abstracts contained in the Abstract Volume shall be helpful for better understanding of the Earth and its environment; and to devise suitable solutions using Geospatial technologies. It will also encourage young researchers towards understanding the application potential of newer remote sensing data products.

I thank all authors for their interest in submitting their research through abstracts and I wish that the Seminar is a great success.

(Prakash Chauhan)

March 22, 2022

Indian Institute of Remote Sensing (IIRS)

Dr. S. K. Srivastav

Dean (Academics), IIRS

PREFACE

I am extremely happy that Indian Institute of Remote Sensing (IIRS) and Indian Society of Remote Sensing-Dehradun Chapter (ISRS-DC) are jointly organizing the National seminar on **"Recent Trends in Geospatial Technology for Environment and Health"** on March 24, 2022 for the postgraduate students and research scholars. This event will provide an excellent opportunity to young students and research scholars to showcase their research findings to their peers.

An overwhelming response is received within a very short time. I understand that total 123 abstracts in different themes are received from across the country, out of which 103 contributions are accepted for presentation. I congratulate all the authors whose abstracts have been accepted for the presentation in the seminar.

My appreciations to the organizing team for doing a commendable job in bringing out the Abstract Volume in a short time. I am sure that it will serve as a good reference material for innovative research ideas.

I wish all the best for the success of the seminar and fruitful deliberations among the participants and experts working in this domain.

March 22, 2022

(S. K. Srivastav)

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Theme: Geospatial Technology for Water Resources

Urban Heat Island and its Relationship with Fog Hole in the Indo Gangetic Plain

Shailja Mamgain, Kshama Gupta, Pooja Jindal, Arijit Roy, Harish Karnatak, Prakash Chauhan

Indian Institute of Remote Sensing, Dehradun

Fog formation is a quite common phenomenon in the Indo- Gangetic plains of India during the winter season. It generally starts from the November and continues till February having maximum frequency and intensity in the month of December and January. It results in the low visibility which causes disruption in the aviation services, difficulty in transportation and eventually leads to accidents. A study by Gautam et al., 2018, has highlighted the formation of holes in the fog over the urban areas such as Delhi, Ludhiana, and Patiala etc which impelled the present study. In this study, the fog over the Indo- Gangetic plain was retrieved and analyzed from 15th December, 2021 to 23rd January, 2022 using the daily data of MODIS (Aqua and Terra). MODIS channel 22 and 31 were used for the night time fog detection using Brightness Temperature Difference technique. Out of these 40 days, fog hole was observed on nine days i.e. 17th December, 2021, 5th January, 10th January, 11th January, 13th January, 14th January, 17th January, 18th January and 20th January, 2022. The analysis was focused on the Delhi- NCR by making 10 km buffer around Delhi. These fog holes were correlated with the built-up density, Land Surface Temperature (LST) and the night light data. MODIS LST, VIIRS Nighttime Day/Night Band Composites data and built up data from GHSL (Global Human Settlement Layer) were used. Optimized Hotspot analysis was done by calculating Getis-Ord Gi* statistic of built- up and land surface temperature and overlaid on the fog hole image to observe the relation between the fog hole extent and the hotspots of land surface temperature and built- up area. This study concludes that there is a possible linkage between the formation of fog holes and the Urban Heat Island phenomenon but the pattern is not visible constantly during entire winter season and hence further analysis is required to identify other factors which are responsible for the formation of fog holes over these areas.

Sea Surface Signature of Extreme Indian Ocean Dipole Events using Remote Sensing

Amit Kumar Jena, Sachiko Mohanty

Indian Institute of Remote Sensing, Dehradun

The sea surface signature of extreme positive (2019) and negative (2016) Indian Ocean Dipole (IOD) events are analysed using temperature, salinity, rainfall, wind, current, and chlorophyll over the tropical Indian Ocean (IO). The extreme positive IOD event is characterized by warm sea surface temperature anomaly, enhanced convection, higher sea level, excess rainfall and less salinity along the western equatorial IO and cooler sea surface temperature anomaly, supressed convection, lower sea level, deficit rainfall and increase salinity along eastern equatorial IO. The reverse pattern is observed during negative IOD event. The anomalous wind along the Sumatra coast causes strong coastal upwelling during positive IOD event, which enhances the chlorophyll concentration and hence marine ecosystem. The variability of Kelvin wave and their propagation associated with extreme positive and negative IOD events are observed from altimeter derived sea surface height anomaly data. Easterly and westerly anomalous wind trigger an upwelling equatorial Kelvin wave and downwelling Rossby wave during the positive and negative IOD events respectively.

Development of AOD Retrieval Tool for OCEANSAT-2 Data Over Land

Anushree Jain, Manu Mehta

Indian Institute of Remote Sensing, Dehradun

AOD retrieval through satellite data over land can be done using decoupling of at-sensor signals into various components like surface reflectance, aerosol reflectance, and Rayleigh reflectance, which requires solutions to radiative transfer models. There have been various remote sensing algorithms developed to calculate AOD retrieval for different sensors like MODIS, MISR, CALIOP, etc; these algorithms are tailored for specific datasets and sensors. In this paper, AOD retrieval tool made for the OCEANSAT-2/OCM dataset is illustrated. The algorithm used in the tool is a simple physics based algorithm that is dependent on the estimation of input parameters like surface reflectance, asymmetry parameter, and single scattering albedo. The solution for AOD is calculated using stepwise iteration. Furthermore, deep blue bands 412 and 443nm are utilized to calculate AOD at 550nm using Angstrom law. The tool is built using python on PyQt and Pyinstaller. The functionality of the developed tool is such that it does pre-processing, estimation of input parameters, and AOD calculation, along with an interactive tab to check sensitivity analysis of the algorithm. The outputs from the tool are AOD at 412, 443, and 550nm and Angstrom exponent.

Estimation of Urban Energy Fluxes using Earth Observation Data

Manushi Miteshbhai Bhatt, Kshama Gupta, Abhishek Danodia

Indian Institute of Remote Sensing, Dehradun

The modification in quantum of sensible heat, latent heat and ground heat flux in urban area due to rapid urbanization alters urban energy balance. Anthropogenic heat emissions further modifies the energy balance in urban areas and can be attributed to three main sources such as human metabolism, transportation emissions and emissions from the buildings. Therefore, the study aims to estimate and evaluate urban energy fluxes using earth observation dataset for the city of Delhi and its surrounding areas. Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) dataset along with ERA5-Land hourly data has been used for computing various parameters like NDVI, surface emissivity, land surface temperature, albedo, shortwave radiation, longwave radiation, etc. that are used in the energy flux estimation. After spatially estimation of net radiation, latent heat flux, ground heat flux and sensible heat flux, the artificial sensible heat flux as residual energy from urban landscape was calculated. The results corroborate with that of other studies and finely depict the built-up areas with the highest anthropogenic heat. Artificial sensible heat flux in the densely populated central part of Delhi and heavy industries exceeded 330 W/sq. m. while the rest of the built-up in the study area displayed flux more than 240 W/sq. m. This assessment of anthropogenic heat flux plays a beneficial role in formulating policies, regulations and action plans related to mitigation and control of heat stress and climate change. Apart from this, the findings also have an important use in urban micro-climate modelling and improved weather forecast modelling. In future research studies, the use of detailed surface roughness parameters for calculating urban energy fluxes has a potential to give improved results.

An Appraisal of the Indian Summer Monsoon System under Future Warming Scenarios

Manali Saha and Charu Singh

Indian Institute of Remote Sensing, Dehradun

This research aims to assess the Indian Summer Monsoon (ISM) using several climate coupled models, including its sensitivity to climate change scenarios. For the investigation of the Indian Summer Monsoon, the monthly averaged datasets of twelve climate coupled models are taken from the Coupled Model Intercomparison Project phase 6 (CMIP6) outputs for the historical period of 1980-2014 and the future period 2065-2100. The model outputs are compared to various ground-based observations, satellite, and reanalysis datasets to evaluate the historical simulation of the models. In addition, robust climatic models were chosen to represent ISM behavior under a warming scenario. The comparison of historical simulations of models with observational/reanalysis datasets reveals differences, however only a few models, such as CESM2-WACCM, MRI ESM2, and NorESM2, best characterized the ISM pattern. This study also found significant inter-model disparities. The statistical analyses used to compare the differences between historical and future warming scenarios indicate that climate change will cause a significant change in the pattern of the Indian Summer Monsoon. As a result, by comparing historical simulations and observations with CMIP6 models, it can be determined that there will be a considerable change in the Indian Summer Monsoon in the future.

Spatio-Temporal Distribution of Heatwaves across India

Laivy Rose Augustine, Arijit Roy, Kshama Gupta

Indian Institute of Remote Sensing, Dehradun

With the rise in global mean temperature, extreme hot events with high frequency and intensity are also increasing. The heatwave, one of the deadliest natural disasters are observed to be significantly increasing over the years putting large population at risk. Traditionally ground-based observations are used widely to study the heatwave patterns, however, it fails to provide the spatial distribution of heatwaves which is mandatory to identify heatwave hotspot regions as well as for mitigation strategies. Hence, this study aims to assess the Spatio-temporal distribution of heatwaves in the Indian sub-continent by employing daily daytime (01:30 pm) MODIS AQUA LST data of March, April, May and June from 2003 to 2021. Seven heatwave indicators covering the Duration, Intensity and Frequency of events has been studied in detail based on the heatwave thresholding criteria of the Indian Meteorological Department (IMD). The analysis shows central and western parts of the country comprising Rajasthan, Gujarat, Madhya Pradesh, and Maharashtra, and parts of Telangana and Andhra Pradesh under 'high to extreme' heatwave hazard regions in India. These regions displayed a trend of long-lasting, high-intensity heatwaves with magnitudes crossing 45°C during the peak summer. Odisha, Jharkhand, Chhattisgarh, Uttar Pradesh, Bihar, Punjab, Haryana, Delhi and parts of Tamil Nadu also fall under moderate hazard regions. The state-wise heatwave vulnerability and mortality list provided by IMD validate the results of this study. North-Eastern states comprising Assam, Meghalaya, Arunachal Pradesh, Mizoram, Manipur, Nagaland, Sikkim, and parts of North-Western Himalayan states consisting Himachal Pradesh, Uttarakhand, Jammu and Kashmir, and parts of Western Ghats on Kerala and Karnataka side reported no or very less events over the years. The results of the study can be used in determining the heatwave hotspots within the states in order to prepare heatwave resilient development plans and policies to reduce its adverse effect on health and livelihood.

Pre and Post COVID-19 Comparison of Air Quality using GEOS

Harshith C Prince, Sneha Mendiratta, Aditi Ahlawat, Shanti Kumari, Arijit Roy

Indian Institute of Remote Sensing, Dehradun

Near Surface Concentrations (NSC) of PM2.5, NOx and SOx are few of the most critical determinants of air quality worldwide. This study aims to compare the variation in NSC of these pollutants using Goddard Earth Observation System dataset before the lockdown in 2019, during the lockdown in 2020 and after the lockdown in 2021. This study is carried out in northern India where high anthropological activities like residue/stubble burning takes place along with other fire events. The analysis is carried out in python environment. Results show that the estimated NSC of PM2.5, NOx and SOx in 2020 present significant variations during different periods of the COVID-19 lockdown in northern India compared to 2019. In addition, the variations in the NSC of PM2.5, NOx and SOx during the COVID-19 lockdown in northern India possibly due to restrictions in the anthropogenic activities.

Simulation of Tropical Cyclone 'Yaas' using the WRF Modelling System

Sukanya Mukherjee, Sanjeev Kumar Singh

Indian Institute of Remote Sensing, Dehradun

A Tropical Cyclone (TC) is the most dangerous meteorological phenomenon, capable of wreaking havoc on human life, property, and urbanization. Therefore, accurate prediction of TC parameters like wind, intensity and rainfall is very much required to prevent loss of life and damage. The present work is focused on numerical simulation of TC Yaas using the Weather Research and Forecasting (WRF) Model. A Very Severe Cyclonic Storm Yaas was a powerful and destructive tropical storm that formed over the Bay of Bengal (BOB) in the year 2021 and had a major impact on West Bengal. In the present study, nested domains have been used to simulate the TC. The parent and nested domains are chosen as 27 km and 9 km spatial resolutions respectively. A automatic moving nested domain algorithm has been used to track the movement of the TC Yaas. Model Initial and boundary conditions are calculated using NCEP-FNL (National Centers for Environmental Prediction-Final Analysis) data with a 1° x 1° resolution. A series of experiments have been conducted from the initial condition of 0000 UTC of each day throughout the life span of TC. The tracks are generated every six hours up to 72 hours from each initial condition. Following that, track and landfall errors were validated against the best track data from the Indian Meteorological Department (IMD). The simulated intensity and rainfall are also compared with IMD and satellite observations. More details will be presented during the conference.

Estimation of Solar Energy Potentials in Western Himalayan Region

Saurabh Verma, Charu Singh

Indian Institute of Remote Sensing, Dehradun

Solar technologies are viewed as feasible options for reducing greenhouse gas emissions and encouraging long-term adaptation in the context of climate change and rising energy demand. Solar energy is India's second-largest renewable energy (RE) source, and it will play an increasingly important role in the country's low-carbon energy portfolio in the future. Jammu and Kashmir and Ladakh are the northernmost states of India, with elevations ranging from 205 to 8564 meters above the mean sea level. Both states are located just south of the Karakorum and having subtropical and cold-arid environment with scarce renewable energy resources. The researchers note that the solar panels at high elevations are more efficient and can produce 20% more energy due to a thinner atmosphere and decreased solar zenith angle, which reflecting less incoming solar radiation from the sun. Moreover, very high mountains, prevailing in India, nudge above the clouds and offer more sunshine hours. The National Renewable Energy Laboratory (NREL) dataset at 10 km horizontal resolution with the one-hour temporal resolution is used to calculate Direct Normal Irradiance (DNI) and Global Horizontal Irradiance (GHI). The monthly variation is shown using MERRA-2 dataset that cover the globe with spatial resolution of 0.5°-0.625°, a temporal resolution of 1- hour, and 72 vertical levels. The findings indicate the availability of high-quality energy potential over the western Himalayas. The long-term annual average demonstrated the high efficiency of GHI and DNI over Leh and Kargil and low over the Jammu region. High value of GHI are found between March to October, varying from 225 to 375 W m-2 and lower during November to February, values are less than 220 W m-2. This study is performed to identify the seasonal variation of solar potentials for near-term climatological future to understand the energy variation over the western Himalayan region.

Spatio-Temporal analysis of Glacial Lakes of Western Himalayas in Chamoli and Pithoragarh Dist of Uttarakhand using Remote Sensing and GIS

Thahira. U, Bulu Basak, Shahid Gulzar

Bharathidasan Univerisity, Tamil Nadu

Remote sensing has a paramount advantage in monitoring fragile ecosystems that are inaccessible for infield investigations. Remote sensing technology provides a spatial-temporal database that can be used to track the dynamics of water bodies. Global climatic change has a substantial impact on the dynamic activities of glaciers and glacial lakes and in turn, affects the surrounding ecosystem. Thus, monitoring and maintaining an updated database about the glacial activity is essential for disaster preparedness. In this study, Spatio-temporal analysis of glacial lakes of western Himalayas in Chamoli and Pithoragarh district of Uttarakhand using remote sensing and GIS was undertaken using Landsat 5, 7, and 8 imagery during 1994,2000,2010,2020. Cloud-free Landsat imagery was chosen for this study. ASTER DEM of 30m resolution, downloaded from USGS explorer (https://earthexplorer.usgs.gov/) was used to understand the topography of the terrain by creating slope, aspect, hill shade, and relief maps. Upon regional analysis after applying NDWI, We chose three glacial lakes that showed significant Spatio-temporal changes in the study area. High resolution google earth imagery -Google earth Pro was used to cross-check the existing features of these glacial lakes. These three glacial lakes showed an increase in their aerial extent from 0.086742 to 0.106037 sq. km (GL_S), 0.11612 to 0.219626 sq. km (GL_G),0.070755 to 0.168089 sq. km(GL_A) in the time period 1994 to 2020. GL_A had a sudden tremendous growth in the interim period from 2010 to 2020 which is a matter of concern and was cited as a very high dangerous lake in many research works. These three glacial lakes have nearly doubled in their area. This progressive growth of the volume of glacial lakes may tend to many disasters like GLOF(Glacial lake outburst floods). The study area holds many tourist pilgrimages attractions and it needs sufficient monitoring on several factors over the entire fragile region for the construction of any infrastructures, disaster mitigation, Urban development process, etc Therefore,sufficient monitoring is required to predict and mitigate in case of catastrophe.

A Case Study of Changes in Particulate Matter Pollution during COVID-19 Lockdown in Delhi

Arshad Peer Mohamed S H, Manu Mehta, Luvkesh Attri, Bhargavi B A, Gaurish Singhal

Indian Institute of Remote Sensing, Dehradun

Covid-19 had a disastrous impact on the human race, thus forcing many countries to impose regional and nationwide lockdown as an attempt to suppress the spread of the virus. India was amongst one of the first countries that imposed nationwide lockdown from March 24, 2020. Although a few earlier studies have reported the impact of pandemic on air pollution over Delhi, our study aims for a detailed evaluation of spatio-temporal changes in particulate matter pollution before, during and after the Lockdown condition over several locations in Delhi. It attempts to utilize GIS to analyze the changes in air quality by considering the pre-lockdown (2019), lockdown (2020), and post-lockdown (2021) period. There are established monitoring stations throughout Delhi under the supervision of the Delhi Pollution Control Committee (DPCC) and the Central Pollution Control Board (CPCB) to monitor real-time air quality changes. Multiple statistical analysis is used to assess Particulate Matter (PM 2.5, PM 10) to find monthly contributions of the same toxic pollutant. Interpolation techniques were used for spatial intercalation to analyze spatio-temporal changes in the pollutant level during the pre-lockdown and lockdown phases. The study reveals that the Particular Matter plays a major role in decreasing pollutant levels tremendously in residential and commercial areas during the lockdown, followed by a sudden increase in the later phase of the lockdown due to the relaxed restrictions on curbs and other transportation activities.

Glacier and Glacial Lake Dynamics of the Rishiganga Basin, Chamoli using Remote Sensing Techniques

Shubham Mishra, Pratima Pandey, Shovan Lal Chattoraj

Indian Institute of Remote Sensing, Dehradun

Health of a Glacier is a key indicator of climate change and can also act as a trigger of many glacial hazards, therefore monitoring and understanding the dynamics of glaciers becomes important. However, the field-based study of high mountain glaciers becomes difficult due to complicated logistics and political or cultural conflicts. A remote-sensing-based approach contributes to crucial information of spatial and temporal changes of Glaciers cost-effectively.

The present study investigates the Glacier retreat for the years 1994-2021 and the Surface Velocity of the Glaciers along with Glacial Lake dynamics for the years 2014-2021. Landsat series of satellites provide essential information of Earth's Surface change for the longest period (since 1972), so this data is used for temporal variation related study. To study the glacier advance/retreat the outline of glaciers lying within the basin were marked for the time period 1994-2021 by manual digitization in ArcMap v10.5 and further the glacier area and the altitude of the snout was computed for each glacier. The glacial lakes were marked using NDWI and FCC images by visual interpretation. Glacier velocity and glacier ice thickness are important parameters to study the glacier dynamics as they are dependent on ice mass change. Surface velocities using optical feature tracking were estimated by COSSI-Corr (Co-registration and correlation) feature tracking algorithm, a module in the ENVI v5.0.

The study reveals that the total area near the terminus (ice-loss) decreased by ~0.3 sq. km. between the years 1994-2021. The maximum loss in the area near the snout was observed for Bethartoli Glacier. The number of glacial lakes observed in 2021 is 216, which is more than twice the number present in 2014 that is 98. The calculated glacial lake area was 0.595 sq. km in 2014 which increased to 0.620 sq. km in 2021. The present scenario indicates that the majority of the glacial lakes within the basin are of the Supra-Glacial type. The average annual surface velocity of the glaciers within the basin was found to be ~24 m/year

Bibliometric analysis for the Occurrence of Natural Disasters on a Global Scale using EM-DAT (1900-2021)

Waquar Ul Islam, P Danuta Mohan, Dizna James, Akhil Francis T, Bhargavi B A, Akshayasimha C H, Vaishnavi Uday Honap, Madhuparna Majumder, Karishma

Indian Institute of Remote Sensing, Dehradun

Trends in disasters across the globe have exhibited a robust increase over the past century and the impacts of these disasters have affected the lives of people, infrastructure, and the economic stability of the countries. Climate change and anthropogenic activities enhanced the frequency of occurrences of meteorological, climatological, hydrological and geophysical disasters. Understanding the spatio-temporal distribution of these disasters on a global scale is significant for disaster management and mitigation planning. This study explains the variations in the world wide spatio-temporal occurrences of these disasters over the time period of 1900-2021 using the International Disaster Database EM-DAT. The long-term global trend in natural disaster deaths, annual disaster frequency, total number of people affected, and damages by each disaster category were analyzed and mapped for the entire globe. The study helps in understanding the pattern and frequency of disasters which are vital for the disaster management planning for better livelihood.

On the Extreme Rainfall Events over Uttarakhand Region for Recent 22 Years by using Satellite Based Data

Arvind Pagire, Charu Singh

Indian Institute of Remote Sensing, Dehradun

In the perspective of mountain ecosystem of the world, the Indian Himalaya has its own importance due to its most complex and diversified nature. Cloudburst events over the Indian Himalayas and around the southern part of Himalayas are volatile in terms of its location and time of happening. The Himalaya region is highly prone to extreme rainfall events as cloudburst which trigger large scale mass movement and flash flood. Most of the cloudburst events over many areas of the Himalaya often go unnoticed due to limitations of meteorological observation. The present study aims to analyse the features of extreme rainfall events (EREs) over Uttarakhand region by using latest release Integrated Multi-Satellite Retrievals for Global Precipitation Measurement (GPM)(IMERG) 10km resolution data for the period of 2000-2021. The latest release IMERG algorithm is beneficial over the large part of the Earth's surface that inadequate to precipitation-measuring instruments on the ground. Features of EREs are identified using extensively used percentile threshold method. There is a strong positive correlation is found between IMERG and IMD dataset over the study region. The EREs frequency temporal analysis shows that there is no trend present over Uttarakhand region, spatial variation of frequency suggest that plain areas are highly prone to Extreme Rainfall Events compare to mountainous region. The spatial variation of rainfall intensity is analogous to frequency. Return period for such events over Uttarakhand region is near about 1 years. Return period is estimated by using Weibull's method. The overall analysis showed that GPM-IMERG satellite based datasets have significant importance in estimating rainfall extreme accurately over study region.

Development of an Improved NO_2 Emission Inventory over Indian Region using Satellite Data and WRF-Chem Model

Sreeraj R, Shuchita Srivastava

Indian Institute of Remote Sensing, Dehradun

Nitrogen dioxides (NO2) is an important criteria air pollutant which affects both climate and human health. Vehicular and thermal power plant emissions are the largest contributors of NOx (NO+NO2) in India. Chemistry Transport model simulations are often used to understand the various emission sources and their spatio-temporal distribution over a region. However large uncertainties are observed in air quality simulations due to uncertainties in anthropogenic emissions of gaseous air pollutants over the Indian Subcontinent. The present study is aimed at creating an improved anthropogenic nitrogen dioxide (NO2) emission inventory using Weather Research and Forecasting model coupled with Chemistry (WRF_Chem) simulations and tropospheric column NO2 observations obtained from TROPOspheric Monitoring Instrument (TROPOMI) instrument onboard Sentinel 5P satellite over the Indian region. The anthropogenic nitrogen dioxide (NO2) emission inventory is being developed using WRF-Chem model simulations using MACCity anthropogenic emissions, FINN biomass burning emissions and Model of Emissions of Gases and Aerosols from Nature (MEGAN) biogenic emissions. The model is driven with the chemical initial and boundary conditions of Community Atmosphere Model with Chemistry (CAM-Chem) and meteorological initial and boundary conditions obtained from NCEP FNL dataset. The WRF_Chem NO2 profile is used as a priory profile in TROPOMI tropospheric column NO2 retrieval to remove the discrepancy between default TM5 model and WRF-Chem simulated NO2 vertical profile. A relationship between the anthropogenic emissions used in the model and tropospheric column NO2 is established and is iteratively applied using corrected TROPOMI observations to develop an improved NOx emission over the Indian region. The Improved emission inventory will reduce the error in simulations of spatiotemporal distribution of NO2 over the Indian subcontinent. Accurate air pollutants simulations over the Indian region can help in identifying important emission sources and segregating their contribution over the Indian region. This information will be very valuable for policy makers for regulating and controlling the emission of major air pollutants at pollution hotspots.

Long Term Trend Analysis for Surface Temperature, Air Temperature and AOD Derived from MERRA-2 Reanalysis Model for Delhi, Mumbai, Jaipur, Kanpur and Pan-India

Seema Nihalani, Manu Mehta, Harsh Yadav, Sandhya Singh, Shruti Jain, Srishti Bhandari

SVNIT, Surat

Aerosols are finely suspended solid or liquid particles in the atmosphere. Anthropogenic aerosols from industrialization and urbanization are among the prominent factors instrumental in climate change process. Aerosol optical depth (AOD) is a quantitative estimate of the amount of aerosol present in the atmosphere. The rise in concentration of aerosols in the atmosphere has affected the clear sky visibility in most of the metropolitan cities. In the current study, AOD data from MERRA-2 model reanalysis is used to ascertain the variability of changing amount of aerosols in the light of changing air and surface air temperature. The study area considered for the present research comprises of India and with focus on Delhi, Mumbai, Jaipur and Kanpur cities. The present study uses MERRA-2 model reanalysis total extinction aerosol optical thickness (AOT) (550 nm wavelength) data, along with M2IMNXASM, air temperature data at 2 m height and M2TMNXFLX, surface air temperature data. All the data sets were extracted at 0.5° - 0.625° spatial resolution for the post monsoon season (October- November) over the period of 41 years (1980-2020). Annual mean AODs have increased by 30-40% during 1980 to 2000 over all the four cities and pan India. Both AODs and air as well as surface temperature have increased in the last four decades over all the study locations. These findings become important and useful in the context of regional and global climate change in context of rising aerosols. In future, in-depth associative analysis can be carried out using long-term ground based and space-borne measurements in addition to model reanalysis.

Socio Economic Risk Assessment and Prioritizing Nature based Solutions in the Context of Urban Flooding and Climate Change

Manivannan K

Indian Institute of Remote Sensing, Dehradun

Recent years, as reported by Intergovernmental Panel on Climate Change (IPCC), the extreme weather events like severe flood/drought are occurring more frequently owing to climate change. It is becoming challenging for the decision makers to consider climate factors and their effects in their developmental plans, especially in cities where these events cause severe direct and indirect social and economic losses. It mandates the need to recognize the potential future risk in the course of next few decades associated with a development plan and the need to consider the effective adaptation measures for the region under climate projection different scenarios to improve the overall resilience. Recently, nature based solutions are being extensively studied and are recommended to improve the urban resilience against weather extreme events. In this study, a comprehensive flood multi risk assessment is carried out for the entire study area considering direct and indirect damages to people and properties by urban flooding for the projected future climate conditions. Direct damages are related to the immediate physical contact of the flood and easily specified in monetary terms. Indirect damages focus on the cascading effect of the flood on daily usual businesses. After preliminary assessment, depending on the study area and the climate scenario, the NBS solutions are analysed and prioritized accordingly. It uses multi-step process to progressively narrow down the potential NBS measures. It involves evaluation of risks, cost and welfare (societal and environmental) impacts. The methodology is adaptable to different contexts, objectives and urban regions.

Geospatial technology for atmosphere and climate of Ziro Valley-Arunachal Pradesh (Northeast India)

Kago Puniya

SSJ University, Almora

Geospatial technology can play a vital role in global warming research by helping to make a connection between climate change and individual people. It is best achieved by mapping the impact of climate change at the local level through the use of satellite imagery. Geospatial technology is a powerful tool that can be used to locate the unseen and obtain spatial data for the same. Ziro is a town and the district headquarters of the Lower Subansiri district in the Northeast Indian state of Arunachal Pradesh. It is included the Tentative List for UNESCO's World Heritage Site for the Apatani cultural landscape. The atmospheric climate of Ziro Valley (Arunachal Pradesh) supports the unique practice of agriculture-cum-pisciculture that could offer a deeper look into sustainable development. Measuring and collecting climatic data of such interior region tradiitionally is expensive and time consuming. Field work might not be a suitable option to collect data. The goal of this study is to develop a model that could collect necessary climatic data of Ziro Valley without first going into the field, thus saving time, money and reducing the risks associated with remote field localities. A GIS site works by overlaying existing geo-referenced data into a computer program and adding the different data sets after assigning a numerical value to the important fields. For this project, I used climatic map, vegetation map, settlement map and change detection method as to understand the impact of climate in these spheres. The model has demonstrated that it is possible to use this model and apply it to a complex geologic area to produce a usable field map for future field work.

In conclusion, the research is an attempt, a modest one at trying to apprehend the affects of atmosphere and climate on other spheres of Ziro Valley. Ultimately this study meets the requirement to know the past and present climatic condition of Ziro valley and; to appreciate and understand the traditional way of Apatani tribe of Ziro coping the given climatic condition, all using Geospatial technology.

Identification of Rainwater Harvesting Potential Zones in the Man River Basin of Lower Narmada Valley with the help of Geospatial Techniques

Ankit Rathore

School of Studies in Earth Sciences, Vikram University, Ujjain

In the area where sources of water like rivers are not perennial, the groundwater becomes more valuable. This groundwater mainly depends on rainwater. So rainwater harvesting is key to recharging the groundwater. Man River is a tributary of the Narmada River and is situated in the Dhar district. It covers approximately 1500 km^2 of area. The average annual rainfall is about 833.6mm/year and fluctuates between 1330mm/year to 489mm/year in the study area. The land use and land cover scenario in Man river is classified as settlement cover 19% area, water body covers 3% area, bare land covers 5% area, Forest covers 19% area and agricultural land covers more than 70% area. The highest order of stream is 7 in the study area and the length of the main channel is 93km. The groundwater recharge potential map is very useful in areas like the Man basin where hard and impervious rock like basalt covers more than 95% of the area and lineaments are abundant in some part of basin. The potential map for rainwater harvesting is derived with the help of the land use land cover map, lineament map, drainage map, slope map, geological map, and soil map of the study area. All these maps are prepared in the GIS environment. The desired data needed for preparing this map is collected from the Bhuvan, Bhukosh, India Meteorological Department, and others. The Cartoset Digital Elevation Model and Landsat 8 OLI is useful in preparing slope map, drainage map, land use land cover map, lineament map. Rainfall map is prepared by interpolation technique with the help of IMD data. The potential area for rainwater harvesting is identified in the Man river basin. The potential area is further divided into 4 classes. More than 72% area falls under the class 3 or in the fair category, 17% of the area falls under the class 2 or poor category, 10% are in class 4 or good category and less than 1% of area belongs to class 1 or very poor category.

Geospatial Technology in Water Resources Management in Alirajpur District, Western Part of Madhya Pradesh India

Tarun Rathore

Vikram University, Ujjain

Water is a one of most critical resource for the past some decades . Also with the rate of population growth, the availability and quality of water is not increasing at that rate. Absence of rain due to irregularities in nature. The problems related to rain, heavy flood and soil erosion etc causes are decrease with the help of the water harvesting by the different types of civil structure. Groundwater and surface water both are main important for the human life.Hatni river basin is a largest basin in alirajpur district. It have some 8 Major sub basin. In the rainy season the flood water are used for groundwater recharge with the help of the suitable site. And help of artificial recharge mechanisms for the surface water and flood water to store in ground water storgre cause ground water level increase. Aquifer are used in storage water exploration in any season ISRO is provided Remote Sensing satellite service like cartosat satellite resources satellite Oceansat satellite the help of the satellite we can easily known elevation difference in particular area water bodies identification Toposheet number 46J2, 46J3 46J, 46J6, 46J7, 46J8, 46J10, 46J11, 46J12 are covering for study area. With help of cartosat satellite DEM image of our study area downloaded through the bhuvan Indian geo special platform. In this research paper discusses the geospatial methodologies adopted and the results attained from some previous various research paper.

Time Series Analysis of Tanks of Noyyal River Basin using Google Earth Engine and GIS

Akshaya M

TNAU, Coimbatore

The Noyyal River is a tributary of the Cauvery River, which originates in the Western Ghats' Velliangiri Hills. Along its course, the river feeds numerous enormous tanks and has benefited the Coimbatore neighbourhood with its tanks and canals since time immemorial. A study was conducted to analyse the change in water spread area of tanks of noyyal river basin using NDWI, MNDWI and supervised Classification approach. A total of 24 tanks of Coimbatore district were analysed for a time period of 2010 to 2021 and change detection were noticed. Landsat 8 OLI and Landsat 7 ETM+ images was used for mapping the water spread area of tanks across the river basin. Google Earth Engine cloud computing platform was used for processing earth observation data, based on the time series images of Landsat imagery and area of each tank was calculated in GIS. The area obtained through these methods were compared with Survey of India Toposheet. The results showed an increase in water spread area of tanks during the time period and some tanks were deteriorated due to urbanization and other encroachment.

Applying Deep Learning Approach for Groundwater Level Prediction in North-West India

[1,2]Pranshu Pranjal , [2]R. S. Chatterjee, [1]Dheeraj Kumar and [1,3]Ashish Soni
[1]*IIT (ISM), Dhanbad*
[2]*Indian Institute of Remote Sensing, Dehradun*
[3]*Lovely Professional University, Punjab*

Being a water rich country, India is counted among the highest consumers of groundwater around the world and thus, the aquifers fluctuate significantly in due course of time. There are several studies predicting the alarming situation in India, especially in north-west Indian (NWI) region. There is therefore, the study presented in this paper deals to understand the behavior of hydrological parameters that affects the groundwater in NWI using state-of-art techniques. The hydrological parameters such as precipitation, soil moisture, evapotranspiration and satellite based terrestrial water storage anomaly observation are collected on monthly basis for the duration of 2005-2017. Nevertheless, in-situ groundwater has also been used to get groundwater level scenario, which further categorized into four cycles (i.e., Pre to Pre (PrePre), Pre to Post (PrePost), Post to Pre (PostPre), and Post to Post (PostPost) monsoon change) w.r.t the monsoon season to understand the difference (h) in groundwater level. In modelling perspective, regression analysis is carried out using artificial neural network (ANN), convolution neural network (CNN) and Convolution-long short-term memory (ConvLSTM) models to evaluate its fitting for the desired data. The dataset is then partitioned into training and test subset. The training subset comprises of the datasets from 2005 to 2014 which is used to train the models, whereas, the test subset comprises of datasets from 2015-2017 which is reserved to evaluate the model's efficiency and prediction capability. Also, loss function is calculated based on the root mean square error (RMSE) and means square error (MAE), likewise to evaluate the performance of the model, numerous geo-locations were considered for validation. In conclusion, ConvLSTM model fitted well for the dataset due to the consideration of additional time factor and achieved the least error for different cycles. The annual average loss function observed from both the functions for ANN, CNN and ConvLSTM models, is witnessed to be 0.1321, 0.0817 and 0.0319 respectively. Thus, the ConvLSTM based neural network analysis provides spatio-temporal behavior of groundwater level with higher accuracy. Furthermore, it was observed that the annual overall loss function for developed model based on ConvLSTM for the groundwater level changes (i.e., PrePre and PostPost) was 0.0604 and 0.0521 in case of MAE whereas, 0.1099 and 0.0957 for RMSE respectively.

Water Resource Modelling using RS & GIS Methods: Monitoring & Development for Future

Jawahar Raja P

Dr. N.G.P. Arts and Science College

Water dearth in my Erode District Stimulated me to Explore Water resource Zones in my district. Erode lies with geographical area of 572264 hectares on the extreme north of Tamil Nadu. A part of the eastern boundary of the district is formed by river Cauvery, The two tributaries of river Cauvery viz. Bhavani and Noyyal Rivers. With a dry climate area and the soil is not the best using RS and GIS methods to the geomorphology, soil hydrology, land use and drainage map were prepared for my district. Using WBIS of Bhuvan - NRSC and other tools to determined water resources in my district water potential zones in study area obtained by all the thematic maps and recent water body data, even small ponds and lake were found in my surrounding area were monitored and with the support of locals to developed water resources for our future.

Urban Flood Hazard Modelling in a Dense Urban Set-up with Inputs from UAV Data

Ujjwal Kumar Swain, Pramod Kumar, Chandra Mohan Bhatt, Vinay Kumar

Indian Institute of Remote Sensing, Dehradun

In India and also globally, urbanization is progressing at a rapid pace. The number of towns and cities, as well as urban agglomerations, are not only expanding but also becoming wide and larger. The urban infill or expansion causes the rise in impervious surfaces and consequently builds stress on Storm Water Drainage (SWD) facilities. The problem of urban drainage is further exacerbated by unplanned construction and encroachment on existing natural drainage corridors, waterways, etc. In this study, the urban flood hazard modelling is conducted for a part of Roorkee city, Uttarakhand in India having a dense urban set-up with some inputs from Unmanned Aerial Vehicle (UAV) data. Input layers like Land Use/ Land Cover (LULC), Digital Elevation Model (DEM), slope and rainfall data were used to predict flood conditions for different rainfall magnitudes. The Intensity-Duration-Frequency (IDF) curve helped to analyse rainfall data obtained from Tropical Rainfall Measuring Mission (TRMM) to compute rainfall intensities for varying return periods. UAV data was used to derive large scale urban LULC while following the classification schema given in €œDesign and Standards for the Formulation of GIS based Master Plans for Small and Medium Towns using UAV Technology. SWD dimensions and parameters were defined in the Storm Water Management Model (SWMM) to estimate flood peak, depth, flow, etc. The model is calibrated to the prevailing conditions of the study area, and then simulated for the wettest day of June 2013 with the help of all desirable inputs based on kinematic flow routing techniques. Depending on the return period of a heavy rainfall event (17th June 2013), which received 340 mm during the entire day and sub-catchments wise runoff (peak flow, depth) computed. The flood hazard intensity was found to be increasing and thus giving rise to the flood water accumulation. The flow in different conduits were observed to surpass the SWD water holding capacity and thus creating the water inundation. It is found out that the present SWD won't be enough in near future to carry the rapidly increasing volumetric flow of water obtained from flood like condition. The study demonstrates that geospatial techniques can be effectively used to analyse the urban flood hazard in a dense urban set-up and as caused by extreme rainfall events, and therefore be helpful to urban policy makers and planners when it comes to managing the SWD systems.

Spatio-Temporal Analysis of Precipitation of India Using Google Earth Engine

Chirag P. Ladavia, Reena D. Popawala

C. K. Pithawala College of Engg. & Technology, Surat

Precipitation is defined as the fall of moisture from the atmosphere to earth surface in any form. It may be in liquid form or frozen form. In India, precipitation is divided in following major types: Cyclonic, Orographic, Convective etc. This work contains spatial as well as temporal mapping and analysis of precipitation for whole India for year 2011 to 2021. The analysis of rainfall is done for college campus (D6-Civil Engineering Department, CKPCET, Surat) by collecting accurate latitude and longitude data using GARMIN GPS Navigator Device. In this study, daily precipitation values are taken over India, are used to disclose spatial distribution of precipitation. Data components were obtained from the CHIRPS satellite for last 11 years period (2011-2021). The major objectives of the study are is to infer the nature of spatial variation of precipitation over India from satellite based meteorological observations. The analysis will be performed using three graphs: Rainfall time series graph, Seasonal variation graph and Inter annual variation graph. The rainfall anomaly analysis is also performed using proper GIS technique. For all these kind of analysis and mapping various GIS softwares are available, like Arc-GIS, Q-GIS etc. Google Earth Engine is also a very good system to analyze the critical water resources problem using recent geo-spatial technique. For this work Google Earth Engine and java/python coding is used. This study will conclude many important points which are connecting water resources field with Environment Engineering, especially climate change.

Rapid Flood Inundation and Damage Assessment Using SAR and Cloud Platform

Uday Kumar[1], Praveen Kumar Thakur[1], Vaibhav Garg[1], Armugha Khan[2]
[1]Indian Institute of Remote Sensing, Dehradun, [2]Aligarh Muslim University

A natural disaster is an occurrence that occurs as a result of natural earth processes and results in significant losses to agriculture, infrastructure, human lives, and the economy of the affected region. India is vulnerable to various forms of disasters due to its unique topography, climate, and socioeconomic characteristics. Flooding is a common natural disaster that occurs most often as a result of above-normal rainfall. In India, it affects a vast number of people. Flooding and river erosion threatens 12% of the land (National Disaster Management Authority, 2019). Moreover, 40 million hectares (Mha) of the total geographical area of 329 million hectares (Mha) are flood-prone (National Disaster Management Authority, 2021). Floods harm 75 lakh hectares of land on average every year, killing 1600 people and causing Rs.1805 crores in damage to crops, residences, and public utilities (National Disaster Management Authority, 2021). In 1977, the highest number of lives lost (11,316) was recorded (National Disaster Management Authority, 2021). Major floods occur every five years or more frequently. Floods occur frequently, and their negative consequences need researching to determine the causes and improve our preparation and preparedness for such disasters. Flood inundation maps provide valuable information to flood risk preparedness management, mitigation at the time of disaster. Heavy monsoon rains over the west coast of India in July 2021 caused flood events in Maharashtra. Intense rain fell between 19-24 July 2022, pushing reservoirs to their capacity limits and necessitating the release of a huge amount of water into the rivers. As a result, many towns were impacted by flooding. Ratnagiri and Raigad districts of Maharashtra are considered for the present study. Satellite imagery provides data that cover the whole globe on a repetitive basis which is ideally suitable for the generation of flood inundation maps. Due to all-time operability, weather independence SAR data is most suitable for flood inundation map generation. In the present study, Sentinel 1 C-band Synthetic Aperture Radar (SAR) data is used. The polarization of Ground Range Detected (GRD) scenes used in this study is VH. The method used for the generation of flood inundation is thresholding based on the histogram of the difference image of preflood and during flood image. The threshold value obtained after analyzing the histogram is 1.20. Pre-processing of SAR data, change detection analysis of pre-flood image and during flood-image, thresholding and generation of flood inundation map are done on Google Earth Engine. After carrying out the analysis it is found that the mean inundated areas during 15 July-22July 2022 are 5297.83 and 8309.39 ha in Ratnagiri and Raigad district respectively. For damage assessment due to flood, Land Use Land Cover released by ESRI is used. The total mean flooded cropland area from 15 July-22July 2022 is 1456.80 and 4010.50 ha in Ratnagiri and Raigad district respectively. The total mean flooded urban area from 15 July-22July 2022 is 303.39 and 660.82 ha in Ratnagiri and Raigad district respectively. Thus, this approach can be used for operational flood inundation mapping and monitoring.

RS-GIS based Watershed Mapping of Banka District, Bihar

Sushma Kumari, B.K. Vimal, Rajkishore Kumar, Ragini Kumari

Bihar Agricultural University, Bhagalpur

Out of the total geographical area of Banka district only 65 % of the cultivated lands were observed under rice fallow due to limited irrigation. In this context, watershed management may be helpful to enhance the irrigation potential in cultivated lands. Hence, the present study was carried out to trace out the number of watersheds and their characteristics. In this context, satellite data viz. Carto DEM and Land sat 8 (2021) were used to trace out the topographical pattern; water shed delineation and their area estimation using Q-GIS open software. Results revealed that out of the total geographical area of Banka district (3020 km^2), 31 watersheds were traced out with their gradients viz. 0-25 km^2, 26-50 km^2, 51-75km^2, 76-100km^2, 101-125km^2, 126-150km^2 and 151-250km^2 geographical area. However, micro watersheds (0-75km^2) were observed in hilly and plateau regions having minor streams. Some of the watersheds (41%) helped to fill the reservoirs with plenty of water during monsoon, and some of the watersheds (35 %) fallen under non perennial. Data through outcome of the research may be helpful to use supplementary information to analyse the suitable sites for construction of new check dams, and revival of village ponds to provide the life saving irrigation facility for crops.

Application of Microwave Remote Sensing in Identification of Paleochannel

Himanshu Shekhar Sahu, S. Pasupathi, M. Muthukumar

Gandhigram Rural Institute, Tamil Nadu

Paleochannels indeed a mode of groundwater transit conduit with the potential for economic placer minerals, a paleoclimatic repository and various intriguing ties to the region's active river courses. The current work exploits the microwave's longer wavelength applicability towards unearthed the paleochannels of the Cauvery delta, where the fascinating migrational history has been described by several prominent researchers. Depending on the wavelength chosen, the use of microwave remote sensing has become extensive and versatile in recent decades; the following study chose the L band wavelength of Microwave of 15 to 30 cm. The open source; Advanced Land Observing Satellite (ALOS) Phased Array Type L-band has been used to identify buried shallow alluvial curvilinear paleochannels throughout the research region. It has an advantage over other standard techniques such as False Color Composite (FCC), Principal Component Analysis (PCA), and Digital Elevation Model (DEM) for finding paleochannels because of its longer wavelength characteristics. Imagery with a resolution of 10 meters was used for FCC and PCA, whereas ALOS PASER imagery with a resolution of 10 meters was used for DEM. Unlike optical Remote Sensing, microwave images are complex and contain a variety of noises that must be rectified and analysis. L-Band of ALOS PALSER has gone through processes like Amplitude Calibration, co-registration, terrain correction, geocoded and exported as GeoTIFF format in ASF MapReady software. Lee flitter employed ENVI software to reduce speckle noise, and the data was then uploaded to the ArcGIS platform for Paleochannel identification. When standard techniques were compared to orthorectified Synthetic Aperture Radar (SAR) imaging, the results were rather impressive. In which, the exposure of paleochannel traces was improved, allowing for a better understanding of migrational linkages with the active river. Even for improved perception and interpretation with present landscape topography, the computed SAR imagery can be overlaid with a DEM derivative layer like Hillshade with a transparency effect. Hillshade image improves the topographic structure and is quite useful in extracting satellite information dealing drainages and linear and curvilinear depressions. The paleochannels were mapped using the previously stated orthorectified SAR images and Hillshade approach.

Analysis of the GRACE-based Flood Potential Index as a Covariate for Non-stationary Flood Frequency Analysis

Sachin Bhere, Manne Janga Reddy

Indian Institute of Technology, Bombay

The study is based on the hypothesis that multiple factors influence the non-stationarity in the basin. Most of the study uses the single covariate to model the non-stationary flood frequency, assuming that the single factors influence the non-stationarity. To verify that the GRACE-based flood potential index is used as a covariate for non-stationary flood frequency analysis of the Mahanadi river basin. This study engaged the JPL's level-3 version-4 downscaled monthly data of equivalent water thickness as terrestrial water storage at 0.25-degrees spatial resolution derived from GRACE and GRACE-FO from 2003 to 2020. The GRACE-based flood potential index is calculated by determining the storage deficit (Sdef). The storage deficit of terrestrial water storage (TWS) is the amount of water stored before reaching the historic maximum storage capacity (Smax). The low storage deficit combined with high magnitude rainfall leads to high flood potential. Therefore, to calculate the flood potential index, the gridded rainfall data of the Indian Meteorological Department (IMD) is used along with GRACE's TWS data. Then the GRACE-based flood potential index is used as a covariate and compared with the 17 different models, which considers the single covariate over the Mahanadi river basin. Extreme flood events are recorded in the recent past over the Mahanadi River basin, which has high destructive potential that causes social damage and environmental alterations. The Mahanadi River basin is located in the eastern part of India, and with a total length of 850 km, it drains around 142,000 sq. km. of Chhattisgarh and Orissa states of India. Due to the damage caused by flood events in the past, the river is called "Sorrow of Orissa". Due to the sparse network of gauge stations across the basin, it is important to understand and explore the utility of space technology and remote sensing tools like GRACE for observing the hydro-meteorological parameters to quantify the extreme hydrological events and the flood frequency. The study shows that the AIC and BIC value of the model, which considers the combined index is low, and therefore the model is more fit than all single covariate models.

Analysis of Polarimetric Techniques for characterization of Glacial Feature

Shashwati Singh, Shashi Kumar, Praveen K. Thankur, Varun Narayan Mishra

Suresh Gyan Vihar University, Jaipur

In this work, utilizes the capacity of fully polarimetric Advanced Land Observation Satellite Phased Array-Type L-Band Synthetic Aperture Radar (ALOS-PALSAR-2). Here in the study, has covered the two most prominent glaciers of the Indian Himalayas, mainly Siachen and Gangotri Glacier. The capacity evaluation of fully polarimetric L-band data for the glacial facies identification is examined in this research. In the Indian Himalayan region, several characteristics are utilized to distinguish between Dry snows, wet snow, ice and debris-moraine covered area, including backscattering coefficient $f0$, Eigen value- Eigen vector and Freeman Durden three component decomposition and last Stokes vector based approach Circular polarimetry ratio (CPR). To examine the physical characteristics of the targets, the H-A alpha decomposition approach was employed to obtain scattering information. The entropy (H) and alpha angle (a) are calculated using the Eigen values and Eigen vectors obtained from the coherency matrix decomposition. The scattering mechanisms were identified using a both Eigen value Entropy and alpha angle interpretations. Freeman Durden based on covariance matrix produces three type scattering elements. Based on both the decomposition, the scattering mechanism for different glaciers facies is analyzed, but they produces quite contrast results comparatively. To overcome the flaws in both the decomposition, Stokes vector based approach CPR is analyzed, the main limitations of this study is to analyse scattering element for glacier zones without going to field.

Reconnaissance of Aquifer Recharge Zone using Geospatial Techniques in Uri-Baghni Valley, Western Madhya Pradesh

Shafia Khan

Vikram University, Ujjain

This paper is an attempt to identify the aquifer recharge zone in the study area. The Uri and Baghni Rivers are north bank tributaries of the Narmada River in western Madhya Pradesh. The river valley covers an approximate 1800sq km area which is located in the Dhar district of Madhya Pradesh. The average annual rainfall is about 833.6mm/year and fluctuates between 1330mm/year to 489mm/year in the study area. Unsustainable groundwater utilization is becoming a major problem for many areas. To understand the water resources in the basin, sustainable development and management of aquifer recharge need quantitative assessment with the help of geospatial techniques. The land use and land cover of the Baghni basin is classified as forest area is 12%, the agricultural area is more than 70%, bare land area is 4%, water bodies occupied by 9%, and settlement area is less than 1%. A geographical information system is used to prepare the thematic map layers of contributing factors such as lithological map, slope map, rainfall map, soil map, drainage map, lineament map, and land use land cover map. The data were collected from different sources like Bhuvan, Bhukosh, FAO/UNESCO, IMD, Landsat and DEM. These maps are prepared for identifying groundwater recharge potential zone. On the basis of maps, the Baghni basin is qualitatively classified into four classes namely very poor, poor, good, and very good which account for less than 1%, more than 52%, 46%, 8% respectively. This information could be used as an approach to a better estimate of the aquifer recharge zone in the study area.

Applicability of Different Anchor Pixel Selection Techniques in METRIC Model and Model Evaluation with LAS Readings

Pooja Nandagopal, Abhishek Danodia, Bhaskar Nikam, N. R. Patel

Indian Institute of Remote Sensing, Dehradun

Water scarcity is expanding at an alarming rate in the current time in various parts of the globe. India uses about 84% of the total available water in irrigation, thus Agricultural Water Management is now a time requirement for efficient utilization of available water. Crop Evapotranspiration (ET) being the primary consumer, must be well-monitored for efficient water management. Various Surface Energy-Balance based remote sensing models that intend to estimate ET by estimating residual energy fluxes of the Earth. In this study, Mapping Evapotranspiration with Internalized Calibration (METRIC) model is one of the best surface energy models for estimating evapotranspiration. It is mainly based on the selection of anchor pixels for hot and cold points in an agricultural region. With growing research, many authors have used varying techniques (from manual to automated) for the selection of these anchor pixels. The main focus of this research is to study the variation of these techniques in estimating the overall ET that is estimated. One manual and another semi-automated technique were selected for the study. Also, the equations and fluxes obtained in the model are compared to the Large Aperture Scintillometer (LAS) readings which are augmented within the study area (located in the ICAR-IARI campus, New Delhi). The results show an overall ±16% RMSE heat flux estimation however the Sensible heat flux remains unchanged with variation in the anchor pixel selection technique. The research proves immense scope for automation in the METRIC model for the regions of cropland at local to regional scale modelling.

A GIS Based Approach to Depict Water Availability and Demand Scenarios in Varuna River Basin (Varanasi, Pratapgarh and Sant Ravidas Nagar)

Muskan Yadav

Isabella Thoburn College, Lucknow

An assessment of Varuna River basin of India was performed to study the water availability and demand scenario using GIS platform. The use of water resources has increased with rapid population growth. Besides the problem might increase with the potential climate change impacts on the water quantity. Thus, sustainable use of water becomes crucial. Water budgeting is necessary to study the hydrological cycle. Out of the many hydrological components the major is precipitation, Evapotranspiration, surface runoff and groundwater. Precipitation is the main input in the hydrological cycle and it plays important role in defining the stimulations of the cycle. The main objectives of the study are estimation of annual water budget of the Varuna River Basin (for year 2020) and to depict future water availability and demand scenario in the Varuna River Basin for the decadal years- 2021, 2031, 2041 and 2051.Spatial variations of water budget was characterized and the result will contribute to reduction in uncertainties and a better understanding. A simple model was used to assess space- time relationship of water resource availability and demand for Varuna River Basin.

The present study takes the output from a hydrological system model and demand estimates, to compare the supply demand relationship on the basis of expected percentage of demand satisfaction. The entire basin is divided into 5 sub basins covering 5 districts of Uttar Pradesh (Prayagraj, Varanasi, Pratapgarh, Sant Ravidas Nagar and Jaunpur) from which it was found that Varanasi and Prayagraj are the most vulnerable. The future trend shows that the rate of consumption of water will increase sharply for Varanasi. The consumption increases from 52% in 2021 to 66% in 2051 with decreasing water availability. GIS is an effective tool for storing, managing and displaying data encountered in water resource. Arc GIS mapping is done to evaluate water resource status with respect to the projected demand. The districts covered in this report are - Varanasi, Pratapgarh and Sant Ravidas Nagar.

Analysis of Polarimetric Synthetic Aperture Radar (PolSAR) for the Estimation of Snow Pack Density in the Upper Region of Garhwal Himalaya

Avinash Bhatt

National Institute of Technology, Uttarakhand

The enhancing geospatial technology has proven an essential requirement for the analysis and monitoring of the Environment and Health during the COVID-19 pandemic. The trending active remote sensing technology not only catered to monitor the infected patients assisting secure environment for the individuals but also in understanding the phenology of the Environment. Moreover, the ongoing advancements in the field of active remote sensing have led to promising measurements. Several attempts have been made recently in order to acquire quantitative measurements using the modes available in recently developed hybrid-polarimetric synthetic aperture radar (hybrid-PolSAR) configuration. In addition, the decomposition techniques developed for hybrid-pol SAR configuration have helped scientists to monitor and analyze the geophysical and biophysical parameters of Earth. Thus, providing the on-time acquisition of environment phenology catering to resource management. Due to the variability in climate change, the Earth's Ecological parameters such as snow are adversely affected. In such a situation, it is very important to understand the response. As part of this effort and to create a better understanding, various research has been conducted for the identification of gaps in understanding environmental health with possible solutions. Moreover, the rapid change in snowpack density alters the water supply in rivers Indus, Ganga, and Brahmaputra. In order to cater to this issue, the mathematical model can be developed for the analysis of the current change in ecological parameters, thereby gauging change in geophysical and biophysical parameters, adopting sustainable water resource management. The last decade has witnessed a growing interest in polarimetric Synthetic Aperture Radar (SAR) based techniques and their potential applications in active remote sensing. However, only a few initial works have considered the use of hybrid-polarimetry (hybrid-pol) SAR for the estimation of biophysical and geophysical parameters of Earth and the environment. This is especially true for SAR-based modeling techniques such as interferometric SAR (InSAR) and Polarimetric SAR (PolSAR). Despite, Synthetic Aperture Radar is not a new concept and having been investigated before, the hybrid polarimetric configuration of SAR led it to be a promising alternative in geospatial technology due to some of its unique properties. The transmitted and received signals deploying FRS-1 mode of hybrid-pol SAR configuration can be exploited in order to develop a mathematical model for measuring the phenology and biophysical parameters of snow. Since the radar images

contain information about the structure and dielectric property of the land surface, the radar and surface parameters influence the path of the wave. On the other hand, utilizing the hybrid-pol SAR configuration that transmits circularly polarized waves and receives two orthogonal linearly polarized waves, the indigenous mathematical model, can be developed using the SAR datasets, for the retrieval of Environment parameters. Due to varying climatic conditions, variation in Earth resources is observed yearly. The variation in the earth's ecological parameters is an indication of degrading conditions of the Environment. These variations can be extracted using the novel-mathematical model.

A GIS Based Approach to Depict Water Availability and Demand Scenario in the Varuna River Basin (Prayagraj and Jaunpur)

Malvika Tiwari

Isabella Thoburn College, Lucknow

An assessment of Varuna River basin of India was performed to study the water availability and demand scenario using GIS platform. The use of water resources has increased with rapid population growth. Besides the problem might increase with the potential climate change impacts on the water quantity. Thus sustainable use of water becomes crucial. Water budgeting is necessary to study the hydrological cycle. Out of the many hydrological components the major are precipitation, Evapotranspiration, surface runoff and groundwater. Precipitation is the main input in the hydrological cycle and it plays important role in defining the stimulations of the cycle. The main objectives of the study is estimation of annual water budget of the Varuna River Basin (for year 2020) and to depict future water availability and demand scenario in the Varuna River Basin for the decadal years- 2021, 2031, 2041 and 2051. Spatial variations of water budget was characterized and the result will contribute to reduction in uncertainties and a better understanding. A simple model was used to assess space- time relationship of water resource availability and demand for Varuna River Basin. The present study takes the output from a hydrological system model and demand estimates, to compare the supply demand relationship on the basis of expected percentage of demand satisfaction. The entire basin is divided into 5 sub basins covering 5 districts of Uttar Pradesh (Prayagraj, Varanasi, Pratapgarh, Sant Ravidas Nagar and Jaunpur) . For this report, only Jaunpur and Prayagraj district are considered. GIS is an effective tool for storing, managing and displaying data encountered in water resource. Arc GIS mapping is done to evaluate water resource status with respect to anticipated demand.

Analysis of Morphometric Characteristics of Manu Watershed - A Case Study

Anuradha Sahu[1], Susanta Das[2]

[1]Banaras Hindu University, Varanasi, [2]Punjab Agricultural University, Ludhiana

Morphometric analysis of the Manu watershed in Tripura, India, is essential in determining the watershed's characteristics and addressing issues related to potential soil erosion zones. The area, perimeter, average slope, and maximum basin length and other parameters of the watershed were calculated using an ArcGIS digital elevation model (DEM) from the Shuttle Radar Topography Mission (SRTM). The watershed was divided into four sub-watersheds (WS1, WS2, WS3, and WS4), with morphometric parameters such as stream order, stream length, stream frequency, drainage density, form factor, circulatory ratio, elongation ratio, bifurcation ratio, compactness coefficient, shape factor, shape index, and constant channel maintenance calculated for each. The findings revealed that the entire study area has a consistent lithology and is structurally permeable. According to the study, WS3 and WS4 will deliver a faster overland flow to the creek than WS1 and WS2. The hydrological behavior of these four sub-watersheds has a major impact on the river's severity and the high risk of flooding and soil erosion in the Manu River's downstream sections. The knowledge and information generated as part of this study is expected to aid in the effective planning and decision-making for flood disaster risk management and erosion control measures in the Manu watershed.

Time Series Analysis and Assessment of the Seasonal Variations of Water Bodies around Chennai using Landsat 8 data

Vigneswaran S

Chennai is one of the fastest growing metropolitan cities in India with nearly 11 million population. Rapid urbanization, poor planning and water resource management combined with extreme weather events puts Chennai's precious water resources under severe stress. Due to urbanization, most of the city's wetland, lake and reservoirs which helped in recharging the groundwater have disappeared over the years. Climate change also adds to extreme volatility of the city's water resources. Historic rainfall during November-December months of 2015 led to severe flooding across the city causing widespread damage to lives and property. At the same time, the city faced acute water shortage during the year 2019 due to poor monsoon. The city of Chennai has four major reservoirs/lakes: Poondi, Cholavaram, Redhills and Chembarambakkam which supply water to the city. They fill up at the end of the Northeast monsoon (October-November) and supply water until the next monsoon season. It is essential to monitor the reservoirs for better management of water resources and planning. Remote sensing combined with GIS techniques enable accurate spatiotemporal change detection of water resources. Landsat imageries provide reliable and accurate data for the detection of changes of surface water bodies. Normalized Differential Water Index (NDWI) is one of the water extraction techniques which was used to delineate water bodies in Chennai and its surrounding areas. The changes in the surface water bodies were estimated by analysing NDWI images of different seasons. Time series analysis was also carried out to visualise the change in the areal extent of surface water bodies over the years 2000- 2020. The results obtained from the above analysis can provide crucial information about the seasonal variations in water level across reservoirs and how the city's water sources shrank over the years.

Glacier Recession and Ice Velocity of Glacier in Zanskar Basin of Western Himalaya Using Advance Remote Sensing Techniques

Varun Khajuria, Praveen Kumar Thakur, Bhaskar Ramachandra Nikam, Antony Joh Moothedan

Indian Institute of Remote Sensing, Dehradun

Retreat or advance of a Glacier is perfect indicator for the climate-induced changes in Himalayan Basin. In this study we calculated the frontal recession of Padam glacier located in the head reaches of Tsarap River, Zanskar Basin for the area change in glacier and its pro-glacial lake expansion freely available temporal Landsat remote sensing datasets (MSS, TM, ETM+) was used. The Padam glacier shows shrunk in area and Lake shows expansion using temporal Landsat datasets from 1978-2020. The Padam Glacier has shrunk by 1.185±0.65 km^2 at a rate of 0.028±0.01 km^2 a-1. The frontal recession of the Padam glacier was also found to be 923.64±0.5 m at a rate of 21.99±0.01 m a-1. Proglacial Lake formed indicates an expansion of 61±4.4% during 1978 to 2020. Measuring ice velocity helps to model glacier dynamics and infer the health of glacier. The literature suggests that optical image-based correlation techniques appear to be more successful and robust fitting methods than SAR interferometry for measuring glacier ice velocity in the Himalayan region. Therefore, in this study we used Sub pixel Image Correlation Technology (COSI-Corr) for calculating glacier ice velocities using Landsat Images.. Rigorous post-processing was performed to improve the accuracy of remote sensing derived velocity products by discarding the pixels having SNR value greater than 0.9. The annual mean glacier velocity was denoted for the period of 2014-2015 and 2019-2020 was ~23.07 m/year and ~26.38 m/year respectively. From previous studies it is reported that lake terminating glacier shows much retreat than land terminating glacier. The ice velocity increase in 2019-2020 indicates the high snowfall, but according to our study and published literature, overall this glacier shows decrease in mass which is also an indicator of Climate change.

Digital Techniques for Soil and Plant Health Assessment

Karthikeyan B, Bhakiyathu Saliha B, Senthilkumar A, Ramamoorthy P, Nagaraj S

Agricultural College & Research Institute, TNAU Madurai

Soil health is defined as the continued capacity of soil to function as a vital living system, by recognizing that it contains biological elements that are key to ecosystem function within land-use boundaries. As population is escalating very fast and consumer demand for high value agricultural products (fruits and vegetables, animal or fish products, etc.) is also changing rapidly. Hence, there is need to take stronger step to increase yield. Remote sensing is a prominent tool in agriculture. The simplest form of remote sensing uses photographic cameras to record information from visible or near infrared wavelengths. In the beginning cameras were positioned above the Earth's surface in balloons or kites to take photographs. Repeated photographs with different time interval will be useful for monitoring of soil quality status and assessment. Reflectance of electromagnetic radiation forms the basis for soil quality assessment. Satellite imageries are developed in false colour composite.These images helpful in spatial and temporal assessment of soil and plant health. Electro-chemical sensors like potentiometric, amperometry and conductometric sensors are accurate and rapid in estimation of soil moisture, pH, EC and nutrient detection. Now days earth observation satellites like LANDSAT, CARTOSAT, RISAT are used in estimation of Land Surface Temperature, Soil moisture with the help of TIRS band. Plant health was assessed through the vegetation indices like NDVI, SAVI, NG, NR, DVI. Information and communication technology (ICT) is a online platform which integrate resource person and user, with the help of ICT farmers can easily access the Soil Testing Laboratory (STL). ICT gives information about soil and plant health status through mobiles and helps in making decision about fertilization and soil management practices. ICT is the basis for smart agriculture.

Exploring Urban Form and Environment with Spatial Analysis Techniques

Monica Kashkari, Tejwant Singh Brar

Sushant University, Gurugram

With the world becoming more urbanized year on year and reaching the fifty per cent urbanized limits, the toll being taken by the urban environment is unmissable. Cities are changing and modifying, and the direct impact is on the land use and cover as on its built form. This is the most significant impact on the environment as the availability of conducive land for apt and ideal development is a paramount goal of all urban governments and hence becomes an important starting point to start the debate on sustainability. Also, when LULC has been studied to understand the sprawling urban areas. Various researchers have made several assessments to understand the land use and land cover and its impact on the environment; however, very little work has been done concerning the overall ambit of urban form and to make it relevant for urban planners. Thus, this paper tries to examine the urban form in the variable of urban shape and sprawl and how it effects the urban environment. The various advances in GIS and other spatial analysis techniques has been primarily used to examine this.

Study of Urban Heat Island Manifestation and Its Impact in Delhi using Remote Sensing & GIS

Richa Jain, Tejwant Singh Brar

Sushant University, Gurugram

Air temperature in built up urban areas is always higher than those of the surrounding rural country and this phenomenon has been recognized widely as the Urban heat Island (UHI). It is estimated that nearly 70% percent of the global population will live in urban areas (Population Reference Bureau, 2010) resulting in an ever greater urban sprawl. According to the World Bank (Angel, Sheppard and Civoco, 2005) cities of 100,000 or more are expected to triple their built-up land area in most of the developing countries. Urbanization being the anthropogenic progression of human settlement away from the natural and rural habitations has had several series of impacts. The formation of the Urban Heat Island (UHI) (Oke, 1980) has had the consequence of greater absorption of heat energy and the slow cooling of urbanized surfaces as compared to the surrounding rural and greener areas. Recurrent impact associated with UHI influence on the local microclimate, thermal discomfort, impacts on public health and changes in hydrological behavior, with a displacement of water masses. This study aims at analyzing the UHI impact in Delhi. Delhi possesses of mixed land use and the presence of substantial tree cover along certain roads. The presence of the Delhi Ridge forests and the River Yamuna cutting across the city tend to have a high influence in moderating the surface temperatures. Extensive urbanization has transformed the land use/cover (LULC), by modifying the pervious land into impervious land, making the city warmer than the remote area and surroundings. The growth of industries and vehicles add to greenhouse gases in the atmosphere that also absorb the outgoing long wave radiation and contribute to increasing temperatures in the city. As a result, the city center is heated up much more than the periphery, leading to the creation of UHI. This paper focuses on the review of literature on urban dwelling units vis-a-vis building and town planning in Delhi within the purview of the impending UHI effect, its various mitigation adaption strategies and another aspect is to review the use of Remote sensing and GIS to mitigate UHI Effect using different mitigation strategies and identifying the research gap.

Estimation Acreage of Senna (*Cassia angustifolia Vahl.*) using Remote Sensing and Geographic Information System

Paras Hirapara, R. Nagaraja Reddy, Sujay Dutta, B. B. Basak, Manivel P., B. K. Bhattacharya

Directorat of Medicinal and Aromatic Plant Research

Senna is a medicinal plant cultivated in India. However, lack of information of acreage of crop limits prediction of its demand and supply in the country. Thus, the main objective of the study was to explore prediction of acreage of Senna using remote sensing and geographic information system. The study was carried in Bhachau block of Kutch district, Gujarat, India during crop season. Unsupervised classification has been used for crop identification with help of sentinel 2A data. Six progressive dates were used to generate signature data of Senna. Extraction accuracy (OA) of Senna was 80% with identification accuracy of 96.47%. A two stage ISODATA unsupervised classification technique is proposed for accurate estimation. The method gives quick estimate of acreage of Senna having application in prediction of supply and demand of Senna in India.

Development of QGIS Plugin for the Detection of the Built-up Area Using Machine Learning Algorithm

Dev Dinesh, Kamal Pandey, Prasun Kumar Gupta, Prabhakar Alok Verma, Sameer Saran, Harish Chandra Karnatak

Indian Institute of Remote Sensing, Dehradun

More than half the world population lives in urban settlements and this is only set to increase proportionally in the coming decades. The resultant built up area expansion will have wide spread connotation on urban planning, natural resource management, food security and biodiversity conservation and hydrological systems globally and therefore wide spread quantitative mapping of built up areas and corresponding LULC changes from large datasets has become essential. This study attempts to utilize Machine learning Algorithm using Tensor Flow library to build a neural network (NN) in order to automate the process of built-up area detection in Landsat 9 satellite images. The objective of this study is to develop a plugin which depict a built up area in QGIS.

High-Resolution Satellite Data for Delineation of Cashew Area through Image Classification Methods

Sabthapathy M, Ragunath K P, Sudarmanian N S, Pazhanivelan S

Tamil Nadu Agricultural University, Coimbatore

With the global shift in the market economies, reliable information on crop areas has gained more importance than ever before. Hence, genuine statistics concerning the area and production of Cashew are necessary for market planning and export. The introduction of remote sensing technology into crop acreage estimation using satellite data has proven reliable and efficient in collecting necessary information. Optical remote sensing data with higher resolution are preferred for crop delineation and acreage estimation due to the capability of interacting directly with the object under investigation. A research study was conducted using Sentinel-2 optical satellite data to delineate and map cashew area. Major Cashew growing districts in Tamil Nadu are Ariyalur, Cuddalore. Ground truth points with attribute data were collected in the districts for classification and validation purposes. Per-pixel classification and Object-based classification were used for area estimation. Ariyalur district recorded 26897.4 ha with 83.1 per cent accuracy, while Cuddalore district recorded 27384.18 ha with 80.3 per cent accuracy in Per-pixel classification (Maximum-likelihood classification). Random forest (RF) algorithm was used in object-based classification method, by which Ariyalur district recorded 31486.59 ha with 88.6 per cent accuracy and Cuddalore district recorded 31432.23 ha with 90.1 per cent accuracy. On comparison with standard statistical data from Department of Economics and Statistics, Tamil Nadu, this study concludes that area estimated through object-based classification is more accurate and reliable.

Assessment of Vulnerability of Mountain Slope Instability Hazard Using Remote Sensing Techniques – A Case Study of Rishiganga River Basin, Uttarakhand

Ishita Raj, C.M. Bhatt, Pratima Pandey

Indian Institute of Remote Sensing, Dehradun

Slope failure and landslide are among the most prevalent devastating hazards throughout the Himalayan region. On 7th Feb, 2021 a disastrous glacial avalanche coupled with rapid debris flow and flash flood occurred in the Rishiganga river basin, which invites a wide scope to carry out further studies for such similar event in this region. The present work aims to identify the spatial distribution of areas which are potential to slope failure events in Rishiganga river basin in Uttarakhand, a highly dissected mountainous tract, using remote sensing technique and GIS tools. Taking into account various causative and triggering parameters like slope aspect, slope angle, curvature, relief, drainage density, distance to drainage, S P I , geomorphology, lithology, faults and lineaments, NDVI, land cover, and rainfall distribution, the present study was carried out adapting Frequency Ratio Model. Class frequency or individual class weight was derived using this model. All the thematic layers for analysis were prepared according to multi temporal high resolution Sentinel 2 images, Alos Palsar DEM, and images available at google earth platform of various time scale and with the help of Erdas Imagine and ARC GIS software (10.6.1). Then Rishiganga river basin was classified into 5 potential slope failure hazard susceptible zones. Finally, results obtained from this study were validated with the recent event report, inventory mapping and various ancillary data. This kind of local level study of slope failure susceptibility mapping can play a crucial role in identifying consequent effects in the lower catchment area where more precise assessments of potential hazard should be taken, which could help in reducing the risk and to adopt appropriate mitigation.

Comparison of Hybrid Polarimetry and Fully Polarimetric Spaceborne SAR Data for Characterization of Manmade and Natural Features

Awinash Singh, Shashi Kumar

Indian Institute of Remote Sensing, Dehradun

Synthetic Aperture Radar (SAR) is an active remote sensing technology that has the best capability to monitor landcover targets. It is widely used to distinguish between man-made and natural features of an area as it has an all-weather capability as it can penetrate the clouds as well as the soil up to a few metres. The main advantage of hybrid polarimetry over other polarimetry as it can transmit circularly polarized waves and receive two orthogonal mutually coherent polarization. This work is carried out on Radarsat-2 fully pol data and RISAT-1 dual-pol data over San Francisco in the USA. The main focus of this study is used to compare both of the polarimetry techniques i.e. hybrid polarimetry and fully polarimetry technique and to visualize the result accordingly based on the decomposition model used for each of the polarimetry techniques on a common study region. The models used in this work for fully polarimetric data are Freeman-Durden, Yamaguchi-3 and Multi-component scattering model decomposition (MCSM) which is a five-component scattering model and for Hybrid polarimetric data is Raney decomposition. A small part of the region is analysed for the surface scattering, volume scattering and double-bounce scattering for water bodies, vegetation and urban areas respectively. The results of the models are compared with each other and with sensors to ensure the ambiguities present in the areas and to characterize different features, too with the Google Earth image as some models enhance the volume scattering in the urban areas. The MCSM decomposition showed better results when compared with the other two decomposition model used in fully polarimetric data. The Raney decomposition model of the Hybrid-pol gives a better result when compared with the other decomposition models used in this study.

Soil Phosphorus Variability Impacts Inherent Soil Properties in Young Alluvial Plains of Kosi Region through Digital Agriculture

Rajni Prabha Rani , Y. K. Singh , Rajkishore Kumar

The present study was designed to investigate the impact of available phosphorus (P) modelling by using prediction model like Circular model, Spherical model, Exponential model and Gaussian model for spatial distribution of available P with different soil properties. The study aid to prediction map after best fitted model through geostatics. The results concluded that available phosphate high nonlinear dimensional relationships, resistance to "overfitting" of unknown soil properties. Principal component analysis (PAC) illustrated that soil available P governed more loading factor in PC1 (37.6%) and PC2 (18.5) components. This study leads to decision-making processes for P management in the soil.

Semi-Physical Approach based Spatial Rice Yield Estimation

Tamilmounika R, Pazhanivelan S, Ragunath K P, Kumaraperumal R, Sudarmanian N S

Tamil Nadu Agricultural University, Coimbatore

India is the second-largest producer of rice worldwide after China. Remote sensing based yield estimation provides timely and real-time statistics about rice production priory and precisely. Early prediction of crop yield is an essential factor for taking various policy decisions. Therefore, many spatial based yield estimation techniques were developed to accomplish the yield estimation from crop growth parameters by combining the environmental and edaphic factors. Among different techniques, the Semi-physical approach computes the daily biomass integrated over the crop growing season and the economic grain yield. It is an intermediate approach to the empirical and simulation models. This study was carried out in the Cauvery Delta districts of Tamil Nadu viz., Thanjavur, Thiruvarur, Mayiladuthurai and Nagapattinam during samba season 2020. Among the four selected districts, Thanjavur district recorded the highest rice grain yield of 3438 kg ha-1 while Thiruvarur, Mayiladuthurai and Nagapattinam districts recorded the mean yields of 3216, 3000 and 2652 kg/ha. The predicted yield were compared with the observed yield from the farmers€™ field. The mean agreement between estimated and observed mean yields at the district level was found to be 85.47 per cent. Mean R2, RMSE and NRMSE were found to be 0.78, 532.74 kg/ha and 14.52 per cent.

Knowledge - Based Approach in Generating Digital Soil Class Information for Tiruppur District, Tamil Nadu

S. Janarth, R. Kumaraperumal, S. Pazhanivelan, K.P. Ragunath

Tamil Nadu Agricultural University, Coimbatore

Using a decision tree approach, a study was done to provide soil class information for the Tiruppur district at the subgroup level. Digital Soil Mapping (DSM) creates a soil map by combining already available soil data, environmental variables, machine learning algorithms, geostatistical approaches, and knowledge-based methodologies. The SCORPAN model was used to carry out DSM. DSM was carried out based on the SCORPAN model. A total of 5185 soil profile points are collected from already available NRIS soil map (5072 Nos.) and actual profile observation (113 Nos.). The Tiruppur district is found to have the orders of Alfisol, Entisol, Inceptisol, Mollisol, Ultisol and Vertisol with 27 subgroups. A total of 38 layers of environmental covariates was generated representing the causes of soil formation viz., climate (3 layers), organism (8 layers), relief (20 layers), and parent material (7 layers) and layer stacked to obtain common spatial resolution. In this study, C5.0 function in the C50 package in R were used. It is a non-parametric decision tree structure based on Quinlan's C5.0 algorithm. The training data consists 80 per cent of field data and the remaining 20 per cent for validation purposes. The digital soil subgroups were predicted using the decision tree algorithm with 27 subgroups. According to the map, Alfisols covers an area of 29.80 per cent of the study area, followed by Entisols (25.67%), Inceptisols (25.47%), Vertisol (12.57%), Ultisols (2.32 %) and Mollisols (0.03%). From the generated subgroups, it could be concluded that the subgroup of Vertic Ustorthents occupied the major area of about 12.58 per cent, followed by Typic Ustorthents (9.11%) and Lithic Rhodustalfs (8.89 %). The overall accuracy of the map is 62 per cent with the kappa index of 0.61, which indicates the decision tree classifier's performance is good.

Performance of Ten Vegetation Indices on Tree Species Identification

Himali Vaghela, R A Alagu Raja
Thiagarajar College of Engineering, Madurai

Land a notion which broadly includes soils, vegetation, topography, climate, and other natural resources, is the basis for human life on the earth. The interaction between these components is vital for determining the productivity and sustainability of agro-ecosystems. Today, the identification of tree species has become essential in order to protect biodiversity, ecological equilibrium, and fulfil medicinal purposes. It is beneficial for large parts of society, foresters, farmers, biologists, conservationists, and landscape architects. The process of identifying tree species by conventional methods is time consuming and prone to human error. So, development of automatic tree species identification system is essential. Remote sensing is now a very important and popular area of research. Vegetation indices play a vital role to identify different tree species. A Vegetation Index (VI) is a spectral transformation of two or more bands designed to enhance the contribution of vegetation properties and allow reliable spatial and temporal inter-comparisons of terrestrial photosynthetic activity and canopy structural variations. Vegetation Indices (VIs) have been historically classified based on a range of attributes, including the number of spectral bands (two or greater than two); the method of calculations (ratio or orthogonal), depending on the required objective. The objective of this research is to identify tree species like Banana, Coconut, Guava, Mango, and Papaya from Sentinel 2 multi-spectral images. To carry out this research, sentinel images are downloaded from USGS explorer for Madurai region, South India by Jan 2021. Reference data are collected from laborious field visit. Based on reference data, regions on sentinel image are selected and Vegetation Indices AFRI1.6, AFRI 2.1, BNDVI, Datt1, EVI, LCI, NDII, NDRE, NDVI, and TCARI are calculated from sentinel data. Also, average values are calculated for different fields that are occupied by banana, coconut, guava, mango, and papaya. Different graphs of vegetation indices are drawn and analysed for choosing best performing index. Among 10 indices, four indices such as AFRI2.1, BNDVI, Datt1, and NDII are perfectly identifying listed tree species. From the indices calculated, the range occupied by different tree species and their mean are obtained. The range of AFRI2.1, BNDVI, Datt1, and NDII for Banana are 0.4-0.8, 0.47-0.52, 0.32-0.79, and 0.02-0.28, for coconut 0.59-0.84, 0.52-0.57,0.25-0.74, and 0.023- 0.37, for guava 0.36-0.66, 0.585-0.635, 0.24-0.62, 0.022-0.11, for mango 0.43-0.79, 0.055-0.60, 0.36-0.63, 0.021-0.114, for papaya 0.4-0.62, 0.57-0.62, 0.24-0.56, 0.024-0.149 respectively. The mean values for different tree species are much useful to discriminate different tree species. The mean values for AFRI 2.1, BNDVI, Datt1, and NDII for banana are 0.455, 0.502, 0.4405, and 0.148, for coconut 0.624,0.548,0.4305, and 0.1655, for guava 0.439,0.618,0.324, and 0.0345, for mango 0.54,0.577,0.424 and 0.091, for papaya 0.49,0.59,0.325, and 0.0575 respectively. If satellite data is provided for testing purposes, the range and average index values of the listed trees can be utilised to determine the existence of trees.

Assessment of Soil Salinity in Bandar Canal Command Area using RS and GIS

P. Indraja, Dr. H.V. Hema Kumar, Dr. K. Krupavathi, Dr. A. Mani

Dr. NTR College of Agricultural Engineering, ANGRAU, Bapatla

Land, a non renewable resource is becoming degraded in terms of productivity. Mostly land is affected by wind and water erosion, which is about 80% of land degradation followed by salinization/ alkalization and waterlogging. In India the extent of salt affected soils is about 6.73 million ha. Soil salinity reduces crop yield and in severe cases causes complete abandonment of agriculture. It is a major form of land degradation in agricultural areas, where information on the extent and magnitude of soil salinity is needed for better planning and implementation of effective soil reclamation programs. Hence assessment of soil salinity in irrigated lands of Krishna Central Delta was taken up using digital image processing and GIS techniques. Krishna Central Delta constitutes the command area of Bandar canal which off takes at prakasam Barrage, constructed on the holy River Krishna in Vijayawada, Andhra Pradesh. Different salinity indices were prepared from Landsat8 satellite images of Krishna Central Delta (KCD) which covers about 18 mandals of Krishna district, Andhra Pradesh. Normalized Difference Salinity Index (NDSI) was found to range from -0.71 to 0.22. Brightness Index (BI=Sqrt (R2 + NIR2)), Salinity Index-1 (SI1= Sqrt (B - R)), Salinity Index-2 (SI2= Sqrt (G - R)), Salinity Index- 3 (SI3 = R / NIR) and Salinity Index-4 (SI4=(SWIR1-SWIR2)/ (SWIR1 + SWIR2)) were found to range from 0.7 to 0.13, 0.42 to 0.11, 0.44 to 0.1, 6.0 to 0.64 and 0.43 to -0.42 respectively in KCD region. On comparing the correlation of all the indices with measured EC values of soil samples collected from the study area, NDSI index showed the best correlation of about 89.3%. It was found that the lands along the coast are mostly affected by soil salinity. From the thematic maps, it was clearly identified that the highest salinity patches fall in the mandals of Machilipatnam, Pedana, Koduru and Nagayalanka. Soil salinity was characterized into five different classes and out of entire KCD ayacut of 1,11,307.81 ha, an area of about 68,754.01 ha was found to be affected by moderate salinity conditions.

Landform Element Analysis for Soil Quality Parameters Assessment using Digital Terrain Model and Remote Sensing Data

Nandhakumar Murugan, Suresh Kumar, Justin George K.

Indian Institute of Remote Sensing, Dehradun

Landform elements classes are used as basic landform in describing soil type variability in the hilly and mountainous landscape. They are used as fundamental terrain units at the hillslope scale that controls the variability of soil forming processes and governing soil quality parameters. Digital terrain models (DTMs) are commonly being used to characterize land surface by analysis of slope, aspect, curvatures (convex and concave) and terrain indices in delineation of landform elements. Topographic Position Index (TPI) is a proven GIS based approach to derive the various landform classes from Digital Terrain Model (DTM). ALOS PALSAR DEM with 12.5 m resolution of radiometric-terrain corrected DTM data has been for terrain analysis of intermediate sub-catchment of Tehri Dam Catchment and to study variability in soil quality parameters. The annulus neighborhood with a 2*22 map scale was applied to derive the TPI. Small scale size in annulus neighborhood accurately achieved the delineation from ridge to valley in the sub-catchment. The combination of aspect and TPI provide seven landform classes i.e., ridge, shoulder (south & north), back slope (south & north), toe slope, and valley area. LULC was generated using sentinel 2A/B dataset in Google Earth Engine (GEE), with 5 major classes of agriculture, forest, scrubland, settlement, and water. Combining landform classes with LULC were produced the physiography of the study area. Among seven landform classes valley (28.22%) covers major class of the intermediate catchment. Twenty-three soil-physiography units as landform- land use classes were delineated in the intermediate sub-catchment. 116 soil samples were collected from the area representing different landforms during soil survey and analyzed to characterize soil quality parameters in the sub catchment level. pH in the area ranged from 4.28 to 7.72 and soil organic carbon ranged from 0.80 to 22.86%. The shoulder landform element exhibited maximum soil organic carbon content compared to other landform classes. Loamy to sandy loam soil textural classes were found to be predominant in most parts of study area. Total carbon and nitrogen contents ranged from 0.46 to 13.29 % and 0.10 to 0.66% respectively. Soil aggregate stability under different landform elements in the area ranged from 0.143 to 0.952, indicating wide spatial variation of soil quality parameters. The soil quality parameters varied widely with respect to different landform elements in the study area.

Forest Fire Monitering using Normalized Burn Ratio (NBR) and Burnt Area Algorithm in the Pauri Garhwal District, Uttarakhand

Rahul Pandey

SSJ University, Almora

Forest fires are the unplanned and uncontrolled fires having high flames up to several meters and the area burnt is also comparatively so large. Such wild fires are being supported by several other natural and men-made factors that provides fuel or heat to the uncommon incidents in the forests of the world as well as Uttarakhand. Remote sensing and GIS provide a platform to monitor these incidents and also to analyze further. Use of remotely sensed data and several burnt area extracting techniques and indices made it easier to complete the study and provide a better result and understanding of such incidents. On the tally of 13 districts, Pauri Garhwal has the largest share of the forested area in the state. The incidents are also comparatively much frequent in the district. This is a temporal study of the for five consecutive years (from 2017 to 2021). The data used is of landsat-8 (OLI & TIRS) having a resolution of 30 meters and a 15 meters panchromatic band. Red, NIR, Thermal and SWIR-2 bands are used to extract the burnt areas. For all the years, the data set used is of may during which the incidents of the forest fires are at the peak. The data taken of Landsat 8 is gone through the corrections like Top of Atmosphere (TOA) before and then used for finding Normalized Difference Vegetation Index (NDVI) and Normalized Burn Ratio (NBR). For better results and accuracy, the thresholds of 0.4 and higher are taken into consideration. Further, algorithms are prepared to extract the burnt areas more precisely and accurately. The study can be used to detect the changes in the burnt forested areas and it can be concluded how the incidents are increasing or decreasing with time. The expected outcome of the study is that the incidents of forest fires lead to degradation in forested area along with time. This study can be used as a reference and also be used to exactly get the burnt area in the district to bring the attention of the authorities towards the forests.

Machine Learning based Long Term Crop Pattern Change Analysis using Time Series Data

Joyita Dash, Prabhakar Alok Verma

Indian Institute of Remote Sensing, Dehradun

Agriculture is the largest livelihood provider in India and it plays a vital role in shaping the economic condition of the farmer as well as the whole country. During the past 140 years India has experienced significant land use land cover changes including deforestation, cropland changes and urban expansion. Remote sensing is one of the effective tools that can provide precise and actual information on the changes in cropping pattern over the time. The main advantage of remote sensing from satellites is the synoptic and repeated collection of data which allows retrieval of time series information on the spatial distribution of the cropping pattern over large areas.

Monitoring the spatial and temporal variations in cropping systems helps to describe the cropping pattern. There are many methods and techniques adopted for cropland classification that include phenology based algorithms, classification regression trees, decision tree algorithms, Fourier harmonic analysis, spectral matching techniques, support vector machines and Random forest algorithm. Machine learning algorithms are capable of learning complex pattern from training data. Many studies have adopted supervised and unsupervised classification algorithm. Supervised classification rely extensively on in-situ data or on interpretation of spectral signatures, making the classification process exhaustive.

MODIS NDVI time series data at a resolution of 250 m from 2003 to 2020 were used to extract changes in cropland use and cropping pattern by means Random Forest algorithm. The Google Earth Engine (GEE) cloud computing platform is used in this study to collect reference data of MODIS NDVI and to generate the classified map. The GEE is a system designed to enable visualization of geospatial dataset and provide a consolidated environment of massive data catalog for scientific analysis. The user friendly front end allows interactive data and algorithm development. In this study rather than statistical data, Machine Learning algorithm in addition to satellite derived NDVI time series data at a resolution of 250m from 2003 to 2020 is used to describe the changes in cropland and cropping pattern in Uttar Pradesh. Study revealed that agricultural growth in Uttar Pradesh has been relatively less volatile than that experienced at the all-India level in the past two decades.

Mapping the Spatial Distribution and Height of Rubber Plantations by Integrating Optical, Lidar and SAR Data Using Random Forest Algorithm in Sepahijala District of Tripura, Northeast India

Yamini Bhat, Subrata Nandy

Indian Institute of Remote Sensing, Dehradun

Rubber (Hevea brasiliensis) plantations are one of the rapidly expanding plantation systems especially in tropical areas, due to a growing demand for natural rubber. In India, Tripura is the second-largest producer of natural rubber. The present study aims to map the spatial distribution and height of rubber plantations in the Sepahijala district of Tripura by the synergistic use of optical, LiDAR, and SAR data using Random Forest (RF), a machine learning algorithm. Rubber plantations were mapped using the RF classifier in Google Earth Engine cloud computing platform on a median composite (November 2020 to March 2021) of Sentinel-2 imagery, capturing the deciduous nature of rubber to separate it from the evergreen forests of the region. A total of 10 spectral bands and 7 indices derived from the Sentinel-2 median imagery were used for the classification. The training sites used in the classifier were extracted from the high-resolution images of Google Earth. Out of the 17 predictor variables used in RF, the most important variable for mapping rubber was found to be enhanced vegetation index, followed by red band and soil-adjusted vegetation index. The user's and producer's accuracy of the rubber mapping was found to be 88.88 % and 96 % respectively. The overall classification accuracy of the land use land cover (LULC) map was 90.67 %. The rubber map was extracted from the LULC map for mapping the canopy height of the rubber plantations. The canopy height map of the rubber plantations was generated by integrating spaceborne LiDAR (ICESat-2) and c-band SAR (Sentinel-1) data. To map the canopy height, VV and VH backscatter values of Sentinel-1 and gray level co-occurrence matrix texture values derived from the backscatter were used as independent variables. hcanopy derived from the ATL08 product of ICESat-2 was used as the dependent variable. Based on the predictor importance, ranking of the independent variables was done and an RF model was developed using the best predictors to map the canopy height of the rubber plantations. The canopy height information generated can be an excellent input for modelling the carbon stock of the rubber plantations. There is a dearth of studies related to mapping the spatial distribution of rubber and its height in the Indian context. Hence, following the methodology adopted in the present study the mapping and monitoring of the rubber plantations of India can be done, which can be very effective for its management. The present study was carried out using freely accessible satellite data, algorithm, and platform, making it easy to apply on the rubber growing regions.

Analysing the Temprature Change through Indices: A Case Study in Haldwani City Uttarakhand (2000-2022)

Abhay Singh Parihar, Arvind Pandey, Dheeraj Chandra Kurai

Department of Remote Sensing and GIS, Almora Campus

As the population is increasing day by day, construction of building is taking place rapidly all over the world. Due to this forest cover is decreasing rapidly and the average temperature is rising. According to previous studies , the average global temperature on Earth has increased by atleast 1.1° Celsius (1.9° Fahrenheit) since 1880. The effect of this can even be seen in the hill state Uttarakhand. In last two decade, Haldwani city has witnessed a quick decline in forest cover due to the increasing number of built-up. This study is done for 5 different years (2000,2005,2010,2015 and 2021).The data used for this study is LANDSAT 7 ETM+ and LANDSAT 8 OLI/TIRS having high resolution and better thermal sensor . The data is radiometrically corrected using Top of Atmosphere (ToA) and then Normalized Difference Built-Up Index (NDBI) and enhanced vegetation index (EVI) is calculated .The main focus of this work is analysing the relationship between increasing built up area and declining forest cover in the Haldwani city of Uttarakhand district. The result of this study will help in the better implementation of smart city plans taking into consideration the changing climate scenario.

Analysing the Spatio-temporal Variations in Land Surface Temperature and Mapping the Urban Heat Islands in Dehradun

Sneha Pandey[1]; Gautam Talukdar[1]; Subrata Nandy[2]

[1]Wildlife Institute of India, Dehradun
[2]Indian Institute of Remote Sensing, Dehradun

Land Surface Temperature (LST) is the effective emitting temperature derived through infrared radiation; LST can be retrieved from space-based thermal infrared (TIR) data. Accurate information on land surface temperature is essential to a range of issues and themes in earth sciences. As the Indian cities continue to grow demographically and spatially, the urbanisation process will naturally lead to significant encroachment into other competing land uses. A major environmental consequence of urbanisation is the Urban Heat Island (UHI) Effect, wherein a few pockets of the city would experience higher temperatures than their surrounding areas. UHI effect is characterised as the most evident characteristic of urban climate.

This study addresses the gap of unavailability of temporal analysis of the Land Surface Temperature (LST) variations, which is leading to the expansion of the Urban Heat Island (UHI) effect. The study was conducted for Dehradun city, the capital city of Uttarakhand, lying between northern latitudes 30°13’ 38” and 30°25’ 01” and eastern longitudes 77°55’ 51” and 78°8’ 23”. This study reflects the spatial and temporal variations of the LST and UHI effect in Dehradun city. The satellite data-based analysis was done using Google Earth Engine, and ArcGIS version 10.7 was used to prepare the maps. We have identified the patterns of LST variations in Dehradun from 1984 to 2021 and mapped the locations experiencing the UHI effect. Landsat series of satellite data (Landsat 4-5, Landsat 7 and Landsat 8) has been used to calculate the LST over the Dehradun city region. The LST retrieved was used to investigate the urban heat island effect over the city both spatially and temporally. The temporal LST variations show that from 2010 onwards (i.e., 2010 to 2021), the annual increase in the LST of the city and UHI effect has increased more quickly compared to previous years. Several urban heat islands (UHIs) and Urban Heat Spots (UHS) was extracted as the most heated zones within the city boundaries due to increasing anthropogenic activities. Moreover, most UHIs and UHSs have a temperature 2-4 C higher than the surrounding natural areas and are developed within the built-up area with a dense population. Officials of Mussoorie Dehradun Development Authority should consider LST and UHI-related parameters for sustainable development within the city.

Impact of Vegetation Structure and Elevation Gradient on ICESat-2 Canopy Height Uncertainty

Divesh Pangtey, Rahul Bodh, Hitendra Padalia, Ishwari Datt Rai

Indian Institute of Remote Sensing, Dehradun

Vegetation canopy height is a key physical attribute for estimating biomass, habitat quality, carbon dynamics, modeling carbon stock, etc. The recently launched Advanced Topographic Laser Altimeter System (ATLAS) instrument on-board ICESat-2 (Ice, Cloud, and land Elevation Satellite) space-borne LiDAR offers the potential to quantify the canopy heights of forests from regional to global scale. The ATL08 geophysical data product of ICESat-2 specifically extracts terrain and canopy heights from the ATLAS point clouds. It provides critical information for estimating vegetation structural parameters, and the uncertainties associated with terrain and canopy heights for each LiDAR points. Before using the canopy height of ICESat-2 for any analysis it is important to understand the response of possible canopy height uncertainty with respect to vegetation and land surface parameters. For this study, the canopy height uncertainty of ICESat-2 points falling on the Nandhaur landscape over a year was analyzed. The ICESat-2 data were filtered and only the strong beams were used for the analysis. The study area is located at the foothills of the Himalayas comprising both mountainous and flat regions with elevation ranges from 200 to 1100m MSL. It was observed that tree density, canopy height and elevation influenced the canopy height uncertainty of ICESat-2 data points. As the tree density, canopy height and elevation increase the canopy height uncertainty also increased. The depiction of the response of possible uncertainty of ICESat-2 would help the researchers to effectively use ICESat-2 data that can help in precise estimation of biomass, habitat quality, modelling global carbon stock, carbon dynamics, canopy height map etc. at a regional and global scale.

Mapping Leaf Area Index and Chlorophyll in Tropical Moist Deciduous Forest Using PRISMA Hyperspectral Data and Partial Least Squares Regression

Mahima, Hitendra Padalia, Taibanganba Watham

Indian Institute of Remote Sensing, Dehradun

Leaf pigments, such as chlorophyll and leaf area index (LAI) are indicators of forest's health status. Photosynthetic potential and primary production depends on chlorophyll concentration. Whereas, LAI is a key biophysical parameter that influences the process of photosynthesis and transpiration as well as interception of rainfall by canopy. To understand the key processes of forests canopies (e.g. photosynthesis, respiration and transpiration), information regarding their spatial variation is necessary. Hyperspectral remote sensing data provides an effective and inexpensive method of estimating key biophysical and biochemical parameters. In the present study, the potential of space borne PRISMA hyperspectral data was assessed in estimation of leaf chlorophyll content and LAI. Partial least squares regression (PLSR) was used for estimating LAI and leaf chlorophyll content and determining important predictor variables. The study was conducted in tropical moist deciduous forest. In-situ LAI was recorded using plant canopy imager, concurrent with the acquisition of PRISMA hyperspectral image. Non-destructive estimation of leaf chlorophyll content was done using CCM- 200 plus chlorophyll concentration meter. CCI measurement was converted to absolute chlorophyll content values using published empirical relation between the two for different forest types. PLSR provided better predictions for LAI (R2 = 0.62, RMSE = 0.12) compared to leaf chlorophyll content (R2 = 0.41, RMSE = 2.87). Vegetation indices (VI) derived from NIR and green band combination provided best prediction for LAI, whereas, VI derived from NIR and red band combination provided best prediction for leaf chlorophyll content. The study suggests that further rigorous field sampling and laboratory analysis of leaf chlorophyll content is required for exploiting the full potential of PRISMA hyperspectral data.

Use of Hidden Markov model (HMM) to Quantify Animal Movement in Heterogeneous Landscapes

Amrapali Tiwari[1,2], Sameer Saran[1], Kirti Avishek[2]

[1]IIRS Dehradun, [2]BIT Mesra, Ranchi

Conservation of wildlife especially big cats is immensely important in India because of their lower frequencies and the fact that they belong to the top of the food chain as top consumers. It is essential to comprehend animal behavior before devising conservation mechanism for them. Tracking animal movement can be used as method to analyse animal behavior in a landscape. With availability of remotely sensed data and improvement in tracking technology various research avenues have been opened in this area. Yet this technology is vastly underutilized owing to the unavailability of statistical tools for appropriate analysis. Such studies are immensely important in conservation biology because deciphering probable routes for animal movement in the landscape would help in controlling human-wildlife conflict in the zone. In India, cases of human-wildlife conflicts are increasing because of uncontrollable increase in population and forest land encroachment threatening various endemic species of India. Being one of the mega biodiverse country in the world it is crucial for India to conserve its natural resources. This paper reviews state space models (SSMs) and their use in analysis of animal movement data to draw inference about their behaviors. One of the SSM, Hidden Markov model is applied on the GPS location data of royal Bengal tigers (Panthera tigris tigris) acquired from GBIF in and around landscape of Jim Corbett tiger reserve. An R package moveHMM is used to execute this model. This model relies on the understanding that animal movement in a landscape is driven by underlying behavioral modes and it has been successfully used in various studies for analyzing animal movement data. The results reveal hypothetical movement paths for tigers in the study area. The results can further be refined by incorporating topographical, anthropogenic and other constraints in the model.

Potential of Planet Scope, Sentinel-2, LANDSAT-8 data for characterizing Alpine plant communities using Random Forest Algorithm

Joyal Arya, Ishwari Datta Rai
Indian Institute of Remote Sensing, Dehradun

Alpine is one of the most diverse and sensitive ecosystems of the world which accounts more than 4% of world's known flowering plant species. In Himalayas, the alpine zone forms nearly 33% of the geographical area. The alpine area in Himalayas starts at 3000mtrs abmsl, i.e., just after the tree line which is occupied by the krummholz (stunted vegetation) formation. It is important to monitor the smallest of changes in diversity in the areas which are inaccessible over time as. Remote sensing (RS) has emerged as the most practical tool in elucidating the larger area conditions that influence the distribution, abundance, and interaction of species. It is one of the most useful technologies for characterizing the plant communities in the alpine region over larger spatial and temporal extent. One of the major issues of working in the alpine region is availability of cloud free data. Various medium-resolution satellites like Sentinel 2, Planet-Scope are freely available which have high temporal resolution as it gives higher chances to avail cloud free data. The study focuses on applying the ground data on various remotely sensed data for characterizing the alpine communities using Random Forest Machine learning model. Machine Learning models based on the training data provided by the user generates the predicted classified map based on the plurality of decision trees. The use of Remote Sensing along with the Machine learning model helps identify various communities pockets helpful in the conversation. The major plant communities like Danthonia Grasslands, Kobresia Meadows, Rhododendron anthopogon, Potentilla fulgens-Geum elatum, Saussurea obvallata - Bistorta affinis which are highly medicinal and rare are mapped which helps forest planners and researchers for better conservation planning and policies for the alpine ecosystems.

Comparison of Trend and Distribution of First and Third Wave of COVID -19 in Rishikesh using GIS Technology

Anaswara Manohar, Dr Smita Sinha

AIIMS Rishikesh

Background: After the emergence of new viral infection in 2019 the whole world was under the grip of COVID -19 infection. Even India comes under the wrath of novel coronavirus. From 2019, till date we have faced the third wave of COVID -19. Since, the viral gene is mutating, there is change in distribution and trend of COVID -19 cases too. Geospatial technology is one of the advanced technologies, which helps in epidemiological distribution of diseases.

Aim and objective: The research is proposed to study the comparison of trend and distribution of first and third wave of COVID -19 in Rishikesh using GIS technology.

Methodology: The proposed study will be conducted in two phases. In phase one: Distribution of COVID -19 cases in first and third wave in Rishikesh will be mapped using GIS technology. Phase 2nd : Comparison between COVID -19 cases distribution in first and third wave will be done to see the trend.

Conclusion: Inferences of the study results can be differences in the rate of spread and virulence of COVID -19 in the first and third wave.

Role of Health GIS in Assessment of Infectious Disease Caused by Avian Hosts: Migratory Birds

Vishal Kumar[1,2], Sameer Saran[1], C Jeganathan[2]

[1]IIRS Dehradun, [2]BIT Mesra, Ranchi

Disease effect not only humans but other species too. Once in the food web, microorganisms spread to entire species associated to it. Some are afflicted, while others serve as hosts. Birds are also an integral component of food webs. Migratory birds traverse thousands of kilometers across different countries and thus have high potential to carry and spread pathogens globally via. their migratory flyways. This study gives an overview and analysis of emerging infectious diseases (EID) due to factors like international travel, migrations and climate change which are main cause of EID€™s in humans (Jones et al. 2008). Many diseases in past has spread through avian host, most popular example is of West Nile virus (WNV), spread over southern Europe and North America (Kilpatrick 2011; Ulbert 2011). Other diseases caused by pathogens of migratory birds like avian malaria, cholera, influenza, aspergillosis and botulism are likely to increase as a result of climate change (Gilbert et al. 2008; Atkinson and LaPointe 2009; Traill et al. 2009). For example, tick-borne encephalitis (TBE) virus found in higher altitudes have been introduced there due to increasing temperatures. Another case is of eastern North America, where increased precipitation creates wetland that attracts migratory ducks carrying influenza with them. Similarly, in Europe harsh winter restrict waterfowl to smaller areas creating conditions conductive to H5N1 transmission. Global warming can facilitate the spread of tropical parasites and their vectors to higher latitudes, inversely climate change also has the potential to disrupt the host-pathogen relationships that have developed through time. These climatic changes and globally spreading EID€™s shows remarkable spatial variations which can be effectively and efficiently analysed using Geo-health and spatial data. Birds can be geotagged and spatial data of birds movement can be analysed by bird-monitoring network operated by experts and help in early detection of emerging avian viruses. Apart from geolocating, the habitat suitability of affected birds can be used to spatially delineate areas having greater probability to be affected. Modeling of Potential distribution of West Nile Virus(WNV) by combining birds surveillance data with environmental factors indicating high risk areas where prevention measures should be implemented (Valiakos et al. 2014). With spatio-temporal knowledge of birds breeding, nesting and wintering sites, GIS based surveillance programs can be designed accordingly. The spillover of pathogen to human and livestock can be monitored by using spaced based technologies and thus efforts should be made in Geo-health sector to monitor and mitigate the disease spread. The most recent examples of spillover are Nipah, Ebola, COID-19 out of which COVID-19 applications demonstrate wide usage of geospatial technology in global and national surveillance and management of health-care facilities.

Assessment of Relationship between Prevalence of Non-Communicable Diseases (NCDS) and Availability of Urban Green Spaces using Geospatial Technology in Rishikesh

Parteek Walia, Ranjeeta Kumari, Yogesh Bahurupi, Nisarg Arvindan

AIIMS Rishikesh

Introduction- NCDs being chronic generally have slow progression rate and are believed to be combination of mainly genetic, physiological, behavioral and environmental factors. All these are interlinked with one another and form a web of causation for various NCDs across the globe. NCDs not only cause human suffering but have deteriorating effects on socio-economic development of a country too. Rapid unplanned urbanization and Globalization are among various factors that led to epidemiological transition in India. Thus today there is even a greater need of stronger scientific reasoning as to why and how environmental factors are associated with NCDs. Uttrakhand being a mountainous state is facing a mass and rapid phase of urbanization as more and more of public is migrating to lower plane areas from mountains in search of better living conditions. Thus, need for establish a strong relationship among NCDs and its various causative factors increases many folds so that perquisite for any unwanted outcome can be done.

Aim & objectives- The research aims to find relationship between numbers of people per hectare of urban green spaces to prevalence of NCDs among population residing in the town of Rishikesh, Uttrakhand. The study will also try to predict future consequences (if any) in term of proportion of people with NCDs given the situation for urban green spaces remains unchanged.

Methodology- The prevalence of NCDs will be assessed by thorough analysis of available research material and HMIS data available for the state of Uttrakhand following which availability of urban green space/s would be mapped using GIS based property database conducted by Finance Department, government of Uttrakhand and will be confirmed using geospatial platforms like Google maps, Google earth etc. following which total population will be calculated by analyzing available governmental data.

Expected Outcome- The study will result in formation of an association (If any) between availability of urban green spaces and prevalence of NCDs among urban localities. The number of population per hectare of green space will also be calculated to help form a baseline for further future policy making. This will also help to evaluate present Urban development policies and check whether they align with the concept of health in all policy or not.

Assessment of Relationship between Prevalence of Cancers and Availability of Green Spaces Using Geospatial Technology in Rishikesh

Nisarg Aravindan, Ranjeeta Kumari, Yogesh A Bahurupi, Prateek Walia

AIIMS Rishikesh

Introduction- Cancer is a disease that kills 10 million people every year with it being the second leading cause of death worldwide. At least one third of common cancers are preventable by reducing the exposure to risk factors such as tobacco, obesity, physical inactivity, infections, alcohol, environmental pollution, occupational carcinogens and radiation. A few modifiable risk factors like physical inactivity and environmental pollution are also dependent on the topography of the environment such as green spaces. Large green spaces are present in the Indian state of Uttarakhand, which is a mountainous state undergoing rapid urbanization and decreasing green cover. Thus, there is need for assessing a relationship between prevalence of cancers and the availability of green spaces using geospatial technology in Rishikesh, Uttarakhand.

Aim & objectives- The research aims to find relationship between numbers of people per hectare of green spaces to prevalence of cancers among population residing in the town of Rishikesh, Uttarakhand. The study will also try to predict future consequences (if any) in term of proportion of people with cancers given the situation for green spaces remains unchanged.

Methodology- The prevalence of cancers will be assessed by thorough analysis of available research material and HMIS data available for the state of Uttarakhand following which availability of green space/s would be mapped using GIS based property database conducted by Finance Department, government of Uttrakhand and will be confirmed using geospatial platforms like Google maps, Google earth etc. following which total population will be calculated by analyzing available governmental data.

Expected Outcome- The study will result in formation of an association (If any) between availability of green spaces and prevalence of cancers among urban localities. The number of population per hectare of green space will also be calculated to help form a baseline for further future policy making. This will also help to evaluate present urban development policies and check whether they align with the concept of health in all policy or not.

Urban Heat Island or Urban Cool Island: An analysis of Major Cities in India

Sreeraj R, Kshama Gupta

Indian Institute of Remote Sensing, Dehradun

Urbanization in the 21st century has given rise to many critical issues such as increase in pollution levels, climate change and increase in temperatures of urban areas. The rise in temperatures in the urban area has led to the formation of Urban Heat Islands (UHIs). However, the spatial pattern of UHI has high diurnal, seasonal and inter region variability and sometimes it leads to formation of Urban Cool Island (UCI) at a particular time of the day in a geographic setting. UHIs in the urban areas have severe health effects on the urban population including high mortality due to high temperatures and heat waves. The present study is aimed at analysing the diurnal and seasonal variability of Land Surface Temperatures within different climate zones of India. These include cities like Delhi, Lucknow, Bangalore, Kolkata, Chennai, Patna, Dehradun and Jodhpur for the year 2020. The core urban built up area was extracted from the Global Human Settlement Layer (GHSL) and MODIS Terra satellite daily and 8-day average data was used to analyse the Land Surface Temperature (LST) values of different cities to assess diurnal and seasonal variability. The months of May, August and December were selected to represent Summer, Monsoon and Winter, the three main seasons of India. Ten buffer zones of 1 km each were generated outside the core urban built up area and LST differences of the buffer zones with the urban built up were calculated. The Advanced Wide Field Sensor (AWiFS) Land Use land Classification (LULC) obtained from Bhuvan portal data was used to calculate the land use classes in the study regions. Most of the cities displayed high temperature in core urban area than the rural area (10th buffer zone). However, Jodhpur (situated in arid region) showed a UCI effect. Similar trends were seen in Bangalore urban area which has displayed both UHI and UCI effect. The temperature decrease from the built up area towards the rural area was mostly characterised with the increase in vegetation cover in the subsequent zones. However, in Patna city presence of large water body (River Ganges) shown profound impact on spatial patterns of UHI. A sharp decline in LST was also observed over the Kolkata urban area due to the increase in forest area between the core urban built up and zone 1. All the cities except for Chennai showed a higher LST in the Built up and the consecutive zones during the august season compared to the other seasons. An understanding of the LST variations in and around urban centres can help to mitigate the rising LST and plan for future UHI mitigation strategies to reduce the health impacts of UHI.

GIS Technology for Mapping Dengue Cluster Cases in Haridwar and Accessibility to Nearby Health Care Facility

Aakriti Jasrotia, Vartika Saxena, Yogesh Bahurupi

AIIMS Rishikesh

Introduction: Geospatial technology plays a very crucial role in public health by detecting the source of disease and mapping the cluster of cases. Through GIS technology, information regarding the accessibility of healthcare facilities can be assessed. In Spite of an intensified dengue prevention programme, 550 dengue cluster cases were found in Haridwar alone in 2021 as per a report by Times of india. AIM & OBJECTIVE: The research proposal will be built on the aim to map dengue cluster cases in the Haridwar district of Uttarakhand state using GIS technology and to assess the accessibility of health care facilities.

METHODOLOGY: The research will be conducted in two phases: In Phase one: Mapping of all cases of dengue during the peak season from June to September found in Haridwar district of Uttarakhand state will be done using geospatial technology .In phase two: after mapping accessibility to health centers will be assessed to analyse how far patients have to go to get their treatment done . CONCLUSION: Implication of study results can be location where more dengue cases were found and reasons for cluster of dengue cases. Inferences from the study results can be whether the dengue cases found in difficulty in accessing the treatment from the health care facility.

Local and Spatial Analysis of Women's Health Access Index and Health Center: A Case Study of Rajasthan

Tulika Tripathi, Vijay Kumar

Central University of Gujarat

Access to health remains a crucial concern for the treatment seeking behavior in India, particularly for women. So far in the health literature, access to health have been analyzed from the perspective of availability of health centers, cost of care and attitude to seek care. However, the local and spatial characteristics of the health centers which has an important implication for the approachability of the health center have not been studied. With emergence of GIS methods of analysis, such studies will have important policy information to setup the health centers. We have hypothesized that in India with the strong gender norms of mobility and issues of transportation to medical fecality and other locational characteristics will play important deterrent for women€™s access to health care. For the present paper we have taken the case study of Rajasthan, due to the data availability. We have used the number of public health center for all the districts of Rajasthan for 2021. Using unit data from NFHS-4 we have developed the women access to health care index. Further we plot the health center data with the health care index data on the district level map of Rajasthan, using GIS. We have developed the district level map of Rajasthan, that shows the availability of public health centers along with the women€™s access to institutional delivery, maternal mortality, BMI, Anemia level and the composite index of access to health care. The results of the study suggest overall state the respectively positive correlation between health centers and institutional delivery or BMI 0.20 and 0.21. However, the district wise correlation is different, which means positive or negative, based on the availability of health centers in districts. We have seen the availability of health centers are significantly less in many districts on a location basis. The variation in the access to health services controlling for the number of health center suggest that the locational factors play important role in determine access to health services for women. The study sets the background for further research using GPS locations of health center and access to health services of the household in the distance of 5-10 KM as per the GOI standard norms.

Geospatial Technologies and Tools Cut Through the Thick Fog of Alternating Views about Healthcare and Bring Real Data and Results to the Forefront

Vedant Raj Chittravanshi

University of Allahabad

In the recent times, with the COVID-19 outbreak, the twin threats to lives and livelihoods were the major areas of concern, but gradually these threats were overshadowed by, the will to re-establish the pre "pandemic world order and stabilisation, and how this manoeuvre is to be supported with expanded opportunities, digital tools and new public health surveillance programs". The Use of Geospatial Technology in Health Care would- Enhance, decision making in, efficiency, improve quality management, and reduce cost of, various Healthcare facilities. Help geographers/administrators integrate social determinants and community-specific information into their population health management strategies. Ensure that emergency personnel can be deployed before/after an area would get affected by a hazard due to various natural /anthropogenic factors. A frequent continuing problem of most of the places in the world lies in a poor spatial conceptualization of risk factors; in many studies, existing knowledge of healthy environment, awareness regarding the terrain/slope, socioeconomic distress, and other determinants is not incorporated. This problem is solved by using Geospatial Technology that gives healthcare professionals the capability to visualise health trends and take targeted actions primarily based upon those results. One example of this action could be from tracking cancer outbreaks in India and finding evidence of increased prostate cancer levels in communities adjacent to crops heavily sprayed with pesticides. The Danida-assisted National Leprosy Eradication Program (DANLEP) is one of the foremost organizations to deploy Geospatial Technology in the health sector in India. The DANLEP mapped the drug delivery points to patient location for the entire state of Madhya Pradesh. The map so developed by DANLEP is being extensively used by other health sector programs, like TB control, HIV/AIDS, Maintaining Cold Chain equipment for Pulse Polio, etc. If we take the example of PRAYAGRAJ-The 'Main Centre' has the best health care facility in the entire city, largely comprising of the economically well to do sections and hence for them receiving medical aid becomes easy. As we move away from the core, we can see that the number of health care facilities have grown, these facilities are mainly used by the middle class residents and are able to sustain because it is generally near the residences of the doctors/medical practitioners as well as near medical colleges. The last circle comprises of industrial areas and slums or the residences of the working class, the number of health care facilities are the least and are far flung, thereby failing to provide immediate medical aid and advice, because of which the people

seeking help, have to travel farther inside the city.Conclusion-The Geospatial Technology merged with Healthcare has a very wide potential applicability and it sustains and grows with the technology advancement. However, that is a still far cry in countries like India where healthcare system, even in the private sector, is more of a subsidized system with the burden of cost-cutting and cost restrains. Apt expenditure for proper infrastructure can however change this established system, targeting the distant future and the expenses for it, and is also considerate about the futile and losses if any.

Change in the Geographical Accessibility to Trauma Centers after the Addition of 7 New Trauma Centers in the State of Rajasthan

Kartik Nair, Amba Shetty

National Institute of Technology Karnataka, Surathkal

The number of accident-related deaths in the state of Rajasthan, India is increasing yearly as compared to the decrease in national accident cases and accident-related mortality rates. This increases the burden on the Trauma Care Facilities in the state. Recently in June 2021 the Rajasthan government has announced 7 new TCFs in existing CHCs. This study focuses on assessing the geographical accessibility to trauma centers in the state of Rajasthan and the effect of the addition of 7 new TCFs on the same. Primary population and administrative data are collected from Census 2011 and the software used for computation of results is QGIS. Open street map is used as the base map and also used for extracting the road transport network. ORS Tools plugin is used for generating Isochrone maps. Our analysis suggests that the addition of 7 new TCFs leads to the change of 30 min serviceable area from 12.76% of the total area of the state to13.52% of the total area of the state. This study shows how GIS could be useful for decision evaluation, especially focusing on improving availability and geographic accessibility. Programmatic planning, particularly for optimizing resource allocation is made easier with the help of GIS tools.

Vaccine Distribution Optimization Using GIS

Bijo George Philip, Priyadarsini Sivaraj, Mehak Jindal

Indian Institute of Remote Sensing, Dehradun

Vaccinations have been proven effective in preventing illness, disability and death from infections over hundreds of years, and optimizing their distribution is a critical step toward ensuring equitable and efficient coverage among a population. The most common challenges in vaccine distribution are the lack of presence of global suppliers, gaps in the supply chain, unequal procurement processes, and also the digital divide. Addressing the issues associated with the development and distribution of vaccines will augment the effort to efficiently get vaccines to hundreds of millions in the shortest period of time. In majority of the cases, since vaccination progress is tracked in terms of numbers, the spatial distribution of the same is generally unavailable. Using the COVID-19 pandemic as a case study, this paper examines the potential for using GIS for vaccine distribution optimization.

In the proposed optimization strategy, there are two major components: First, the time required to develop herd immunity by vaccinating atleast 70% of the population is calculated so that the vaccination distribution could be carried out for that phase in an equal manner. The main steps include finding the present state wise distribution of vaccinated individuals in India and calculating the number of days needed for vaccinating atleast 70% of the population in each district. Once the herd immunity is achieved, the prioritization of drives in low vaccination rate areas is done through identification and initiation of dynamic vaccination drives based on user inputs with the help of GIS tools. The analysis is then carried out in terms of projected vaccination rates versus number of days required. Further, survey forms are created using QRealTime plugin, and the vaccine requirement hotspots are identified. Finally, based on the derived results, vaccine distribution is prioritized and distributed over the conventional way of allocation across centres.

Interactive Map Visualization of COVID-19 World Data with 3D Virtual Globe

Priyadarsini Sivaraj, Bijo George Philip, Mehak Jindal

Indian Institute of Remote Sensing, Dehradun

The COVID-19 pandemic has demonstrated the interconnected nature of the world and has brought out the importance of data availability. This data needs to be efficiently conveyed to people, since in the event of a pandemic like this, intuition cannot substitute for facts to understand how the spread is advancing. Data when combined with interactive visualization techniques would enhance the power of data and has always played a key role in scientific analysis. The on-going COVID-19 pandemic poses new challenges to data scientists for its vast and rapid spread and significant economic impact. This project aims to develop a solution to this problem by facilitating an interactive visualization of COVID-19 data on the 3D virtual globe. A time range slider is also provided so that the timeline of the pandemic could be shaped and the spread be documented. This temporal visualization would be helpful in identification of the hotspots and understand the spread of disease over time. The globe.gl (UI component for Globe Data Visualization) template for displaying a choropleth is taken and changes are made according to the project objective. The COVID-19 data is taken from API that gets automatically updated on daily basis. The code is further modified to display the choropleth of total number of COVID-19 cases reported in each country. A table is created (by means of coding), to display the relevant details like the total cases, new cases reported, test positivity rate, vaccination rate, etc. pertaining to a specific country, over which the cursor is hovered upon. A time slider is also incorporated to visualize the temporal data. The visualization achieved here is interactive as there is a dynamic update of details corresponding to the country over which the cursor hovers.