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LAND USE AND CLIMATE CHANGE

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Content

Impact of Climate Change on Land use/land cover change at watershed level: Case studies from Rajasthan, India

Sayema Jamal, Ayesha Jamal, Akram Javed

1. Introduction

The ecosystem is always believed to be frail in an arid region and the land cover changes often shows the most significant effect on the environment because ofanthropogenic activities or natural processes (Zhou et al., 2008). Land use/land cover change (LU/LC), associated with climatic changes, has become a focus of the study on the interaction between human activities and the natural environment. Land cover changes can be regarded as one of the most sensitive indicators that echo these interactions (Bisht and Tiwari, 1996).

Watershed management has acquired immense importance in the recent past years and involves the development and conservation of natural resources with the active participation of local people, institutions and organisations in harmony with the ecosystem. It has emerged as a new paradigm for planning, development and management of land, water and biomass resources with a focus on social and environmental aspects. Watershed management programmes yield multiple benefits, such as sustainable production, resource conservation, groundwater recharge, drought moderation and employment generation.

Remotely sensed data because of its synoptic view and its ability to acquire images in a time series domain has extensively been utilised in LU/LC mapping and assessing change detection (JayaKumarand Arockiasmy, 2003).Since watershed data and watershed processes have spatial dimensions, GIS acts as a powerful tool for understanding these processes and managing the potential impacts of human activities.

2. Objective

In the current study, an attempt to correlate the changes in climatic conditions with land use and land cover has been made at the watershed level. Two watersheds namely Mithri Watershed and Jaggar watershed from Pali and Karauli district, respectively have been chosen for the present study.

3. Study Area

3.1 Mithri Watershed, Pali district (Western Rajasthan)

The Mithri watershed lies in the western part of Pali district, Bali block and covers an area of about 313 km^2. The watershed has maximum and minimum elevation of 1059 and 287 meters above mean sea level (MSL) respectively. Digital Elevation Model (DEM) derived from ASTER data reveals that higher elevations ranging from (838-1059 m) are encountered in the South-East part of the watershed represented by Hills and Ridges. The Mithri river is ephemeral in nature and flows from South East to North West direction.

3.2 Jaggar watershed, Karuli district (Eastern Rajasthan)

The main Jaggarriver flows almost south to North and joins the main Gambhirriver at 26°51' 29" North and 77°04'52" East. The area is mainly drained by the Jaggar river and its tributaries. A small check dam (called Jaggar bandh) is built in the central part of the watershed, which primarily serves as a source of irrigation for agriculture at the local level through the canal. The elevation information derived from ASTER shows maximum and minimum elevation of 388 and 202 meters above mean sea level (MSL) respectively.

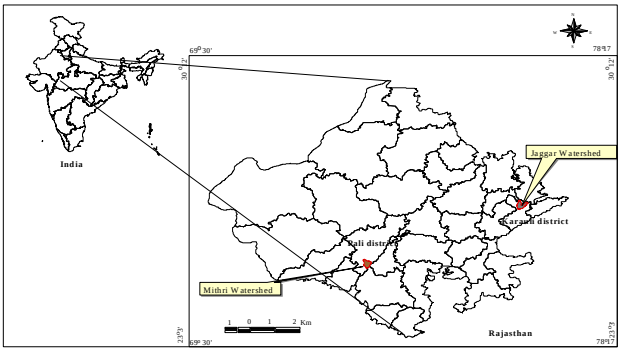

***Figure 1**:* Rajasthan map showing the location of the watersheds

4. Methodology

Data sets used for the present study were derived from multiple sources and agencies, such as Survey of India Topographical Maps, Satellite Imagery from NRSA, Hyderabad. Moreover,meteorological data were collected from Indian Meteorological Department, Pune, ground data/GPS coordinates through field visits and secondary data from various government and non-governmental agencies.

Survey of India (SOI) topographic map numbers 54F/1 & 54 F/2, 54 F/5 for Jaggar watershed, Karauli district surveyed in 1968-1969 and 1983-1984 and 45 G/8 for the Mithri watershed, Pali district surveyed in 1971-72 on 1:50, 000 scale, were obtained from Survey of India, New Delhi, and Dehradun. For the purpose of demarcation of boundaries of the watershed, toposheets were used and slope, elevation and directions of drainage flow were taken as the basic inputs.

Geocoded Standard False Colour Composites (FCCs) of Indian Remote Sensing satellite IRS IA Data Linear Imaging Self Scanning (LISS II), (Path-Row: 29:49) of 30th May 1989; IRS-1C Linear Image Self Scanning (LISS III), (Path-Row: 96-52) of 13th May 1998; IRS-P6 (LISS III), (Path-Row: 98-52) of 27th May 2009 on1: 50,000were procured from National Remote Sensing Agency (NRSA), Hyderabad for the Mithri watershed.

Geocoded Standard False Colour Composites (FCCs) of Indian Remote Sensing satellite IRS-1A Linear Image Self Scanning (LISS II), (Path-Row: 31-51) of 19th May 1990; IRS-1C (LISS III), (Path-Row: 98-52) of 28th April 1998; (IRS-P6) LISS III (Path-Row: 93-54) of 7th May 2010 on 1: 50,000were procured from National Remote Sensing Centre (NRSC), Hyderabad for Jaggar watershed.

Meteorological data observed and recorded for the annual average maximum and minimum temperatures and annual average rainfall for the period 1977 – 2007 for Karauli district and 1969-2008 for Pali district were obtained from India Meteorological Department (IMD), Pune.

5. Results and Discussion

5.1 Climate data analysis

Mithri Watershed, (Pali district) Western Rajasthan

Maximum daytime temperatures in summer and winter have been found to be increased by 0.2°C and 0.15°C respectively, whereas, for monsoon, it shows a decline of 0.06°C. The minimum night temperature also shows a decrease in summer, winter and monsoon seasons by 0.12, 0.19 and 0.13°C respectively. The rainfall data analysis shows a declining trend from 596 mm in 1969 to 455 mm in 2008 with a total decline of 141 mm with a standard deviation of 338.34% for 1969-2008. The steep plunge in rainfall graph in the years 1969, 1974, 1987, 2002 and 2008 points towards the years of severe droughts that occurred in the study area (Figure 2a).

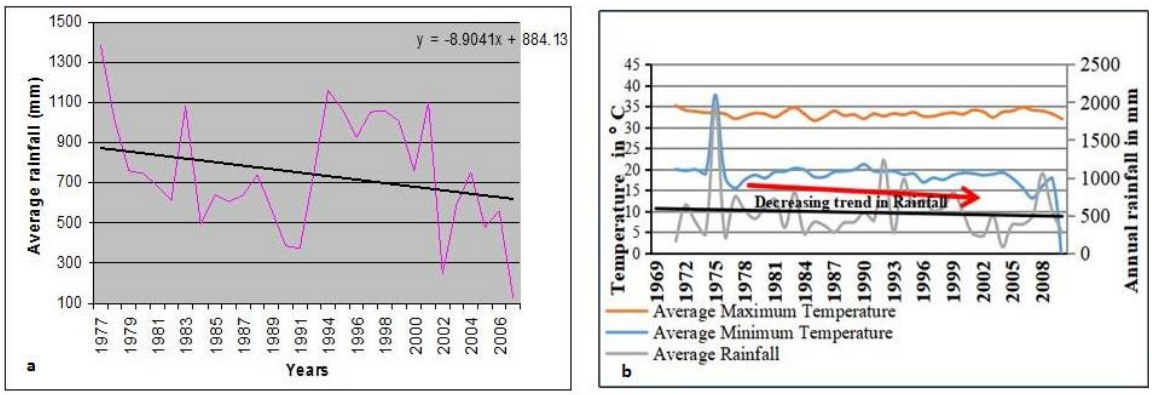

***Figure 2**:* Graph showing variation and general declining trend of rainfall in two watersheds ((a) Mithri and (b) Jaggar).

Jaggar Watershed, Karauli district (Eastern Rajasthan)

The trends computed for the annual average maximum and minimum temperatures show an increasing trend from 1977 to 2007, for all three seasons, except for maximum temperature in the winter, which show a declining trend. Analyses of temperature data reveal that the maximum daytime temperature in the winter season has decreased by 0.06°C whereas temperatures in summer and monsoon seasons have increased by 0.03°C and 0.32°C respectivelyduring the period of 1977-2007. Minimum night-time temperature also exhibits an increasing trend by 0.03°C, 0.20°C and 0.23°C during winter, summer and monsoon seasons respectively. As per the analysis of rainfall data, a markedalteration in average annual rainfall has been indicated as illustrated by a zig-zag trend for the period of

1977-2007. The standard deviation of annual rainfall is about 288 mm with a coefficient of variation of 37.062% with a total declineof 269 mm (Figure2b).

5.2 Land use/Land Cover Change Analysis

Land use/land cover assessment is one of the most important parameters to meaningfully plan for land resource management. Remote sensing and GIS effectively assist in natural resource management by providing timely, accurate and up-to-date information obtained from satellite-based high-resolution remotely sensed data on a cost-effective basis.

Mithri Watershed, Pali district

From the satellite data (Figure 3 a,b,c), cultivated land, uncultivated land, wasteland, forest, settlement, waterbody, and the dry river was clearly delineated. Pali district has faced several drought years, which has resulted ina reduction in cultivated land due todecreased net sown area. Additionally, due to the drying up of the surface water and the reduction in water by 12 to 15 m in the deep wells in the region, the cultivated landshave alsoendured a setback due toinsufficient irrigation facilities. It covered an area of 60.23 km^2 (19.36%) in 1989, which reduced to 37.31 km^2 (12.36%) in 1998. Dense forest-covered 112.38 km^2 (35.86%) in 1989, but decreased to 90.09 km^2 (28.75%) in 1998. In a span of another 12 years, it has further decreased to 72.94 (23.87%) in 2009.

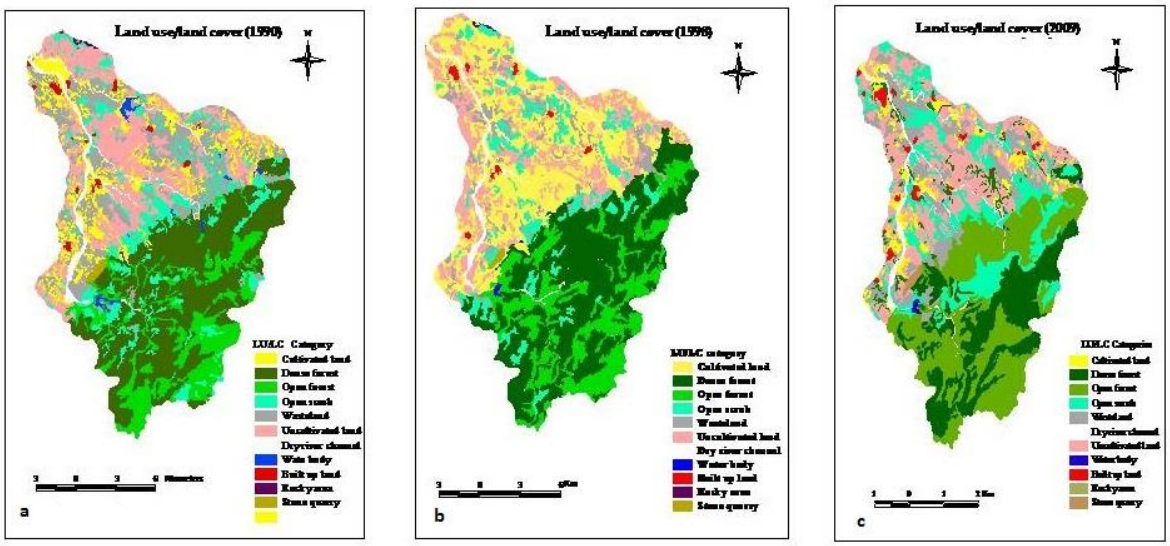

Figure 3*:* Land use/ land cover maps for Pali District of the derived from IRS data of (a) 1990, (b) 1998 and (c) 2009

Open forest occupied 20.35 km^2 (4.93%) in 1989, which increased up to 25.12 km^2 (11.42%) and further increased to 32.74(11.42%) in 2009. The area under uncultivated land in 1989 was 30.35 km^2 (9.75%), which increased to 38.36 km^2 (13.97%) in 1998 and augmented to 49.23 km^2 (16.56%) in the year 2009. As the water resource in the region is dependent on scanty and erratic rainfall, the duration of availability of water in water

bodies gets drastically reduced in the drought years. For the last 10-11 years, Mithririver has been witnessed to be dried in the Pali district. Shallow wells dry up fast and deep wells become deeper. The quality of groundwater depreciates and the concentration of undesirable constituents e.g. fluoride and nitrate reach toxic levels. Dry river channel area increased from 7.08 km^2 (2.25%) in 1989 to 7.42 km^2 (2.36%) in 1998 and to 8.10km^2 (2.5%) in 2009. Surface water body, however, shows an increase by 0.86 km^2 (0.2%) in 1998 because of the construction of a check dam in the northern part of the watershed. However, the water body area decreased to 0.70 km^2 (0.22%) because of the drying up of dam and other surface water bodies.

Jaggar Watershed

Eight major land use/land cover identified and delineated on the imageries based on photographic and geotechnical elements include open forest, ravenous land with open scrub, open scrub, agricultural land, wasteland, exposed rock with open scrub, water body and built-up land (Figure 4). Area statistic of major land-cover categories hasbeen calculated for the year 1990, 1998 and 2010. Comparative analysis has shown significant changes in land-cover during 1990 to 1998 and 1998 to 2010 period. Comparative analysis of land use/land cover maps derived from satellite imagery has revealed the vulnerability of the watershed towards the changing climatic conditions. Change analysis shows a decrease inagricultural land at the expense of increase in open scrub and wasteland. The situation calls for immediate adaptation measures to counter the effects of climate change, which has threatened the ecosystem and the livelihood of the local population. Jaggar watershed has lost 5% of its forest cover in a decade. In the year 1998, the area under open forest was 49.98 km^2 (14.19%), which decreased to 33.60 km^2 (9.52%) by the year 2010. The area under open scrub has increased from 46.55 km^2 (13%) in the year 1998 to 67.78 km^2 (19%) in the year 2010. Agricultural land in the watershed has decreased from180 km^2 (51%) to 120 km^2 (34.2%) from 1998 to 2010. Two majorscereals normally grown are wheat and Bajra, but for the last several years, wheat has almost vanisheddue to the decline in rainfall and most of the farmers have switched to Bajra.

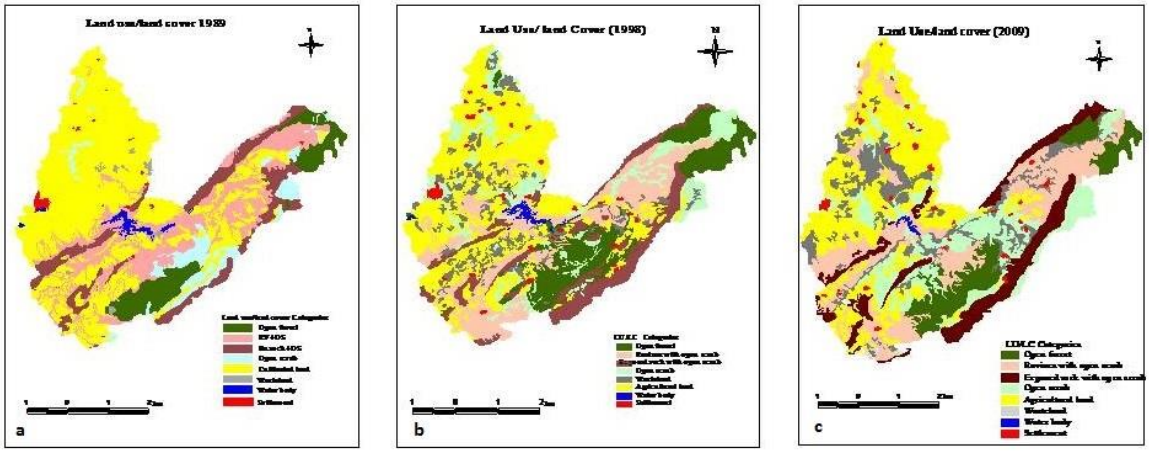

Figure 4*:* Land use/ land cover maps for Karauli District of the derived from IRS data of (a) 1990, (b) 1998 and (c) 2010

6. Conclusion

In the present case studies, it is clearly suggested thatthe climate change has significant role in impacting availability of natural resources at watershed level in the state of Rajasthan. The two watersheds are under great stress as far as change in climate and availability of resources is concerned.

The satellite data analysis further proves that the land use/land cover changes, which have taken place in the two watersheds are the result of climatic changes and anthropogenic activities. The major land cover changes in a short period of 20 years reflect the prevailing climatic conditions and depletion of vegetative cover. The present study has proved the utility of remote sensing data in monitoring the land cover changes in space and time at a watershed level.

7. Acknowledgement

Authors are thankful to the University Grants Commission (UGC), New Delhi for their financial support extended through the Major Research Project to the senior author. We would also like to thank the chairman of the Department of Geology, Aligarh Muslim University, Aligarh for the support. Sincere thanks to Navjyoti Vikas Sansthan, Pali and Society for Sustainable development, Karauli, the two NGOs for assisting in household surveys in Pali and Karauli districts respectively. Thanks, are also due to DrMohdYousufKhanday and Sana Iftekhar for their help in data generation and analysis.

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Takeaways from the IPCC's Special Report on Climate Change and Land for India

Aseem Kumar Anshu

1. Introduction

Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by United Nations General Assembly. The primary task of IPCC was to prepare a comprehensive report based on the available scientific knowledge on climate science, the socio-economic impact of climate change, and potential response actions towards mitigation and adaptation. Since 1988, IPCC has released five cycles of assessment reports, each containing special reports. The first assessment report released by IPCC in 1990 focused mainly on the importance of climate change and the perspective challenges requiring international cooperation. The first assessment report played a decisive role in the constitution of UNFCCC, an international treaty to reduce global warming. The second assessment report released in 1995 provided crucial information, which led to the adoption of the Kyoto Protocol in 1997. The third assessment report in 2001 focussed on the impacts of climate change and strategies for adaptation. The fourth assessment report in 2007 laid a foundation for the post-Kyoto Protocol for limiting global warming to 2°C. The fifth assessment report was finalized in 2013-2014, which provided the scientific inputs for the Paris Agreement. The sixth assessment cycle is still under production, which includes the first special report on 'Global Warming of 1.5°C' released in 2014-2015, which was prepared on request by governments under the Paris Agreement.

2. Takeaways for India

The special report on Climate Change andland by IPCCis the second special report of the sixth assessment cycle with a final report expected to be released around 2022. The second special report was released in 2019, and it is the first time that IPCC has focused its attention exclusively on the land. The report indicates that deforestation is one of the major contributors to the current GHG emission globally; hence conservation and restoration of the forest could play an instrumental role in the mitigation. According to the report, anthropogenic activities, such as agriculture, industries, cattle rearing, forestry, and urbanization affect the total GHG emission positively or negatively. It has also linked land degradation with several climate variables, including temperature, precipitation, and wind.

Extreme heat can reduce photosynthesis in plants and affects the growth rate of leaves and the tree. The decline in the plants in an area can be foreseen as soil erosion and hence land degradation. The report has anticipated that heat stress, and flooding will increase the chances of land degradation by reducing soil moisture, delayed planting, increased soil compaction, and thus losses of deciduous trees and vegetation. The IPCC report defines desertification as the degradation of land in arid, semi-arid, and dry sub-humid areas, known as drylands, induced by many factors, including anthropogenic activities and climatic variations. It has been projected that desertification will significantly increase due to climate change. The report states that a decline in vegetation can increase the rate of soil

erosion, which in turn increases the likelihood of sand and dust storms leading to a decrease in precipitation at the regional climate, thus further exacerbate desertification. Additionally, climate change is expected to impact food security through increased temperature, changed precipitation patterns, and increased frequency and intensity of extreme weather events. The report notices the impact of climate change on agricultural productivity, seasonal copping pattern and yield, livestock productivity andnutritional compositions in the future.

Since India is among the developing countries that have multiple issues related to land and climate change, such as poorly planned urban development, deforestation, wetlands filling, high carbon emissionetc. Apart from severe climate change witnessed in recent years, India has been experiencing several negative outcomes, such as land degradation, desertification, decline in crop yield, water and food insecurity, biodiversity loss, extreme rain, heat waves and dust storms, habitat loss and environmental and human health hazards. Nevertheless, the action plan on climate change prepared bythe Government of India includes massive plantations across the country. India is committed to increasing its forest cover as much as to sink the additional carbon of amount 2.5 billion to 3 billion tonnes by 2031. Needless to say, Land and Climate Change report by IPCC can play a major role in policy framing related to land management and climate change mitigation and adaptation forthe policymakers of India.

3. Reference

IPCC, 2019: Special Report on Climate Change and Land. Available online: https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/

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In the News

COVID-19 Pandemic and Land Use

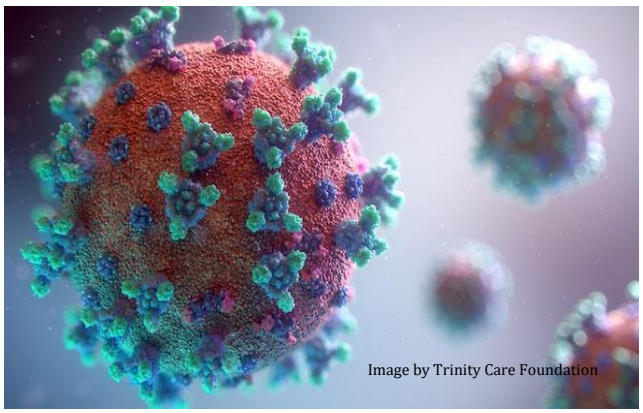


Image by Trinity Care Foundation

A study published in Mammal Review Journal explains a relation between changes inanimal's behaviour due to the land use pattern change anticipated to be one of the factors of an outbreak of COVID-19. The study suggests that most of the human viruses have been observed to be transmitted from animals, particularly the industrially domesticated ones, which are reared in close confinement with greater possibilities of physical contact. The study has investigated the association of land-use changes, such as urbanization, deforestation, and conversion to agriculture, with induction of transmission of such infectious diseases to humans. Nevertheless, the study urges to have more studies that link the impact of land-use changes on the animal ecology and pathogen spread.

Source: https://indianexpress.com/article/india/land-use-changes-may-lead-to-spread-of-new-diseases-like-covid-19-study-6441197/

Land use and flood


Image by Getty Image

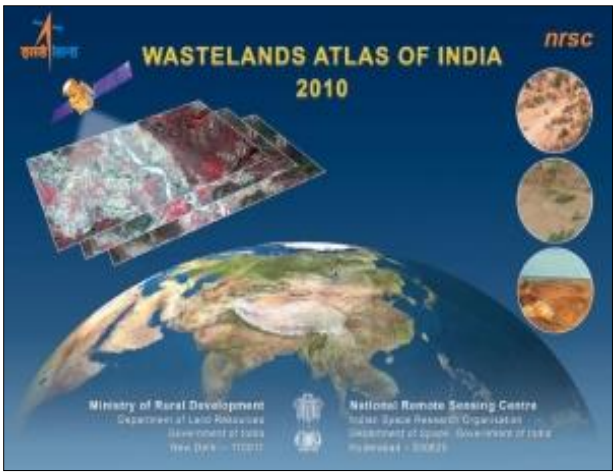
In recent years, Hyderabad city has been witnessing a declining trend in three of the most important indicators of urban flooding – change in land use, change in land cover, and change in vegetation pattern.

The Normalized Differential Vegetation Index (NDVI) for the city ranged from 0.05 to 0.07 in the sparsely built-up areas, and -0.01 to -0.04 in the closely built-up areas. The NDVI of the city was found to be significantly low due to the excessive concretization and loss of vegetation, which considerably impacts the drainage flow. The Modified Normalized Differential Water Index (MNDWI), which is amarker for the availability of water bodies in an area, has been observed drying and vanishing, and the remaining has changed their contours and water content over time. Whereas, the Normalized Differential Built-up Area Index (NDBI) measures the extent of built-up area, which has been recorded to be high,characterizes as the higher degree of run-offs due to the imperviousness of the urban built-up. It has been observed that MNDWI of

the city in 2013 has significantly declined as compared to MNDWI value in 2009, which suggests the water holding capacity of the wetlands has tumbled considerably.

Source: https://timesofindia.indiatimes.com/city/hyderabad/urbanisation-poor-vegetation-making-hyd-prone-to-floods/articleshow/78880227.cms

Wasteland Atlas of India



Wasteland Atlas of India, developed by the National Remote Sensing Centre (NRSC)was released in 2019. It is the fifth edition of the Atlas. The Wasteland Atlas of India - 2019 includes category-wise wasteland information at the state and district level. The Atlas features changes in wastelands from 2008-2009 to 2015-2016. This time, it includes wasteland (12.08 Mha) of Jammu & Kashmir, which was not included in the previous Atlas. The total wasteland area for the year 2015-2016 was recorded as 55.76 Mha which accounts for 16.96% of the total geographical area of India. Whereas, the total wasteland area for the year 2008-2009was 56.60 Mha which accounts for 17.21% of the total geographical area of India.

Source:https://dolr.gov.in/documents/wasteland-atlas-of-india

UNCCD COP-14

The United Nation Convention to Combat Desertification (UNCCD) Conference of Parties 14th edition (COP-14) was held at Greater Noida in 2019. The theme of the COP was 'Restore Land, Sustain Future'. In the Delhi declaration, the commitments were on a range of issues, such as health and gender, restoration of ecosystem, action on climate change, peace forest initiatives, engagement of private sectors, and recovery of 5 Mha degraded land in India. As a national target for action, all the parties agreed to achieve land degradation neutrality by 2030, while conforming to sustainable development goals. A Drought Toolbox was also launched, which is one-stop-shop for all the actions on drought. The parties coalesced on action on Sand and Dust Storm (SDS) by developing a source-based maps of SDS as it affects 151 countries. Additionally, India proposed an initiative of

south-south cooperation for resolving issues related to climate change, biodiversity, and ecosystem and land degradation. India has also committed to raisingits ambition of land restoration from 21 Mha to 26 Mha by 2030. Furthermore, India has proposed to establish a global technical support unit for capacity building and support to UNCCD party countries for the land degradation neutrality target program. A Global Water Action Agenda has also been proposed by India to UNCCD as it is a key component to achieving land degradation neutrality.

Source: https://www.unccd.int/official-documents/cop-14-new-delhi-india-2019

Land use and aquaculture

Case story of Himachal Pradesh

The Government of Himachal Pradesh is mooting on the initiation of land-based fish farming with the help of a new technology called Recirculating Aquaculture System (RAS) to culture various types of fish throughout the year. As a part of the sustainable development of fish farming, the technology is an initiative through the Pradhan Mantri MatsyaSampada Yojana (PMMSY). The Government is prepared to roll out the development of 15 RAS facilities across the State in the next five years. It has been estimated that normal water RAS facilitiescan produce 40 tonnes of fish per unit per year,whereas the cold-water RAS facilities can produce 10 and 4 tonnes of fish per unit per year. This initiative is expected to meet the livelihood and economic commitments of the State

Source:https://timesofindia.indiatimes.com/city/shimla/himachal-to-start-land-based-fish-farming-using-ras-tech/articleshow/78609908.cms

Case story of Goa

The Directorate of Fisheries, Goa has suggested making a policy to use fallow land of the Khazan area in Goa for agriculture and fisheries. The directorate has also recommended the preparation of the Khazan Management Plan. The Khazan land currently spans over 18,500 ha of area, out of which 3,500 ha of the land is either fallow or marshland.

Source:https://www.downtoearth.org.in/blog/wildlife-biodiversity/mangroves-and-khazan-agriculture-sustaining-goa-s-promise-for-fish-curry-and-rice-72460

Bihar plans afforestation drive in villages along the Ganga riverstretch

The Governmentof Bihar is set to launch a massive plantation drive in the villages located along the River Ganga stretch, to reduce soil erosion in the fringe villages and increase groundwater. The plantation drive will be launched across India under the NamamiGangeprogramme. A target has been set to plant5 million trees in India, with an estimated budget of Rs. 1 billion. In Bihar, 100 villages along the bank of Ganga have been selected for such plantation drive. The selected villages are in the districts of Munger, Bhagalpur, Begusarai, Purnia, Samastipur, Patna, Vaishali, Bhojpur, and Saran.

Source:https://www.downtoearth.org.in/news/environment/bihar-plans-afforestation-drive-in-villages-along-ganga-river-63424

Bihar plansdeveloping organic corridor in 13 districts along the Ganga river stretch

As part of Jal Jeevan Hariyali Mission, the Government of Bihar is planning to develop Organic Corridors, passing through 13 districts to keep Ganga clean. The Corridor will have confluencebetween Buxar andBhagalpur. An estimated budget for this plan will be around Rs. 1.5 billion.

Source:https://www.business-standard.com/article/pti-stories/bihar-govt-to-develop-organic-corridor-in-13-districts-120030400153_1.html

Bihar Government to chart low carbon development pathway

Image fromPIB

The Government of Bihar is all set to pursue a climate-resilient and low carbon development pathway with the help of the United Nation Environment Programme (UNEP). UNEP has agreed to provide support to the Government to help meet the climate goals of the State. The UNEP will majorly support with developing a comprehensive Green House Gas (GHG) inventory and building a roadmap to achieve net-zero emissions by mid-century.

Source:https://www.unep.org/news-and-stories/press-release/government-bihar-chart-low-carbon-development-pathway-unep-support

Artificial Intelligence to keep watch on air pollution in Bihar

The State government will be usingGeo-based Artificial Intelligence (AI) and remote sensing technology to identify and monitor the sources of air pollution. The Bihar State Pollution Control Board (BSPCB) has signed a Memorandum of Understanding (MoU) with the United Nation Development Programme (UNDP)to take up this initiative. The technologies like Internet of Things (IoT) and AI will be used to identify and monitor the sources of air pollutions, such as brick kilns, industries, stubble burning, vehicular emissions etc. The platform will be developed in collaboration with the University of Nottingham.

Source:https://timesofindia.indiatimes.com/city/patna/mou-inked-to-check-pollution-through-artificial-intelligence/articleshow/80773918.cms

Highlights

Vedic Approach to Wetlands Restoration

As part of the special lecture series, a lecture on 'Vedic Approach to Wetland Restoration' was organized by the Centre for Environment, Energy and Climate change (CEECC) at ADRI in collaboration with Bihar State Pollution Control Board on March 12, 2021. The lecture was chaired by Dr. Ashok Kumar Ghosh, chairman, Bihar State Pollution Control Board. The speaker of the lecture was Mr. Madhukar Swyambhu, Founder, Cownomics Pvt. Ltd. The key officials from Bihar State Wetland Authority and Department of Environment, Forest and Climate Change, Government of Bihar were also present as the guest.

Available at: https://www.youtube.com/watch?v=hb3t9l4m99M

Valedictory of the Green Skill Development Programme

The Centre for Environment Energy and Climate Change (CEECC) at Asian Development Research Institute (ADRI), a policy research think-tank has organized Valedictory Function for Green Skill Development Programme (GSDP) on Pollution Monitors: Air and Water Pollution, and ETP, STP: Operation & Maintenance on January 22, 2021. The training was organised in collaboration with the Bihar State Pollution Control Board (BSPCB) and Tarumitra. On this occasion, a total of 21 trainees were awarded a National Skills Qualifications Framework (NSQF) level certificate from the Ministry of Environment, Forest & Climate Change, Government of India by Shri Dipak Kumar Singh, IAS, Principal Secretary,Department of Environment Forest and Climate Change, Government of Bihar.

Traffic emissions inventory survey of Patna

The Centre has carried traffic emissionsinventory survey in Patna agglomeration, as part of ongoing work on air quality monitoring and management in non-attainment cities of Bihar. The objective of the study is to quantify the level of emissions contributed by urban transportation to the overall pollution load in Patna post-development of the Patna Clean Air Action Plan. The GSDP trainees from the Pollution Monitors course have been engaged as field surveyors.

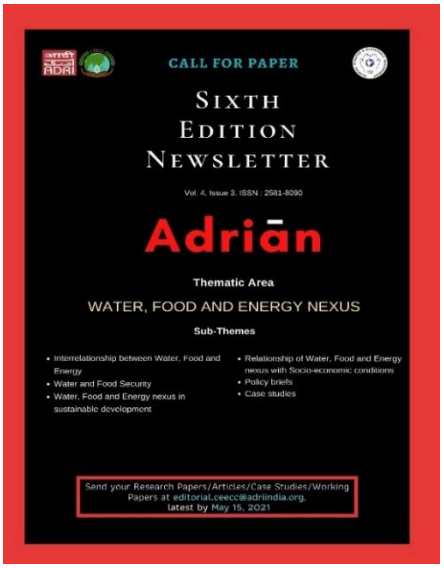
Green Skill Development Programme

This year, the Centre conducted its second batch of Green Skill Development Programme (GSDP)training on Water Budgeting and Auditing, Pollution Monitors: Air and Water Pollution, and ETP, STP: Operation and Maintenance. So far, the Centre has conducted 7 training programmes on different issues, and a total of99 trainees have beenawarded a National Standard for Qualification Framework (NSQF) levelGSDP certificatesissued by the Ministry of Environment, Forest and Climate Change, Government of India. The upcoming courses to be organised by the Centre are:

Training courses	**Minimumqualification**	**Commencement**
Water Budgeting & Auditing (NSQF level 6, 200 hours)	Graduate in any discipline	June 2021
Emissions Inventory (NSQF level 6, 130 hours)	Graduate in science discipline	July 2021
Value addition and Marketing of NTFPs: Bamboo Crafts (NSQF level 5, 400 hours)	Basic literacy	August 2021
Waste Management (NSQF level 6, 300 hours)	Graduate in science discipline	September 2021
Bird Identification and basic ornithology (NSQF level 5, 160 hours)	Xth pass/ dropouts	October 2021
Bird Migration and Migration study techniques (NSQF level 5, 186 hours)	Graduation in any discipline	November 2021
Valuation of Ecosystem Services and Green GSDP (NSQF level 6, 105 hours)	Graduate in any discipline	December 2021
Sustain and Enhance Technical Knowledge in Solar Energy Systems (NSQF level 5, 240 hours)	XIIth pass/ dropouts	January 2022
Wildlife Management using Geospatial Technique (NSQF level 6, 264 hours)	Graduate in science discipline	February 2022

Note: The online application form is available athttp://www.gsdp-envis.gov.in/Index.aspx.

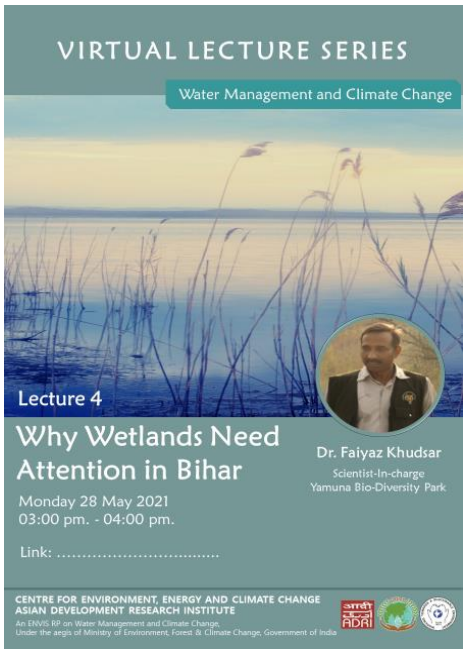
Upcoming Newsletter



The next theme of *Adrian*will be –**Water, Food, and Energy Nexus**.Research papers, articles, case studies, policy memo, policy brief, working papers, etc. are invited till **July 15, 2021. Please send your contributions to:** editorial.ceecc@adriindia.org.

Special Lecture Series

The third lecture of the special lecture series will be on – **Economic Valuation of Wetlands, with special reference to Bihar**by Mr Kumar Deepak, Environmentalist, United Nation Development Programme.



While, the fourth lecture of the special lecture series will on –**Why Wetlands Need Attention in Bihar** by well-known ecologist Dr FaiyazKhudsar, Scientist-In-Charge, Yamuna Biodiversity Park.

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