Training Workshop Report on

Digital Data and Tools for Managing Agriculture: Focusing on Earth Observation Data and Climate Change

21-23 December 2023

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Venue

International Institute of Information Technology (IIIT) Bhubaneswar, Bhubaneswar-751003, India

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Organized by

International Institute of Information Technology (IIIT) Bhubaneswar
International Water Management Institute (IWMI)
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About the IEEE GRSS Kolkata Chapter

The IEEE GRSS Kolkata Chapter covers 13 states in the eastern and north-eastern parts of India. This chapter has been focusing on connecting its members to the experts from academia and industry through organising various lectures, seminars, workshops, national and international conferences, distinguished lectures, and education and outreach activities. https://site.ieee.org/kolkata-grss/

About the CGIAR Initiative on Resilient Cities

The CGIAR Initiative on Resilient Cities aims to generate evidence, technologies, and capacities that help improve urban food systems and secure equitable job and business opportunities, healthy diets for all, human and environmental health, and a reduced carbon footprint. https://www.cgiar.org/initiative/resilient-cities/

About the CGIAR Initiative on Low-Emission Food Systems (Mitigate+)

The CGIAR Initiative on Low-Emission Food Systems, also known as Mitigate+, focuses on reducing GHGE from food systems in target countries by 1.1 gigatons per year (6.5%) by 2030, thus mitigating the predicted impact of climate change on sustainable development and social equity. The approach is consistent with the Paris Agreement, which aims to foster low-emission development without negatively impacting food production. An estimated 8m people will benefit from these reduced emissions and associated benefits over the Initiative's 10-year lifespan. Learn more about Mitigate+ here: https://www.cgiar.org/initiative/32-mitigate-plus-research-for-low-emission-food-systems/

Disclaimer

Responsibility for editing, proofreading, layout, opinions expressed, and any possible errors lies with the authors and not the institutions involved.

This report has been prepared as an output of the training workshop.

Contents

Abbreviations

AI: Artificial Intelligence
BITM: Birla Institute of Technology Mesra
CGIAR: Consultative Group on International Agricultural Research
CSA: Climate Smart Agriculture
DLR: German Aerospace Center
EO: Earth Observation
GEE: Google Earth Engine
GeeT: GHG emission estimation Tool
GHG: Green House Gases
GIS: Geographic Information System
GPS: Global Positioning System
GVA: Gross Value Added
IDE: Integrated Development Environment
IIIT Bhubaneswar: International Institute of Information Technology,
IIWM: Indian Institute of Water Management
IMD: Indian Meteorological Department
IoT: Internet of Things
ISI: Indian Statistical Institute
IWMI: International Water Management Institute
LGRB: Lower Godavari River Basin
KIIT: Kalinga Institute of Industrial Technology
MGNREGA: Mahatma Gandhi National Rural Employment Guarantee Act
MIYCN: Maternal, infant and young children nutrition
ML: Machine Learning
NIT Durgapur: National Institute of Technology Durgapur
OCAC: Odisha Computer Application Centre
OLA: Odisha Legislative Assembly
OSDMA: Odisha State Disaster Management Authority
SAADRI: South Asia Alliance of Disaster Research Institutes
SAR: Synthetic Aperture Radar
SDG: Sustainable Development Goals
SOAU: Siksha 'O' Anusandhan University
SPARC: Scheme for Promotion of Academic and Research Collaboration
SRI: System of Rice Intensification
UTM: Universal Transverse Mercator

Executive Summary

The report presents the prime aims, objectives, discussions and insights from the "Training Workshop on Digital Data and Tools for Managing Agriculture: Focusing on Earth Observation Data and Climate Change" organized at IIIT Bhubaneshwar from 21st to 23rd December 2023. The workshop was attended by 81 participants and jointly conducted by IIIT Bhubaneshwar, IWMI, and IEEE GRSS Kolkata Chapter. The primary objective of the workshop was to equip participants with practical skills and knowledge to utilize digital data and tools, especially Earth observation data, for effective agricultural management in the context of climate change and make evidence-based decisions to confront challenges in the food system, urban water pollution, GHG emissions & nexus. The programme encompassed the challenges posed by population growth, climate change and urbanization on the water, food and energy nexus, and the need to address the complexities to achieve sustainable development and mitigate environmental impacts is necessary. Through various sessions, the workshop highlighted concerns about GHG emissions and their mitigation by transitioning to renewable energy, carbon capture and storage, water hyacinth mapping in urban and peri-urban wetlands, Artificial Intelligence/Machine Learning (AI/ML) applications for rice mapping, flood damage assessment, maternal, infant and young children nutrition deficit under extreme weather conditions, agricultural data collection tools and sustainable agriculture practices.

The CGIAR's Mitigate+: Low-Emission Food Systems Initiative focuses on reducing emissions from the food systems by developing robust science, data, and evidence (among other activities). Another initiative by CGIAR on Resilient Cities generates evidence, technologies, and capacities that help improve urban food systems and secure equitable job and business opportunities, healthy diets for all, human and environmental health, and a reduced carbon footprint. Both initiatives provided resources to support the training workshop to empower students, researchers, scientists, academicians, decision-makers, and policymakers with cutting-edge knowledge and tools to integrate digital data into agricultural management practices. Participants learned about the latest advancements in Earth observation technologies, big data analytics, and digital tools that can help predict and make robust, evidence-based decisions as they confront challenges in the food system, urban water pollution, strategies to reduce GHG emissions, and tackling the nexus challenges. Thus, the workshop was envisioned as a catalyst to empower the agricultural community with digital tools and data, fostering resilience and productivity in the face of climate change.

The criticality of Earth Observation (EO) data and digital tools in informing agricultural management decisions was rigorously examined and elucidated through a comprehensive program comprising six keynote addresses, nine scholarly lectures and six practical demonstrations, all facilitated by esteemed national (including IIT Guwahati, IIWM, Assam University, OSDMA, SAADRI, and SPARC) and international institutions (such as IWMI, World Bank, and DLR). A pre-event catch up with the participants was held on the first day session as a social ice-breaking session. The discourse was further enriched by an expert panel discussion on the 'Role of Digital Tools in Mitigating Climate Change Effects on Agriculture', an intensive brainstorming session entitled 'Data Science and Sustainability Challenge' and a showcase of research presentation by the participants. These engagements highlighted the practical and innovative usages of EO data for managing agriculture in the context of climatic challenges and emphasized how such strategic applications contribute towards attaining the SDGs.

Of the 82 participants, 63% are male, and 37% are female. Among the attendees, 52% were at the graduate and post-graduate level, while 26% of the participants were research scholars from various Indian institutions. Of the other participants, 22% were faculty and professionals. This diversity of participants demonstrates the programme's appeal to different professionals and researchers. The participants come from multiple institutions, including renowned universities and research centres across India like IIT Roorkee, BIT Mesra, ISI Kolkata, Techno Main Salt Lake, IIT Kharagpur, IIT Mandi, Fakir Mohan University, KIIT, and many more. This institutional diversity indicates the programme's broader reach and appeal among academic and research organizations. These analytics provide valuable insights into the participants' gender distribution, designations, education levels, and institutional affiliations.

The inclusivity and diversity, reflected in gender representation and institutional affiliations, created a dynamic and comprehensive learning community. The diverse curriculum gave them valuable knowledge and skills to solve real-life challenges associated with major natural disasters.

Introduction

Agriculture is a practice that has been sustaining human life for ages; it encompasses the cultivation of crops, natural resource management, and the rearing of livestock to meet the basic needs of food, fibre, and fuel (Kremsa, 2021). India being an agrarian economy, with more than 54% of land classified as arable (Kumar et al., 2012), has 195m ha under cultivation, of which some 63% is rainfed (roughly 125m ha) while 37% is irrigated (70m ha) (Soni and Pal, 2021). Agriculture provides livelihood to over 151 million people. Agriculture and allied sectors, including forestry and fisheries, contribute over 24% to the country's Gross Value Added (GVA)[1]. With the growing population and climate change posing challenges, agriculture is becoming a major topic in conversations about environmental stewardship (Currier and Robinson, 2018), food security (Umesha et al., 2018), and sustainable development (Molina-Maturano et al., 2020). The increasing demand for sustainable practices and technological advancements have driven significant changes in the agricultural landscape in recent decades (Khan et al., 2021). Digital data and tools are becoming increasingly important in managing agriculture as the world's population keeps growing and environmental challenges intensify (Saiz-Rubio and Rovira-Más, 2020). EO data and climate change factors are being incorporated into agricultural practices and planning, and digital technologies and data-driven methodologies are revolutionizing agricultural activities (Goel et al., 2021). EO data, coming from ground-based sensors, unmanned aerial vehicles (UAVs), and satellites, has created new opportunities for studying and managing agricultural landscapes. This data enables farmers, scientists, and policymakers to make informed decisions by offering insightful information on crop well-being, patterns of land use, insurance (Ramm et al., 2018) and environmental conditions. Stakeholders can adjust agricultural practices concerning changing climate conditions using digital tools incorporating climate models and real-time data, promoting resilience in the face of environmental uncertainties (Stankovic et al., 2022). Agriculture's contributions to food security, poverty reduction, and environmental sustainability make it essential to achieving several SDGs. While creating revenue for rural people is one way to achieve Goal 1 (No Poverty), improving agricultural output and guaranteeing food access are two ways to fulfil Goal 2 (Zero Hunger). Sustainable agriculture methods encourage resource efficiency and lessen environmental effects, which aligns with Goal 12 (Responsible Consumption and Production). Climate-smart agriculture reduces industry's impact on climate change and supports Goal 13 (Climate Action). Additionally, encouraging biodiversity conservation in agricultural environments advances Goal 15 (Life on Land). Progress towards these objectives is measured by indicators like crop output, land use efficiency, and adoption of sustainable methods, highlighting the connection between agriculture and sustainable development (Gil et al., 2019).

This workshop looks at the different ways that EO data, digital data and tools, and climate change considerations in agriculture can work together. Figures 1 to 29 are illustrating the individual sessions and contributions.

[1] https://ppf.org.in/opinion/paradigm-shift-in-agriculture-is-needed-to-ensure-farmer-welfare-and-food-security-by-vaishali-basu-sharma#:~:text=Agriculture%20and%20allied%20sectors%20which,and%20allied%20sector%20in%20India.

Programme Schedule

Day 1: Thursday, 21 Dec 2023

Time	Program	Speaker/Contributor
08:30 – 09:30	Registration	
09:00 – 10.30	Pre-event catchup with participants	• **Surajit Ghosh,** IWMI • **Sneha Kour**, IEEE GRSS
10:30 – 11:15	Inaugural Session • *Lighting of the Lamp* • Saraswati Bandana • *Welcome remarks* • *Guest of Honour Address* • *Chief Guest Address* • *National Anthem*	• **Ashish Ghosh,** Director, IIIT Bhubaneswar • **Sri Manoj Kumar Pattnaik,** CEO, OCAC, Govt of Odisha {Chief Guest} • **Gyana Das**, MD, OSDMA {Guest of Honour} • **Subhadarsi Mishra**, MD, SPARC • **Surajit Ghosh,** IWMI • **Alok Sikka,** IWMI India Representative {Guest of Honour}
11:15 – 11:45	Group photo and High Tea	
11:45 – 12:30	Keynote Speech	• **Dr. Gyana Das**, MD, OSDMA
12:30 – 13:00	Uncertainty in the carbon sequestration potentials of peri-urban wetlands (Keynote Speech)	• **Arun Joyti Nath,** Assam University
13:00 – 14:00	Lunch Break	
14:00 – 15:30	Panel discussion: *Role of digital tools to combat the impact of climate change on agriculture.*	• **Avinanda Taron,** IWMI (**Moderator)** • **Arun Joyti Nath,** Assam University • **Sourabh Dubey,** WorldFish • **Kapil Chawala,** InnoMick Pvt. Ltd. • **Preeti Bharti,** IRRI • **Sonali Chiddarwar Daniel,** Ex-consultant UNICEF/WHO (online) • **Sudip Mitra,** IIT Guwahati • **Susmita Ghosh,** Jadavpur University • **Surajit Ghosh,** IWMI
15:30 – 16.00	Tea/ Coffee	
16:00 – 17:00	Disruptive Tech for Climate-Smart Sustainable Agriculture **(T)**	• **Nagaraja Harshadeep,** World Bank (Online)
17:00 – 18:00	Agro-Ecotechnology and Climate Smart Agriculture: Paths Toward Sustainable Rural Development (Keynote Speech)	• **Sudip Mitra,** IIT Guwahati
18:00 – 19:30	Utilization of EO data for Rice Mapping **(P)**	• **Guneet Mutreja,** DLR (Online)
19:30 – 21:00	Networking, Refreshments and Dinner	• **Participants and Resource Persons**

Rapporteur: Sneha Kour

Day 2: Friday, 22 Dec 2023

Time	Program	Speaker/Contributor
08:45 - 09:00	Reflection of the previous day	• **Sneha Kour,** IEEE
09:00 - 09:30	Earth Observation data and tools (**T**)	• **Surajit Ghosh,** IWMI
09:30 – 11:00	Application of Earth Observation for monitoring water hyacinth in peri-urban wetlands – Part 1 (**P**)	• **Surajit Ghosh,** IWMI
11:00 – 11:15	*Tea/ Coffee*	
11:15 – 11:45	Promoting citizen science using digital applications for long-term monitoring of urban wetland health (**T**)	• **Chaturangi Wickramaratne,** IWMI (Online)
11:45 – 12:15	Keynote Speech: GHG emission from agriculture and its coupling with climate change (**T**)	• **Bunyod Holmatov,** IWMI (Online)
12:15 – 13:00	Application of Earth Observation for monitoring water hyacinth in peri-urban wetlands – Part 2 (**P**)	• **Surajit Ghosh,** IWMI
13:00 – 14:00	*Lunch Break*	
14:00 – 15:00	Integrated sensing systems for enhancing agricultural water productivity (Keynote Speech)	• **Arjamadutta Sarangi,** IIWM
15:00 – 16:00	Mapping and monitoring of GHG emissions using Earth Observation data – Part 1 (**P**)	• **Surajit Ghosh,** IWMI • **Kounik De Sarkar,** NIT Durgapur
16:00 – 16:15	*Tea/ Coffee*	
16:15 – 16:45	Water Accounting Plus under Climate Change, with a case study in the Volta River Basin **(T)**	• **Moctar Dembélé,** IWMI *(Online)*
16:45 – 18.15	Application of digital survey tool for agriculture (**P**)	• **Surajit Ghosh,** IWMI
18:15 -19:00	Networking and fun activities	• **Participants and Resource Persons**
19:00 – 21:15	*Cultural event followed by dinner*	

Rapporteur: Anuva Chowdhury

Day 3: Saturday, 23 Dec 2023

Time	Program	Speaker/Contributor
08:45 - 09:00	Reflection of the previous day	• **Anuva Chowdhury,** BITM
09:00 – 09:45	Mapping and monitoring of GHG emissions using Earth Observation data – Part 2 (**P**)	• **Kounik De Sarkar,** NIT Durgapur
09:45 – 11:15	Presentations by the participants – Research thoughts on digital tools in Agricultural management	• **Ashish Sarkar** • **Archita Mallick** • **Anuva Chowdhury** • **Khose Suyog Balasaheb** • **Prafulla Kumar Panda**
11.15 – 11.30	*Tea/ Coffee*	
11:30 – 13:00	Application of AI/ML in Agriculture (**T**)	• **Ashish Ghosh,** IIIT Bhubaneswar
13:00 – 14:00	*Lunch Break*	
14:00 – 14:15	Initiative on Disaster Management in South Asia(**T**)	• **Sumit Sen,** IIT Roorkee SAADRI (Online)
14:15 – 15:00	Use of Satellite data, AI, and Data Science towards Sustainable Agriculture Management **(T)**	• **Debajit Mishra**, Vassar Labs IT Solutions Pvt Ltd,
15:00 – 15:30	Appraisal of a flood scenario through the lens of Earth Observation for lower Godavari River Basin, India(**T**)	• **Jayesh Mukherjee,** Aberystwyth University (Online)
15:30 – 16:30	Brainstorming session - **'Data Science and Sustainability Challenge'**	• **Surajit Ghosh,** IWMI • **Participants**
15:30 – 16:15	Valedictory Ceremony Certificate Distribution *Closing remarks, Way forward, and vote of thanks,* *Shanti Mantra*	• **Susmita Ghosh,** Jadavpur University • **Sri Dasarathi Satpathy,** Special Secretary OLA • **Ashish Ghosh,** Director, IIIT Bhubaneswar • **Lipika Das,** IIIT Bhubaneswar • **Surajit Ghosh,** IWMI
16:15 – 18:15	Networking *Tea/ Coffee*	• **Participants**

Rapporteur: Archita Mallick

T: *Theory,* ***P*****:** *Practical,* ***D:*** *Demonstration*

Day 1

The registration process and pre-event catchup kicked off the programme. The purpose of this event was to provide an overview of the three-day course and to introduce participants to help them acquaint themselves with the resource persons and one another. The first day sessions commenced with an inaugural session where dignitaries lighted the lamp, followed by the chanting of the Saraswati Bandana. *Ashish Ghosh*, director of IIIT Bhubaneswar, welcomed the participants and speakers, highlighting the aim and objective of the workshop. The Chief Guest, *Manoj Kumar Mishra*, Principal Secretary of Government of Odisha, then addressed the audience, emphasizing the need for affordable, accessible, and user-friendly solutions and actual extension of digital tools and technologies in the field. Following him was *Subhadarsi Mishra*, MD, SPARC, who stressed the threats posed by climate change, necessitating the use of modern methods to understand and mitigate situations in a better way. He highlighted how the development of satellite imagery and digital platforms has allowed for real-time detection of crops and revolutionized the analysis project.

Fig 1 Inaugural session

Fig 2 Mr Subhadarshi Mishra delivering his inaugural speech

Fig 3 Shri Manoj Kumar Pattnaik giving his inaugural speech

The first keynote speech by **Alok Sikka**, IWMI.

The keynote emphasized water solutions for agriculture using digital tools to implement water resource assessment, monitoring and spatial hydrological modeling to mitigate challenges posed by floods, droughts, and climate change. The core working area of IWMI was mentioned, which highlighted the application of digital innovation, IoT-based systems, and satellite data from sensor technologies in precision farming, irrigation, drought and flood insurance and disaster management. Digital innovations like cloud and drone monitoring systems are being developed in South Asia while conservation works like MGNREGA (2005) are being explored and brought to light. Focusing on the ongoing and benchmarked research projects at the International Water Management Institute (IWMI), the speech emphasized the need for such training workshops to educate young minds on applying geoinformatics and data analytics.

Fig 4 Dr Alok Sikka delivering his keynote speech (online)

The next keynote speech was provided by **Dr. Gyana Das,** MD, OSDMA. Dr. Gyana Das discussed the progress made by the Odisha government in forecasting lightning, floods, cyclones, and droughts, as well as the creation of an oceanographic rainfall atlas. With the help of revenue authorities and data

from technical institutions such as IMD and IIT, the agriculture department has devised a drought monitoring system. The government has proposed supporting climate change adaptation and drought mitigation initiatives to bridge the gap in current data repositories and farmer outreach, particularly in districts vulnerable to drought. Together, the government has created a thorough data reach system to facilitate farmers sharing their insights and experiences with the data.

Fig 5 Dr Gyana Das delivering the keynote speech

Fig 6 End of Inaugural session followed by National Anthem

The session was followed by a group photograph and lunch break.

Fig 7 Group photograph of the workshop

After the tea break, the next speaker was **Prof. Arun Jyoti Nath** from Assam University.

Prof. Arun Jyoti Nath focused on the uncertainties and challenges faced in estimating global soil carbon stocks and sequestration potentials in inland wetlands due to the absence of definitive and accurate measurement methods and changes in climatic conditions. The concerning trend of increased natural wetland degradation and the simultaneous rise in man-made wetlands poses a significant threat to soil organic carbon and managing global carbon storage in wetland ecosystems, thus leading to increasing carbon dioxide emissions. Effective visualization tools to explain the variations in global carbon storage across Ramsar sites, highlighting the importance of these wetlands in the global carbon balance, were discussed in the presentation.

Fig 8 Prof. Arun Jyoti Nath delivering his speech on peri-urban wetlands

Panel Discussion

Climate change is affecting some of the critical services that ecosystems provide to society. For example, ecosystems provide a bounty of food to people. Climate changes, like drought and heat, could affect the availability and quality of some foods and farmers' ability to grow certain crops. Agricultural production stress and other socioeconomic disparities affect food and nutrition security. Digital innovation plays a crucial role in fostering resilience in the face of climate challenges, enhancing agricultural productivity, and contributing to global food security. Policy interventions (utilizing digital innovations) trying to manage extreme climatic events would reduce the risks and challenges related to food and nutrition. Therefore, collaboration among governments, technology providers, and the agricultural community is necessary to successfully implement these innovations.

The panel (**Table 1**) consisted of esteemed panelists from academia, applied researchers, and industry experts to help us understand such policy debates and discuss and debate innovative policies to cater to such challenges.

The industry, government, and academia shared their ongoing efforts in utilizing data for managing agriculture and climate resilience. The discussion, moderated by Dr. Avinandan Taron, served as a platform to exchange ideas and experiences, and it highlighted the significance of collaboration among different stakeholders.

Table 1 Thematic sections of the panel discussion

Sl. No.	Topic	Duration & Time	Panel members
1	Context setting	5 mins	Dr. Avinandan Taron
2	Navigating Climate Change Impact on Agriculture	20 mins	Prof. Arun Jyoti Nath, Dr. Sourabh Dubey, Prof. Sudip Mitra and Dr. Sonali Chiddarwar Daniel
3	Indigenous Knowledge to Digital Tools: Towards Sustainability	20 mins	Prof. Arun Jyoti Nath, Mr. Kapil Chawala, Prof. Sudip Mitra and Mrs. Preeti Bharti
4	Hitting Nutrition Security	20 mins	Prof. Sudip Mitra and Dr. Sonali Chiddarwar Daniel
5	Open data and open house	25 mins	Prof. Susmita Ghosh, Mr. Kapil Chawala and Dr. Surajit Ghosh

Fig 9 Panel Discussion session with esteemed panelists

Discussion

First question for Prof. Arun Jyoti Nath stated, "*With climate change, what are the supporting land and water ecosystem services that are getting disrupted, especially when we think of agriculture? Please provide us with some global/regional/local examples***."**

Prof Nath referred to global incidents like the Dust Bowl's impact in the US, where degradation of arable lands led to a better managed 'zero-tillage agricultural system'. With changes in climate, places are getting more prone to extreme conditions. He addressed the challenges faced in India due to the practice of faulty cultivation methods, thus disrupting the soil system and emphasized the need to promote natural farming for smallholders. He mentioned the Niti Ayog in India, which is trying to implement natural farming, principally conservation agriculture and promoting the incorporation of trees in farmlands and livestock as a source of essential nutrients.

Next question was asked to Dr. Sudip Mitra stated, "*What climate-resilient crop management systems are available to restore ecosystem services? How are these disruptions leading to food disparities under climate shock?"*

The speaker stated that he differs from the previous speaker in certain aspects as he believes that the agricultural practices being termed as faulty are the ones which were adopted at some point of time to benefit the farmers. He believes in converting disruptions to opportunities for innovation. He suggested that one needs to be careful about choosing technologies as they are rebounding in nature. As for the second point, he said that India is food secured but there is a need for continuous technological evolution to combat any kind of disruption in the future.

Next question was asked to Sonali Chiddarwar Daniel stated, "*What are the nutritional challenges to addressing food disparities under climate risk? Provide some evidence at the national/local scale."*

She addressed India's nutrition challenges like obesity and malnutrition. India, having the highest child bearing rate and nearly one million, not being able to afford good quality food suffer from malnutrition since birth. The tragic impact on the intellectual properties, like the brain development of a child, from anemic mothers was mentioned. She further discussed that 12 out of 17 sustainable development goals talk about nutritional values and how we should be trying to become food secure and prioritize enhancing soil quality to overcome these challenges. Her answer also touched on the increment of CO_2 (carbon dioxide) and its devastating impact on micronutrient availability in crops by reducing essential micronutrients like iron and zinc.

Next question was asked to Preeti Bharti stating, ***"****How can we use extension services to reach the grassroots - myth and reality? For example, mobile apps for market information and access, insurance."*

The speaker first discussed how the evolution of communication tools like advanced mobile and Internet services are heading towards different app development processes to aid the agricultural sector. According to her, having multiple systems can develop trust issues and confusion among grassroots-level farmers, and the government should take initiatives to develop applications so that it confidence among these farmers is boosted. She mentioned the need for specificity, cohesion, context specification and human-centred feedback to benefit the farmers. To conclude her answer, she shared the importance of climatic conditions and shed light on the importance of promoting fish harvesting, marketing, and hatching processes.

Next question was asked to Kapil Chawala stated, *"What are available digital tools for agroecological planning under climate risk? For example, IoT and sensors, big data and machine learning, sensor-based irrigation, blockchain technology, data cube, Radio-frequency identification"*

Mr Chawla emphasized on user-centric and context-specific technologies to be developed for agroecological planning. He pointed out the lack of background jobs while developing the application in this sector. According to him importance should be given to private sector collaborations, APIs and large-scale solutions for sustainable projects with the help of AWS, haddock, and investor services integration.

Next question was asked again to Prof. Arun Jyoti Nath stated, *"What indigenous tools are used to plan restoration efforts or agroecological (integrated agrosystem) planning under climate risk?"*

In India, north-eastern states, shifting cultivation is a dominant practice. But due to the increase in human population, the area for shifting cultivation is shrinking, and farmers are taking settled agriculture system, which also helps to conserve a critically endangered tree species. He stressed on learning from these practices and avoiding the pitfalls of hybrid agriculture.

Next question was asked again to Prof. Sudip Mitra stated, *"What climate-adaptive tools and technologies are available, and what are the related challenges for implementation?"*

He highlighted organic agriculture, SRI in Tripura and CSA in the Netherlands. He uniquely connected the word 'agriculture' with the cultural sensitivity associated with cultivators and the important role that they play in agricultural development. Patience is required, as farmers need to understand and feel pride as better technocrats to be able to feed our stomachs. He also mentioned how localization and socialization of engineering are needed to uplift the agriculture sector.

Next question was again for Dr Sonali Chiddarwar Daniel stated, ***"****What is a possible way to integrate such ideas for (i) climate risk, (ii) agriculture, and (iii) food & nutritional security planning? How can digital innovation be supported, and do you find a way to integrate it with digital innovations?"*

To address data integration, she emphasized focusing on the target questions. She highlighted setbacks of the efforts during Covid and discussed the impact of climate change and increasing

carbon dioxide in reducing the protein content and nutritional value of food by 20%. She suggested the need to integrate UTM to overcome the constraints.

Last question was for Dr. Surajit Ghosh, IWMI and Prof. Susmita Ghosh, IEEE GRSS Kolkata Chapter stated, *"Introduce a topic on the digital innovation ecosystem in Global South – extend the questions to each expert for commenting whether the discussion we are doing on the above issues is fruitful and will lead to smooth policy intervention. If not, what needs to be done to boost the ecosystem?"*

Dr. Surajit Ghosh described a pyramid of Data, Information, Knowledge, Wisdom, and Culture to be stacked from the bottom to the top, identifying the shortcomings and proposing data integration and standardization strategies to uplift the agriculture sector.

Prof. Susmita Ghosh pointed out the need to integrate culture with quality. She talked about learning from examples of AI and ML and connecting ancient practices to modern technologies, thus transferring our learning mechanism. She spoke about climate change impacting yield and nutritional values and how data integration can become a fruitful tool to overcome the challenges.

In conclusion, the discussion revealed the intricate interconnectedness of agriculture, nutrition, and data integration. It emphasized the urgency of collaborative efforts, breaking down departmental silos, and adopting innovative approaches to surmount challenges and achieve sustainable agriculture. The report serves as a comprehensive snapshot of the rich and insightful dialogue, providing a foundation for further exploration and action in the realm of agriculture, data integration, and sustainable development.

Following a tea break, the second session commenced.

Dr. Nagaraja Harshdeep, from the World Bank, showcased various platforms like the World Bank Geospatial Platform, USDA Global Agricultural & Disaster Assessment System (GADAS), Earthmap.org, OpenET (https://explorer.etdata.org), Pluto Beta, and Digital Twin Technology for efficient monitoring and use of EO data focusing on disruptive technology and fundamental data acquisition systems. He highlighted the exploration of community monitoring, using sediment concentration analysis to gain grassroots insights for managing agriculture.

Fig 10 Dr. Nagaraja Harshdeep delivering his speech (online)

Next **Prof. Sudip Mitra**, IIT Guwahati, highlighted the role of agrotechnology in the context of EO data and climate change and dived into the significant benefits of soil diversity. Better drainage systems, water retention, enhanced nutrient cycling, increased microbial activity, carbon sequestration and emphasizing the role of biodiversity in promoting resilience and sustainability in agricultural ecosystems were brought to light. He emphasized the pressing issue of an increasing number of pests,

thus urging the need for climate-smart agriculture as a strategic approach for combining mitigation and adaptation strategies to build a robust ecosystem that can adapt to varying environmental conditions.

Fig 11 Prof. Sudip Mitra's session

In the conclusion session, Guneet Mutreja, DLR, Germany, provided hands-on coding experience using Earth Observation data to analyze and interpret satellite imagery for rice mapping using Google Earth Engine. He provided a brief overview of the GEE cloud platform and how it works. He gave an introduction to the code editor IDE and demonstrated the use of Sentinel 1 SAR data along with thresholding-based rice crops in the GEE IDE. He showed how the code works and explained the workflow as well.

Fig 12 Mr. Guneet Mutreja providing a hands-on session on GEE (online)

This session marked the end of Day 1 of the workshop.

Day 2

The second day commenced with reflections on the previous day's sessions from the participants and basic insights on Earth Observation and Remote Sensing by **Dr. Surajit Ghosh**.

Fig 13 Interaction with the participants

The first speaker for the day was **Dr. Surajit Ghosh**, IWMI. He discussed about the application of earth observation for monitoring water hyacinths in peri-urban wetlands, highlighting difficulties faced while mapping using optical data due to cloud interference, distinguishing between aquatic and free-floating vegetation, and distinguishing between different species of aquatic plants. A progression of water hyacinth over time was shown, which was derived from satellite images (optical and SAR), showcasing the cyclic nature of the phenomenon. He emphasized the importance of field information for model training, testing, and validation. Next associated with this presentation was a demonstration by Mr. Arpan Dawn, who showed the mapping of water hyacinth in the Werahera wetland area, Sri Lanka, using optical and SAR data within GEE. He discussed the challenges associated with this mapping process, highlighting ongoing efforts in method development to improve accuracy. The comprehensive workflow showcased the successful integration of diverse satellite data sources for the precise mapping of water hyacinth in this ecologically significant Sri Lankan wetland.

Fig 14 Dr Surajit Ghosh's session on Water Hyacinth mapping

Fig 15 Mr. Arpan Dawn providing a Hands-on session on GEE for mapping water hyacinth.

The next resource person was **Dr. Chaturangi Wickramaratne** from IWMI discussed the importance of building trust with communities for the promotion of citizen science and informed policymaking using digital applications for long-term monitoring of urban wetland health and the importance of wetlands globally, especially in India and Sri Lanka. She speaks about a digital application in Columbo to ensure wetland health, a project funded by Darwin to increase the residues of biodiversity and livelihoods in Colombo's wetlands and highlights the threats posed to wetlands due to overexploitation of resources and benefits of educating citizens about ecosystem health.

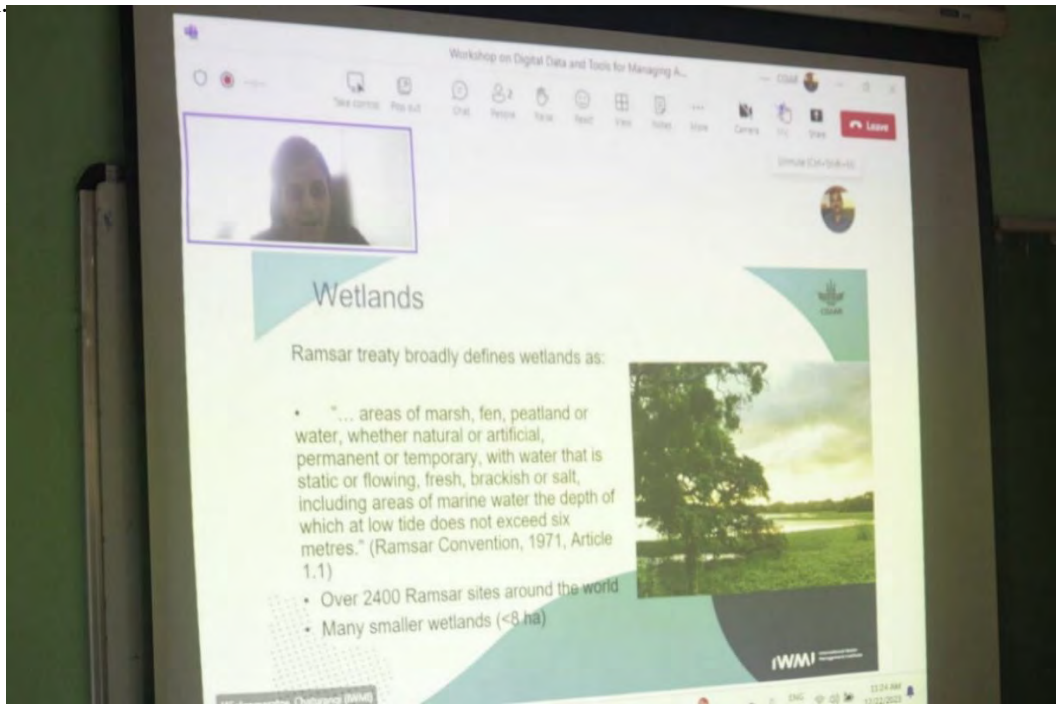

Fig 16 Dr. Chaturangi Wickramaratne delivering her lecture (online)

Following her, was **Dr. Bunyod Holmatov**, IWMI

Dr. Holmatov spoke about the importance of greenhouse gases and the current need for projects that aim to reduce emissions into the atmosphere across various countries. Carbon footprints and water footprints, water management infrastructure were key highlights of the session. Using digital tools and data, increased methane emissions from dams and other pathways contributing to emissions should be estimated, necessitating the need to understand, intervene and leverage points in the system to reduce greenhouse gas emissions can help achieve mitigation goals and reduce the risks of climate change.

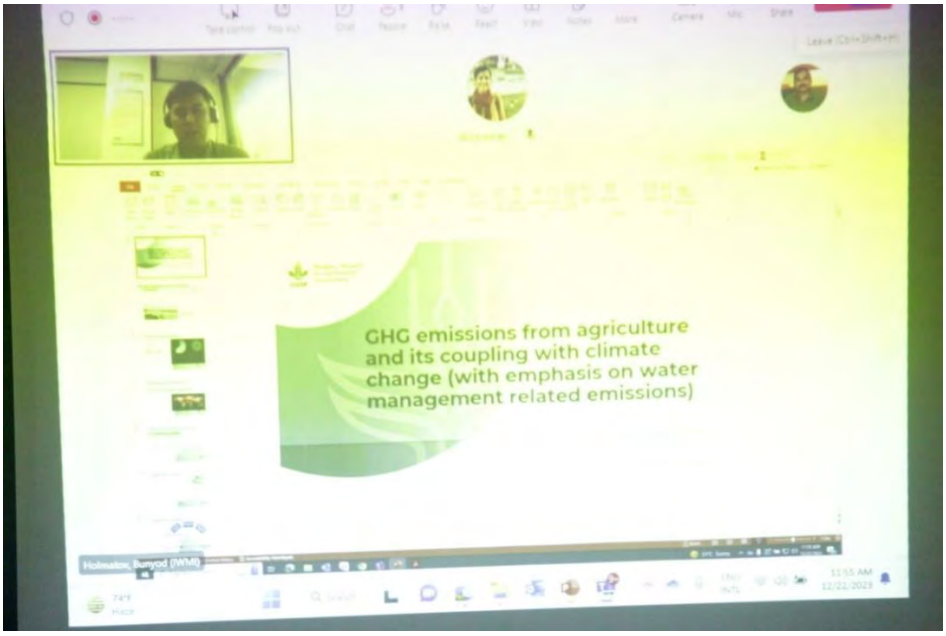

Fig 17 Dr. Bunyod Holmatov on GHG emission from agriculture

Following the lunch break, the next speaker was **Dr. Arjamadutta Sarangi**, IIWM. He discussed the importance of data in agriculture, the use of deep learning techniques for weather prediction, and the role of geospatial data analysis, combining GIS, remote sensing, and GPS for monitoring land, water, and vegetation in sustainable development. He pointed out the impact of anthropogenic interventions on land use and cover, contributing to climate change and carbon credit coverage, the process of using ground truthing to understand garbage and the use of different hydrological models to enhance farmers' livelihoods.

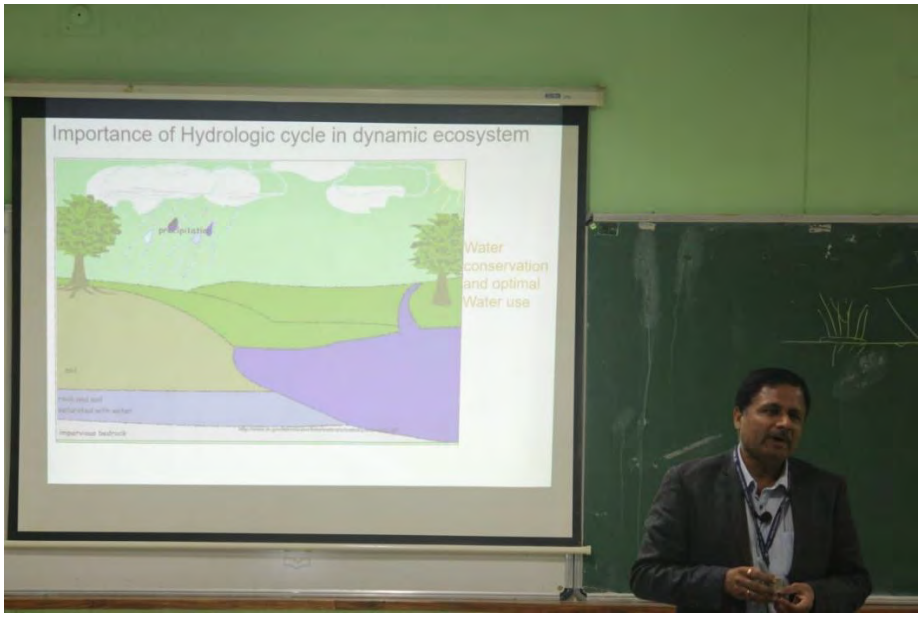

Fig 18 Dr. Arjamadutta Sarangi delivering his speech

The next resource person **Mr. Kounik De Sarkar**, NIT Durgapur, presented the mapping and monitoring of GHG emissions using EO data, highlighting the importance of mitigating methane emissions from hydroelectric reservoirs. After discussing the benefits of these reservoirs, he moved on to studies which prove these hydropower reservoirs to be a potential source of greenhouse gas and how mitigation pathways should be devised to limit these emissions. He further showcased a bibliometric analysis of hydropower and GHG emission, year-wise publication trends with the spatial distribution of published papers in the world. Estimating GHG emission by use of G-res tool was demonstrated to quantify the emission from different pathways from those input data parameters.

Fig 19 Mr. Kounik De Sarkar presenting the monitoring of GHG emission using EO data

The final session was delivered by **Dr. Moctar Dembélé**, IWMI

He spoke about how water scarcity affects half of the world's population, thus posing severe implications for sectors like agriculture, hydropower generation, and biodiversity, with long-term water management policies becoming vital. He spoke extensively on water accounting, a tool for an independent and advised assessment and monitoring of water resources, providing reports on water stocks, flows, and fluxes in natural and disturbed habitats. His speech summarized the complex agricultural processes, including water flow and consumption, based on standards and critical indicators to be implemented with satellite data.

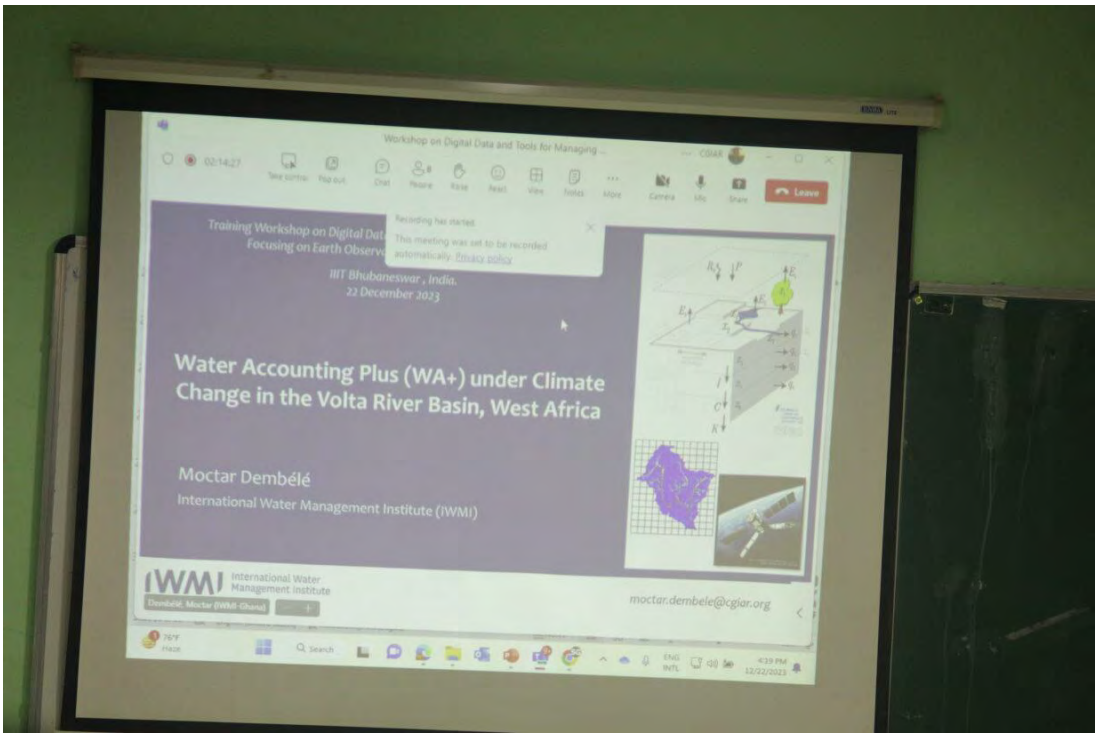

Fig 20 Dr. Moctar Dembélé delivering his speech (online)

Cultural Event: After the lectures during the day, an evening of cultural events was put up by the students of IIIT Bhubaneswar, embracing the rich cultural diversity of India with its diverse art forms like dance and music. The participants of the workshop took an active part in the cultural program, making the day a perfect blend of connecting knowledge to the roots.

Fig 21 Group photo of cultural event

Day 3

Day 3 had new opportunities and challenges at hand for student researchers. Participants were asked to present their research. Topics like Bibliometric Analysis of EO-based Rice Mapping Studies in Vietnamese Mekong Delta, Rice phenology study, drone monitoring, GHG emissions from hydropower reservoirs, water hyacinth mapping and Spatial Analysis of Flood events in India were discussed.

Fig 22 Participants who presented their research in the workshop

Next, **Mr. Kounik De Sarkar** demonstrated G-res tool using Google Earth Engine code, to derive the required parameters to estimate GHG emissions from different pathways. He pointed out some drawbacks that were faced while working with G-res, which led to the need for a GeeT. A comparative study of the results from both G-res and GeeT was drawn in the session.

Next, the keynote speech for the third day was by **Prof. Ashish Ghosh**, director of IIIT Bhubaneswar. Prof. Ghosh emphasized the significance of AI and machine learning methods to improve agricultural output and manage market expansion, precise weather forecasting, and climate monitoring. He exposed the falsehoods in the Indian system, citing the previous year's heat wave. He advocated the potential of AI and ML in improving farmers' production, reducing costs, and making informed decisions. He spoke about the various applications of AI and ML, like the use of IoT systems and automated water spray technology. He also emphasized the importance of ecosystems in agriculture due to the decrease of cultivable land from urbanization. AI analyzes collected data to give rules and make informed decisions, which, according to him, is a powerful feature of a tool that can transform businesses. In agriculture, machine learning algorithms and AI can be used to create more perfect rules if more data is provided.

Fig 23 Keynote speech by Prof. Ashish Ghosh

Prof. Sumit Sen from IIT Roorkee presented the platform of SAADRI and its main objectives, that is to establish a South Asia research network that promotes and engages in all aspects of disaster research, prepare a roadmap for guiding implementable research institutes and groups to resolve challenges faced by field experts. To promote the capacity and development of disaster research institutes and enhance active exchange among researchers and students engaged in disaster research, it strives for active exchange and sharing of data and information for scientific research across the countries. SAADRI also serves as an advocacy organization presenting evidence-based approaches and relevant innovation that influence decision-making processes.

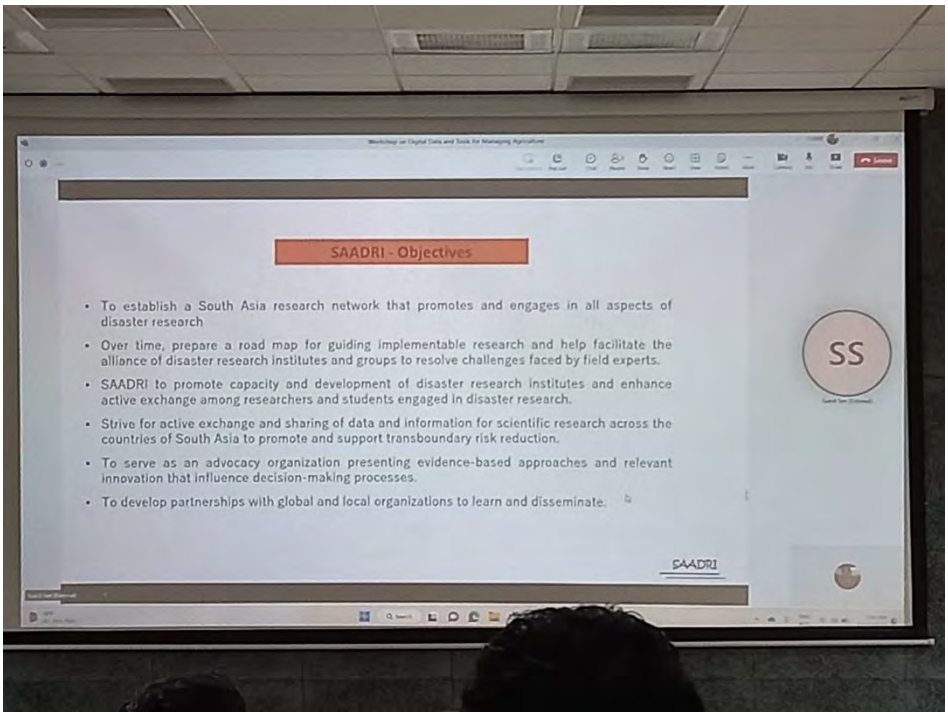

Fig 24 Speech by Prof. Sumit Sen *(*online*)*

The next speaker, **Dr. Debajit Mishra**, Vassar Labs IT Solutions Pvt Ltd, discussed the use of IoT technology and satellite data in agriculture for crop and soil information, moisture revival transmission, and vegetation crop health. Speaking of the development of four open-source expertise platforms that include data servers, search engines, geospatial data handlers, image processing options, AI and deep learning-based analysis servers, and visibility servers, he said that remote sensing technologies, such as GIS and location-based satellite mechanisms can be used for meaningful purposes, particularly for socioeconomic development.

Fig 25 Speech by Dr Debajit Mishra

The final session before lunch was given by **Mr. Jayesh Mukherjee** from Aberystwyth University. He mainly spoke about the widespread flooding in Central India (2022), mainly in the LGRB. His study found flood-prone river stretches and submerged agricultural lands using high-resolution SAR imagery from Sentinel-1. He discussed how well the use of cloud computing frameworks like GEE and EO datasets impacted and enhanced the accuracy of flood assessment, thus underscoring the need for disaster managers and policymakers to integrate such frameworks for timely and informed decision-making.

Fig 26 Online session by Mr. Jayesh Mukherjee

Brainstorming session - 'Data Science and Sustainability Challenge'

The Brainstorming session - 'Data Science and Sustainability Challenge' was proposed during the end session of the 3rd day of the event. In this, the participants were urged to come up with challenges and ideas that can be developed into tools for sustainable agriculture. The participants discussed on several burning issues focusing on Water allocation optimization strategy for irrigation water management, Water Scarcity Monitoring and Management, Early Warning Systems for natural disasters, Crop yield loss prediction due to natural disasters, Sustainable Land Use Planning, and Multi-satellite sensor data cube development for Interdisciplinary Research. The repeated issue that came up during the discussion is the critical need for a high-resolution data robust database for research focusing on natural disasters, agriculture water use, and socioeconomic criteria. Participants from different institutes across the country delivered their opinions on the data challenges that they faced during the research work.

Fig 27 Brainstorming session on *Data Science and Sustainability Challenge*

Conclusion

The three-day training workshop on "Digital Data and Tools for Managing Agriculture: Focusing on Earth Observation Data and Climate Change" offered a platform to experts, researchers, and students for cross-disciplinary discussion and knowledge gain who came together for the event and collectively promoted a variety of information and perspectives on the difficulties being faced in agriculture and water resource management, due to climate change. Throughout the sessions, several speakers offered insightful information and facts on the importance of data, advanced data analytics, and geospatial technology in dealing with the current problems in agriculture. The significant effects of incorporating data-driven strategies for sustainable development and the impact of human actions on the environment were among the topics covered in the discussion. The talks covered a broad range of subjects, including water shortages, greenhouse gas emissions from hydropower reservoirs, mapping of water hyacinth, wetland monitoring, carbon sequestration, and the application of digital technology in evaluating and managing water resources and climate-smart agriculture. Researchers and scholars also got the opportunity to present their work, ranging from bibliometric analysis to spatial analysis of pertinent events.

The students' cultural events gave the workshop a lively touch and were just as important to the event's success as the talks. These cultural events promoted a fusion of knowledge sharing & cultural appreciation while also showcasing the vast diversity of India's artistic expressions. A noteworthy aspect of the workshop was the collaborative spirit evident in the "Data Science and Sustainability Challenge", which encouraged participants to brainstorm and propose ideas for tools promoting sustainable agriculture. This initiative exemplified a shared commitment to fostering innovative solutions for an eco-friendly future. The valedictory session brought the workshop to a close, acknowledging the collective efforts of participants. Certificates, tokens of appreciation, and mementoes were distributed, symbolizing the shared commitment to advancing knowledge in geospatial water resource management techniques.

Sri Dasarathi Satpathy acknowledged the chief guest in the valedictory session. He emphasized the need for a positive attitude, hard work, constant dedication and devotion to achieve success in any initiative and highlighted the importance of a problem-solving approach towards life. He concluded with New Year wishes and a call for success in the audience's careers.

Fig 28 Mr. Dasarathi Satpathy delivering the valedictory speech

Key take way message

The key takeaway message from the workshop emphasizes the critical importance of integrating EO data and digital tools into agricultural management for enhanced decision-making. The use of AI and ML in agriculture, while innovative, calls for responsible and ethical application to ensure that these technologies serve the common good. The workshop highlighted the essential role of wetlands in biodiversity conservation and carbon storage, underlining the urgent need to understand and mitigate GHG emissions from reservoirs. Advancing towards climate-smart agriculture was identified as a necessity, advocating for a synthesis of conventional and contemporary farming methods to ensure sustainability and resilience against climate change. The discussions and sessions underscored the collective need for cooperative research and sustainable practices to address the intertwined challenges of agriculture and climate change.

- The synthesis of EO data, which includes satellite remote sensing, IoT, drones, and other digital tools, is increasingly recognized as an indispensable asset in agricultural monitoring and decision-making. These technologies facilitate real-time surveillance of crops and environmental conditions, enabling stakeholders to react swiftly and effectively to changes and challenges in agricultural systems under climatic extremes. The data gathered from these sources, when processed through advanced analytics (such as cloud platforms), can significantly enhance the precision and sustainability of farming practices. This optimized approach to agriculture not only increases yield but also contributes to the responsible use of natural resources.
- The concept of climate-smart agriculture is gaining traction as a means to secure the future of farming. This approach calls for an integrated strategy that combines traditional agricultural knowledge with cutting-edge scientific and technological methods. By doing so, it seeks to create sustainable, resilient agricultural systems capable of adapting to and mitigating the effects of climate variability and change.
- Wetlands in urban and peri-urban areas play a pivotal role in environmental conservation, acting as significant carbon sinks that aid in climate change mitigation and serving as bastions for biodiversity. The maintenance and protection of wetlands are crucial for preserving ecosystem health, particularly in terms of maintaining water quality and supporting a wide array of plant and animal life. Nonetheless, the scientific community has identified a considerable gap in research concerning the quantification and mitigation of GHG emissions from water reservoirs. Bridging this gap is essential for crafting effective environmental policies and conservation strategies.
- In the realm of agricultural research, the deployment of AI and ML is expanding. These technologies have the potential to revolutionize farming by enabling the prediction of environmental changes, optimizing resource allocation, and enhancing crop management. However, AI and ML applications in agriculture must be approached with caution. Ethical guidelines and responsible usage protocols should govern their deployment to prevent any adverse socioeconomic or environmental consequences.
- Finally, the interdependence of climate change and agriculture is a compelling reason for increased collaborative research and the implementation of sustainable practices. It's imperative that these efforts are not conducted in silos; rather, a multi-disciplinary, cooperative approach is essential. Sharing knowledge and resources across borders and sectors can lead to the development of innovative solutions that benefit farmers, consumers, and the planet. Such integrative and sustainable practices in agriculture are critical to meeting the current and future challenges of feeding a growing global population under the shadow of climate change.

Fig 29 Certificate distribution to participants

References (not in alphabetical order)

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Umesha, S., Manukumar, H. M., & Chandrasekhar, B. (2018). Sustainable agriculture and food security. In *Biotechnology for sustainable agriculture* (pp. 67-92). Woodhead Publishing.

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Saiz-Rubio, V., & Rovira-Más, F. (2020). From smart farming towards agriculture 5.0: A review on crop data management. *Agronomy*, *10*(2), 207.

Goel, R. K., Yadav, C. S., Vishnoi, S., & Rastogi, R. (2021). Smart agriculture–Urgent need of the day in developing countries. *Sustainable Computing: Informatics and Systems*, *30*, 100512.

Ramm, G., Balogun, K., Souvignet, M., & Range, M. (2018). Integrating Insurance into Climate Risk Management: Conceptual Framework, Tools and Guiding Questions: Examples from the Agricultural Sector.

Stankovic, M., Neftenov, N., & Gupta, R. Use of Digital Tools in Fighting Climate Change: A Review of Best Practices. *Availabe online: https://bit. ly/3Gxodt6 (accessed on 21 October 2022)*.

Gil, J. D. B., Reidsma, P., Giller, K., Todman, L., Whitmore, A., & van Ittersum, M. (2019). Sustainable development goal 2: Improved targets and indicators for agriculture and food security. *Ambio*, *48*(7), 685-698.

Annexure 1: Participants statistics

Participants from around 40 different institutes attended the workshop. Out of 82 participants, 63% were male and 37% were female.

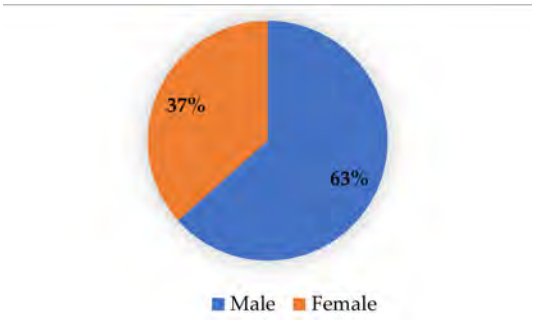

Fig 30 Genderwise distribution of participants in the workshop

The workshop attracted professionals (9), faculty members (9), research scholars (21), post-graduates (22) and graduates (20), mainly students from various disciplines from all over the country.

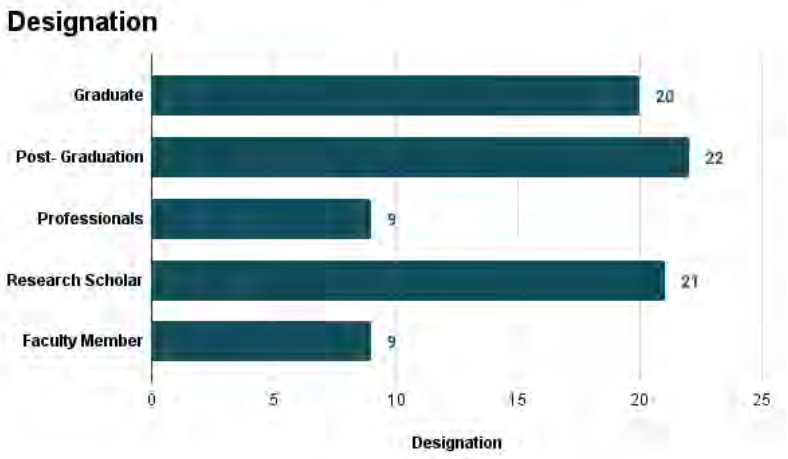

Fig 31 Distribution of designation of participants as per obtained feedback

Annexure 2: Feedback

Out of a total of 81 participants, 75 filled in their responses, and the statistics obtained are as follows.

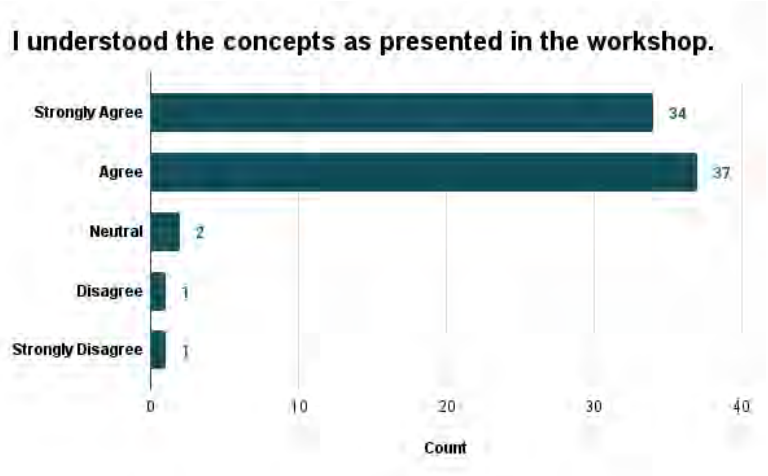

Fig 32 Understandability level of the workshop

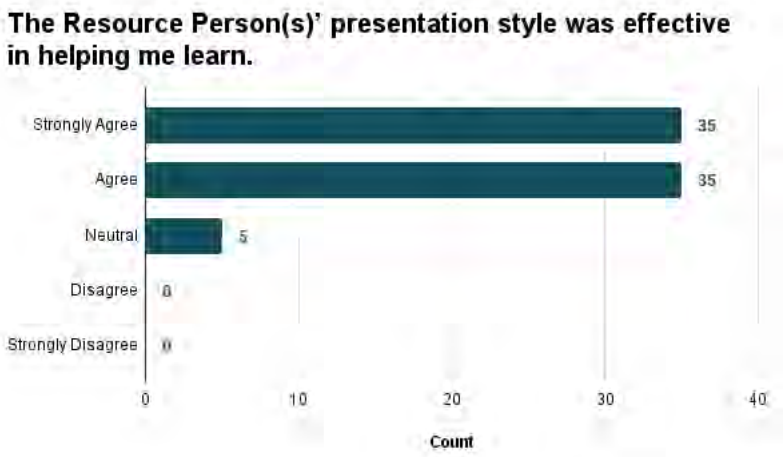

Fig 33 Effectiveness of Resource person's presentation

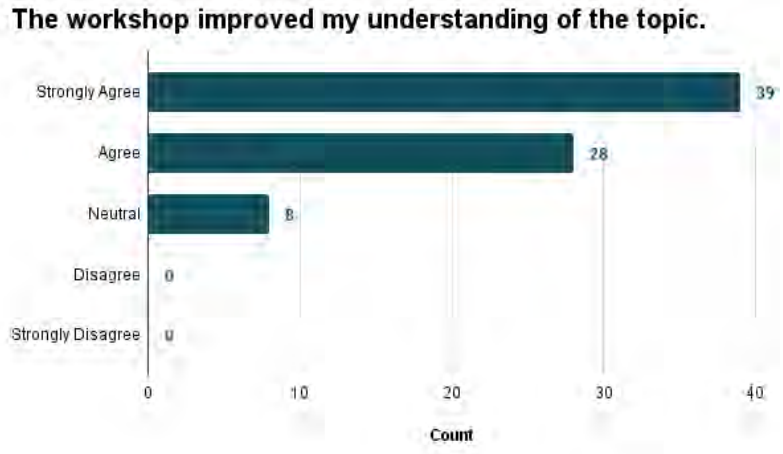

Fig 34 Improved understanding of topics in the workshop

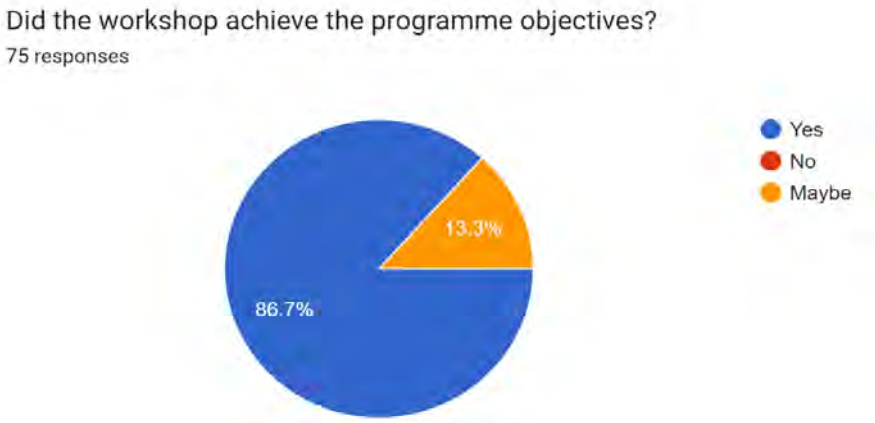

Fig 35 Distribution of achieving programme objectives successfully

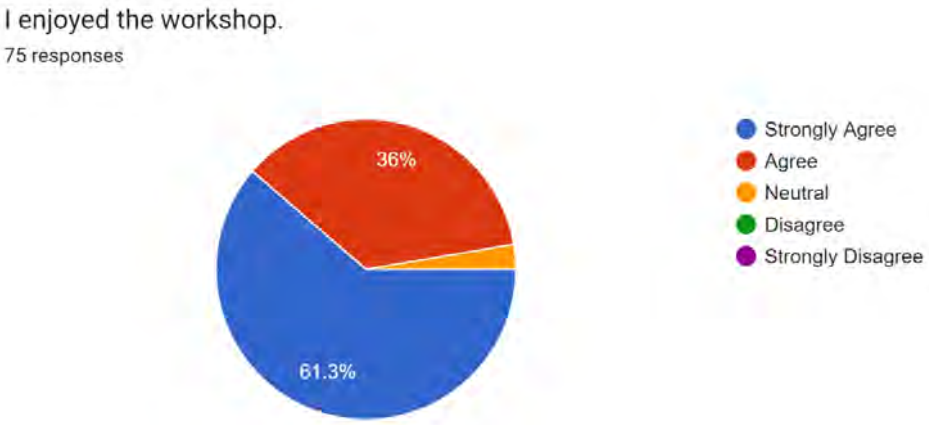

Fig 36 Participants' satisfaction with the workshop

Annexure 3: Social Media activity

Fig 37 LinkedIn post by a participant
https://www.linkedin.com/feed/update/urn:li:activity:7145475219313336320/

Fig 38 LinkedIn post by a participant

https://www.linkedin.com/posts/priyambada-acharya-0b8a38269_ieee-ieeekolkatasection-iwmi-activity-7144714835799212032-wemP?utm_source=share&utm_medium=member_ios

Fig 39 LinkedIn post by a participant

https://www.linkedin.com/posts/pulakeshpradhan_certificate-activity-7144627334866690048-_hIr?utm_source=share&utm_medium=member_ios

Fig 40 Circulation in ResearchGate

https://www.linkedin.com/feed/update/urn:li:activity:7140573414104178688/

Annexure 4: Useful links

Pre-event instructions for the participants
https://docs.google.com/document/d/1d-FPa8fpyTb1rMXI_kzxFxAG945stZQ6Y8ajvRVt3WY/view

YouTube live sessions:
https://www.youtube.com/live/Jqdq2NBAsW0?si=CGVctPjg4OCC7boW

https://www.youtube.com/live/HEfud3h1xdo?si=UplVkhnSVDq0MfTo

https://www.youtube.com/live/DzsuF0rMShU?si=RGAA6iRcQfOqqpdY

https://www.youtube.com/live/W1qP3FCyZmo?si=J2BbbMeLpzDMCsSy

https://www.youtube.com/live/BHxPIG3adbQ?si=2xP79dC_Z40ai8uc

https://www.youtube.com/live/SjKMOU8Fw5E?si=I3gCF9Hbpn3aC3SV

https://www.youtube.com/live/YqcSWR3HPkg?si=aJoEhSRSptPenOWD

https://www.youtube.com/live/Uop4hQpAJ24?si=6IA7DJl6JgoLrElO

https://www.youtube.com/live/0528loxDeu0?si=JTIBpFA8nYikinh8

Photographs
https://drive.google.com/drive/folders/1hq898ClJYfin6imxFKN_uI9oR2bJlEEG

Research papers presented/discussed.

- Graph Theory Applications in Advanced Geospatial Research https://www.researchgate.net/publication/373754025_Graph_Theory_Applications_in_Advanced_Geospatial_Research
- Standardized Analysis Ready STAR data cube for high-resolution Flood Mapping using Sentinel-1 data https://www.researchgate.net/publication/375963187_Standardized_Analysis_Ready_STAR_data_cube_for_high-resolution_Flood_mapping_using_Sentinel-1_data
- Geospatial Paradigms EO's Role in Resource Management and Governance https://www.researchgate.net/publication/376601260_Geospatial_Paradigms_EO's_Role_in_Resource_Management_and_Governance
- EO-based Rice Mapping Studies in Vietnamese Mekong Delta Compared to Global Context: A Bibliometric Analysis https://www.researchgate.net/publication/374741094_EO-based_Rice_Mapping_Studies_in_Vietnamese_Mekong_Delta_Compared_to_Global_Context_A_Bibliometric_Analysis

Annexure 5: Registration

Fig 41 Registration desk

Training Workshop on Digital Data and Tools for Managing Agriculture:
Focusing on Earth Observation Data and Climate change

Venue: IIIT Bhubaneswar, Bhubaneswar - 751003, India
Date: 21-23 December 2023

Registration List

Name of the Participant	Affiliation of Participant's Institution / Organization	Email address	WhatsApp No	Signature
Abhay Kumar Chaubey	Central University Of South Bihar Gaya	abhaychaubey269@gmail.com	8102476207	
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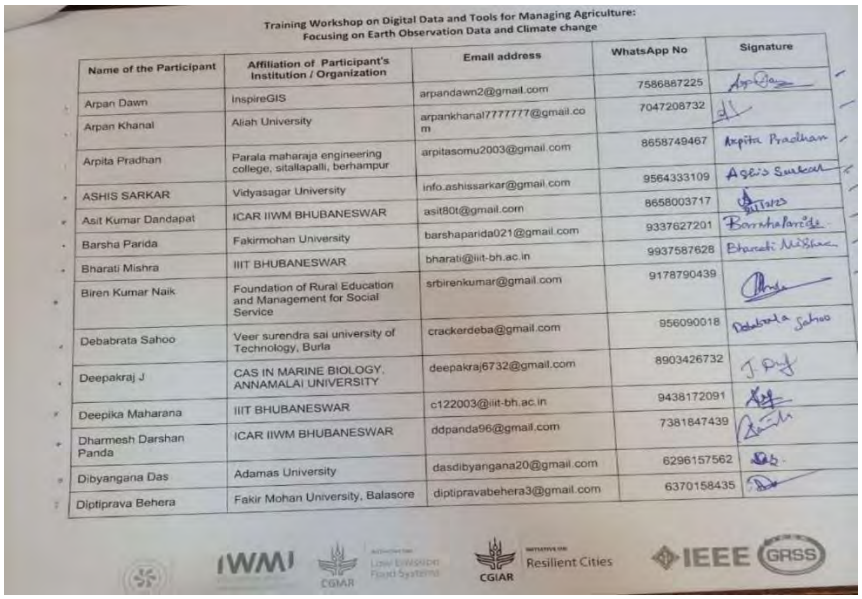
Archita Mallick	Techno Main Salt Lake	architamallick1002@gmail.com	9836702999	



Training Workshop on Digital Data and Tools for Managing Agriculture:
Focusing on Earth Observation Data and Climate change

Name of the Participant	Affiliation of Participant's Institution / Organization	Email address	WhatsApp No	Signature
Arpan Dawn	InspireGIS	arpandawn2@gmail.com	7586887225	
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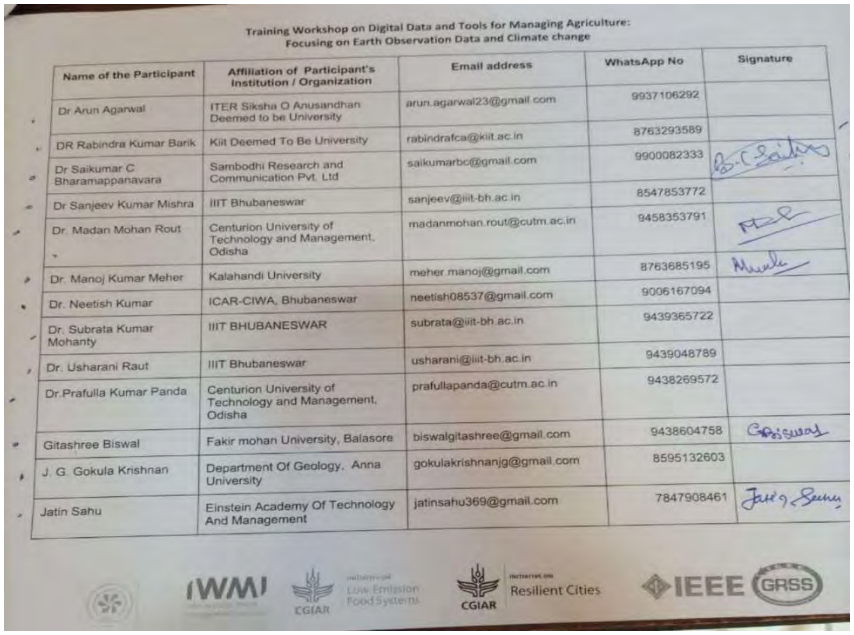
Diptiprava Behera	Fakir Mohan University, Balasore	diptipravabehera3@gmail.com	6370158435	



Training Workshop on Digital Data and Tools for Managing Agriculture: Focusing on Earth Observation Data and Climate change

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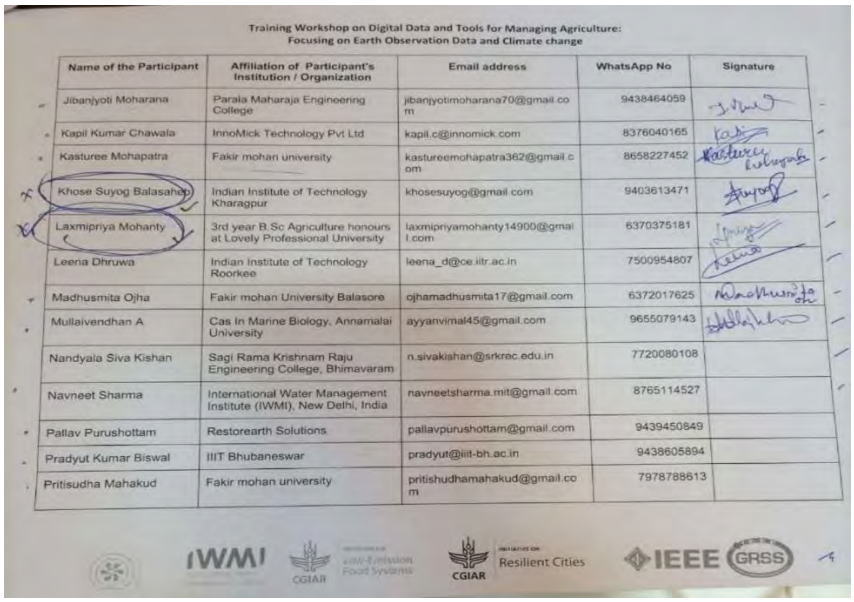

Training Workshop on Digital Data and Tools for Managing Agriculture: Focusing on Earth Observation Data and Climate change

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Focusing on Earth Observation Data and Climate change

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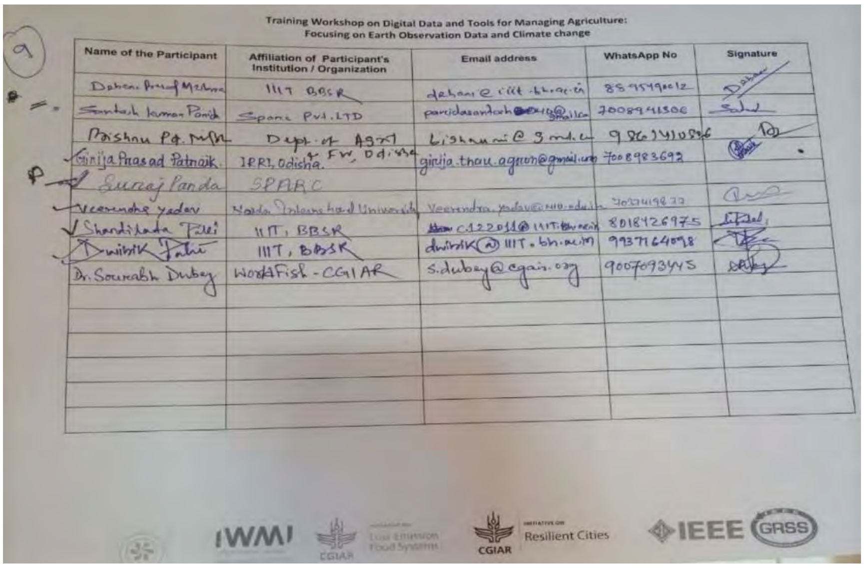
Umamani Subudhi	IIIT BHUBANESWAR	subudhi.uma@gmail.com	8658541510	



Training Workshop on Digital Data and Tools for Managing Agriculture:
Focusing on Earth Observation Data and Climate change

Name of the Participant	Affiliation of Participant's Institution / Organization	Email address	WhatsApp No	Signature
[illegible]	IIIT BBSR	[illegible]	8895490012	
Santosh kumar Panda	Space Pvt. LTD	[illegible]	7008941306	
Bishnu Pd. [illegible]	Dept. of Agri & FW, Odisha	[illegible]	[illegible]	
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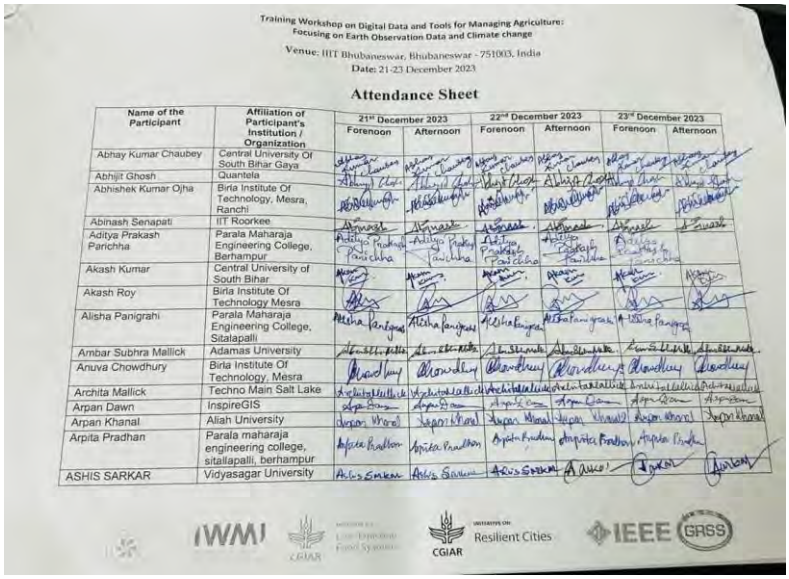
Suraj Panda	SPARC			
Veerendra yadav	[illegible] University	[illegible]	[illegible]	
Shandilyada Palei	IIIT, BBSR	c122011@iiit-bh.ac.in	8018426975	
Dwibik Pahi	IIIT, BBSR	dwibik@iiit.bh.ac.in	9937164098	
Dr. Sourabh Dubey	WorldFish - CGIAR	s.dubey@cgiar.org	9007093445	

Fig 42 Registration Sheet

Annexure 6: Attendance Sheet



Training Workshop on Digital Data and Tools for Managing Agriculture:
Focusing on Earth Observation Data and Climate change

Venue: IIIT Bhubaneswar, Bhubaneswar - 751003, India
Date: 21-23 December 2023

Attendance Sheet

Name of the Participant	Affiliation of Participant's Institution / Organization	21st December 2023		22nd December 2023		23rd December 2023	
		Forenoon	Afternoon	Forenoon	Afternoon	Forenoon	Afternoon
Abhay Kumar Chaubey	Central University Of South Bihar Gaya						
Abhijit Ghosh	Quantela						
Abhishek Kumar Ojha	Birla Institute Of Technology, Mesra, Ranchi						
Abinash Senapati	IIT Roorkee						
Aditya Prakash Parichha	Parala Maharaja Engineering College, Berhampur						
Akash Kumar	Central University of South Bihar						
Akash Roy	Birla Institute Of Technology Mesra						
Alisha Panigrahi	Parala Maharaja Engineering College, Sitalapalli						
Ambar Subhra Mallick	Adamas University						
Anuva Chowdhury	Birla Institute Of Technology, Mesra						
Archita Mallick	Techno Main Salt Lake						
Arpan Dawn	InspireGIS						
Arpan Khanal	Aliah University						
Arpita Pradhan	Parala maharaja engineering college, sitallapalli, berhampur						
ASHIS SARKAR	Vidyasagar University						

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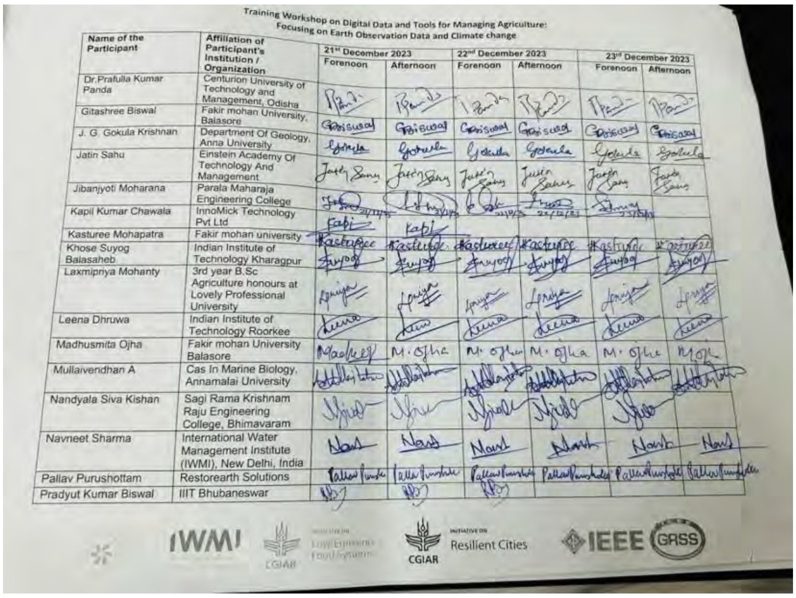
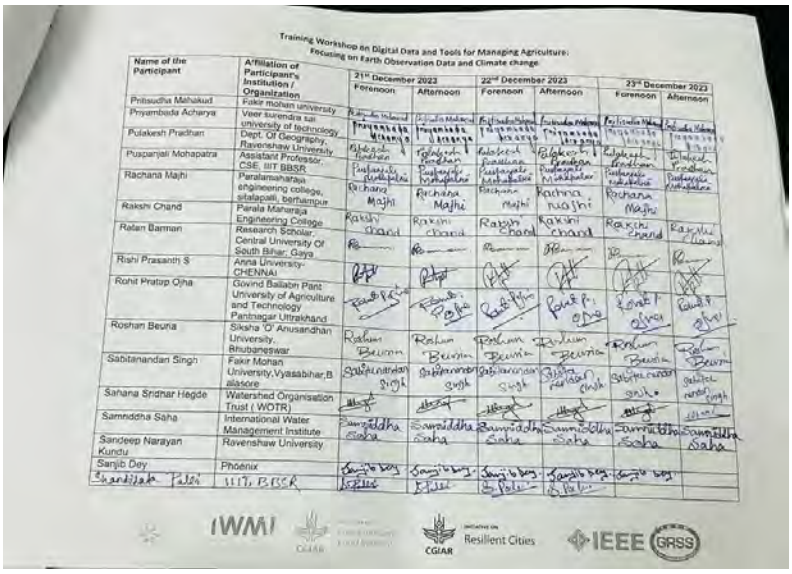
Asit Kumar Dandapat	ICAR IIWM BHUBANESWAR						
Barsha Parida	Fakirmohan University						
Bharati Mishra	IIIT BHUBANESWAR						
Biren Kumar Naik	Foundation of Rural Education and Management for Social Service						
Debabrata Sahoo	Veer surendra sai university of Technology, Burla						
Deepakraj J	Cas In Marine Biology, Annamalai University						
Deepika Maharana	IIIT BHUBANESWAR						
Dharmesh Darshan Panda	ICAR IIWM Bhubaneswar						
Dibyangana Das	Adamas University						
Diptiprava Behera	Fakir Mohan University, Balasore						
Dr Arun Agarwal	ITER Siksha O Anusandhan Deemed to be University						
DR Rabindra Kumar Barik	Kiit Deemed To Be University						
Dr Saikumar C Bharamappanavara	Sambodhi Research and Communication Pvt. Ltd						
Dr Sanjeev Kumar Mishra	IIIT Bhubaneswar						
Dr. Madan Mohan Rout	Centurion University of Technology and Management, Odisha						
Dr. Manoj Kumar Meher	Kalahandi University						
Dr. Neetish Kumar	ICAR-CIWA, Bhubaneswar						
Dr. Subrata Kumar Mohanty	IIIT BHUBANESWAR						
Dr. Usharani Raut	IIIT Bhubaneswar						


Training Workshop on Digital Data and Tools for Managing Agriculture: Focusing on Earth Observation Data and Climate change

Name of the Participant	Affiliation of Participant's Institution / Organization
Dr.Prafulla Kumar Panda	Centurion University of Technology and Management, Odisha
Gitashree Biswal	Fakir mohan University, Balasore
J. G. Gokula Krishnan	Department Of Geology, Anna University
Jatin Sahu	Einstein Academy Of Technology And Management
Jibanjyoti Moharana	Parala Maharaja Engineering College
Kapil Kumar Chawala	InnoMick Technology Pvt Ltd
Kasturee Mohapatra	Fakir mohan university
Khose Suyog Balasaheb	Indian Institute of Technology Kharagpur
Laxmipriya Mohanty	3rd year B.Sc Agriculture honours at Lovely Professional University
Leena Dhruwa	Indian Institute of Technology Roorkee
Madhusmita Ojha	Fakir mohan University Balasore
Mullaivendhan A	Cas In Marine Biology, Annamalai University
Nandyala Siva Kishan	Sagi Rama Krishnam Raju Engineering College, Bhimavaram
Navneet Sharma	International Water Management Institute (IWMI), New Delhi, India
Pallav Purushottam	Restorearth Solutions
Pradyut Kumar Biswal	IIIT Bhubaneswar


Training Workshop on Digital Data and Tools for Managing Agriculture: Focusing on Earth Observation Data and Climate change

Name of the Participant	Affiliation of Participant's Institution / Organization
Pritisudha Mahakud	Fakir mohan university
Priyambada Acharya	Veer surendra sai university of technology
Pulakesh Pradhan	Dept. Of Geography, Ravenshaw University
Puspanjali Mohapatra	Assistant Professor, CSE, IIIT BBSR
Rachana Majhi	Paralamaharaja engineering college, sitalapalli, berhampur
Rakshi Chand	Parala Maharaja Engineering College
Ratan Barman	Research Scholar, Central University Of South Bihar, Gaya
Rishi Prasanth S	Anna University-CHENNAI
Rohit Pratap Ojha	Govind Ballabh Pant University of Agriculture and Technology Pantnagar Uttrakhand
Roshan Beuria	Siksha 'O' Anusandhan University, Bhubaneswar
Sabitanandan Singh	Fakir Mohan University,Vyasabihar,Balasore
Sahana Sridhar Hegde	Watershed Organisation Trust (WOTR)
Samriddha Saha	International Water Management Institute
Sandeep Narayan Kundu	Ravenshaw University
Sanjib Dey	Phoenix
Shandilak Palei	IIIT, BBSR


Training Workshop on Digital Data and Tools for Managing Agriculture: Focusing on Earth Observation Data and Climate change

Name of the Participant	Affiliation of Participant's Institution / Organization
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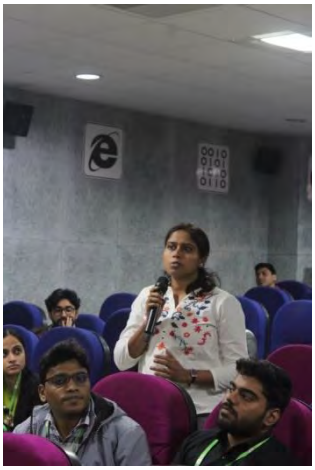
Shivam Priyadarshi	Central University of South Bihar, Gaya
Shradha Ram	Fakir Mohan University
Sneha Kour	Inspiregis
Sonali Sahoo	Fakir Mohan University,Vyasabihar,Balasore
Soumi Sarkar	Indian Statistical Institute
Srikanta Mondal	Indian Institute Of Technology Mandi
Suchismita Malla	Parala Maharaja Engineering College Berhampur
Swadhin Satapathy	National Institute of Science Education and Research (NISER), Bhubaneswar
Swagat Suman Patra	Fakir Mohan University
Tarun Kumar	Central university of South Bihar
Umamani Subudhi	IIIT BHUBANESWAR
Vaibhav Chauhan	HCL Foundation
Wahida Rahaman	Birla institute of technology Mesra
Yalakala Gowtam	Indian Institute Of Technology, Roorkee
Dr. Debi [illegible]	IIIT, BBSR
[illegible] Panda	SPARC
Suraj Panda	CPARC
Dr. Veerendra yadav	Nesh Infrastructural University

Fig 43 Recorded Attendance

Annexure 7: Interactions with participants

Annexure 8: Contributors

Sl. No.	Speakers	Affiliation	Country
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2	**Sri Manoj Kumar Pattnaik**	CEO, OCAC, Govt of Odisha	India
3	**Aloke Sikka**	IWMI India Representative	India
4	**Subhadarsi Mishra**	MD, SPARC	India
5	**Gyana Das**	MD, OSDMA	India
6	**Arun Joyti Nath**	Assam University	India
7	**Nagaraja Harshadeep**	World Bank	US
8	**Sudip Mitra**	IIT Guwahati	India
9	**Guneet Mutreja**	DLR	India
10	**Surajit Ghosh**	IWMI	Sri Lanka
11	**Chaturangi Wickramaratne**	IWMI	Sri Lanka
12	**Bunyod Holmatov**	IWMI	Uzbekistan
13	**Arjamadutta Sarangi**	IIWM	India
14	**Moctar Dembélé**	IWMI	Ghana
15	**Kounik De Sarkar**	NIT Durgapur	Sri Lanka
16	**Sumit Sen**	IIT Roorkee SAADRI	Sri Lanka
17	**Debajit Mishra**	Vassar Labs IT Solutions Pvt Ltd	Sri Lanka
18	**Jayesh Mukherjee**	Aberystwyth University	UK
19	**Susmita Ghosh**	Jadavpur University	Sri Lanka
20	**Sri Dasarathi Satpathy**	Special Secretary OLA	Sri Lanka

Sl. No.	Contributors from the participants	Affiliation
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3	**Arpan Dawn**	Burdwan University
4	**Ashish Sarkar**	Vidyasagar University
5	**Archita Mallick**	Techno Main Salt Lake
6	**Khose Suyog Balasaheb**	IIT Kharagpur
7	**Prafulla Kumar Panda**	Centurian University of Technology and Management
8	**Samriddha Saha**	Burdwan University

Special thanks to **Wahida Rahaman**, BITM and **Pulakesh Pradhan**, Ravenshaw University for their partial contribution to the report

Annexure 9: Brief Biography of the Speakers

Alok Sikka, IWMI

Alok Sikka is a Country Representative of India at IWMI. He expertises in fields of hydrology, climate change, water productivity, irrigation water management, integrated watershed management. Before IWMI, Alok served as Deputy Director General (Natural Resource Management) at the Indian Council of Agricultural Research (ICAR), India, and Technical Expert (Watershed Development) (in the rank of Additional Secretary to the Government of India), National Rainfed Area Authority (NRAA), Planning Commission, Government of India, New Delhi, India. He was Director of the ICAR Research Complex for the Eastern Region, Patna, India, and Basin Coordinator for the Indo-Gangetic Basin under the CGIAR Challenge Program on Water and Food (CPWF) from 2002 to 2007.

Arjamadutta Sarangi, IIWM

Sarangi is a principal Scientist at WTC, ICAR-Indian Agricultural Research Institute WTC, Indian Agricultural Research Institute Delhi, India. His expertise is in Integrated water resources management, Agricultural Water Management, Use of GIS, RS in water resources Management, Crop and hydrological modelling, Development of DSS and use of sensors in Agriculture, Water Saving technologies in irrigated Agriculture.

Arun Jyoti Nath, Assam University

Prof. Nath is Assistant Professor of Ecology and Environmental Science at Assam University, Silchar, India, and a PLOS ONE Academic Editor since 2017. He is an ecologist with diverse experience in research and teaching. His research interest includes climate change vulnerability and adaptation.

Ashish Ghosh, Director, IIIT Bhubaneswar

Ashish Ghosh, currently the director of IIIT Bhubaneshwar, is a distinguished Professor and former Head of the Machine Intelligence Unit, as well as the In-charge of the Center for Soft Computing Research at the Indian Statistical Institute, Kolkata. He earned his B.E. degree in Electronics and Telecommunication from Jadavpur University, Calcutta (1987), followed by M.Tech (1989) and Ph.D. (1993) degrees in Computer Science from the Indian Statistical Institute, Calcutta. A fellow of the West Bengal Academy of Science and Technology, he has received accolades such as the Young Scientists Award in Computer Science from the Indian Science Congress Association (1992) and in Engineering Sciences from the Indian National Science Academy (1995). Additionally, he was selected as an Associate of the Indian Academy of Sciences, Bangalore (1997). His extensive academic contributions have taken him to numerous universities and institutes worldwide, where he has delivered lectures and undertaken research activities. Notably, he spent a post-doctoral fellowship at Osaka Prefecture University, Japan (1995–1997).

Bunyod Holmatov, IWMI

Holmatov is a researcher in Data Analysis and Innovation in Water Management. His expertise in natural resources management, transboundary water management, water security, climate change science and policy, renewable energy systems modeling. Before IWMI, Bunyod worked as a postdoctoral researcher at the University of Twente in the Netherlands, where he focused on identifying and enabling synergistic solutions to tackle competing societal challenges. Bunyod's doctoral research, also at the University of Twente, focused on assessing land, water and carbon footprints of renewable energy systems. He also holds a professional master's degree in environmental management from the Yale School of Environment. Bunyod authored or coauthored over a dozen of peer-reviewed publications.

Chaturangi Wickramaratne, IWMI

Chaturangi is an environmental scientist, Sri Lanka and 2019 Asia Foundation Development Fellow, with a special interest in climate change and water resources. She leads a division at the Environmental Foundation Limited, a non-profit environmental organization committed to the conservation of Sri Lanka's natural environment. Her small but dedicated team works on environmental research projects to address knowledge gaps in the country, provides scientific input for national legal conservational issues, and conducts awareness programs for a wide range of audiences on the importance of sustainable development and environmental

protection. Chaturangi holds a doctoral degree from the University of Adelaide, and a bachelor's degree in Resource and Environmental Management from the Australian National University.

Debajit Mishra, Vassar Labs IT Solutions Pvt Ltd.

He is an advisor: RS/GIS, Image Processing, TS/DGPS, Geo-ICT Web services for e-governance & Development Planning. Project Consultant of two major Projects of Govt. of Odisha: BLUIS -Bhubaneswar Landuse Intelligence System and GOWATER – Odisha Water ERP.

Guneet Mutreja, DLR

He is a PhD student at the German Aerospace Center, specializes in un/self-supervised algorithms for classifying building roof forms. A Computer Applications Master's from SASTRA University and a Bachelor's from GGSIPU underpin his robust educational background. Formerly a Product Engineer at Esri R&D Center, he contributed significantly to the ArcGIS API for Python.

Jayesh Mukherjee, Aberystwyth University

Jayesh works as an AberDoc and President's Scholar for a PhD in Physical Geography in the Earth Surface Processes Research Group at the Department of Geography and Earth Sciences, Aberystwyth University, Wales, UK. He holds an M.Phil in Geography from Jawaharlal Nehru University, New Delhi. His research interest mainly lies in understanding the arid landscapes of the Thar desert, the behaviour and patterns of ephemeral streams and the morphodynamics of the river inland delta, Disaster Risk Reduction and resiliency among the various local communities to solve their real-life issues.

Kapil Chawala, InnoMick Pvt. Ltd.

He is a digital entrepreneur, founder and director of InnoMick Technology Solution Architect with more than ten plus years experience in different technologies. He's a thought leader in digital transformation and uses geospatial technology in various industries. Mr. Kapil Chawla has been instrumental in building solutions and platforms with user centric design and loosely coupled architecture. Furthermore, he stands as a staunch advocate for the creation and utilization of digital public goods and infrastructure. He firmly believes in the potential to benefit the society at large and he has a track record with an unending commitment to the IT sector.

Kounik De Sarkar, NIT Durgapur

Kounik De Sarkar, is a dedicated individual currently pursuing M.Tech. in Environmental Science and Technology at the National Institute of Technology Durgapur, West Bengal, India. With a background in B.Tech. (Civil), Kounik envisions a future where they can actively contribute to environmental improvement, striving to make the world a cleaner and healthier place to live. With 42 connections on their professional network, Kounik values collaboration and networking. Inspired by GIS and connected with professionals like Inspire_GIS and Mullaivendhan Ayyanar, Kounik is eager to share acquired knowledge and insights in environmental science with future generations. Passionate about creating a positive impact, Kounik aspires to play a key role in shaping a sustainable and eco-friendly future.

Moctar Dembélé, IWMI

Moctar is a regional Researcher in Spatial hydrology, in the International Water Management Institute, whose expertise ranges over hydrological modelling, water accounting, water resources assessment, irrigation, drought, climate change, remote sensing, geographic information systems. Before IWMI, University of Bern, Switzerland; University of Lausanne, Switzerland; UK Centre for Ecology and Hydrology, United Kingdom; Delft University of Technology, The Netherlands; Africa Rice Center, Benin; Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), France.

Nagaraja Harshadeep, World Bank

Harsh is a Global Lead for Disruptive Technology at the Sustainable Development Practice Group of the World Bank. In over 25 years at the World Bank, he has led and supported several water, irrigation, climate, environment and natural resources projects and analytical support operations around the world. He has also been a Global Lead for Watersheds, and leads a global focal area on HydroInformatics. He has created and leads a Disruptive

KIDS (Knowledge, Information & Data Services) Helpdesk to facilitate use of emerging technology in operational teams and clients. He has received an Excellence in Leadership award from the World Bank Staff Association in 2020 and a Distinguished Alumni Award at the Indian Institute of Technology (IIT-Madras) in 2022. He holds a Bachelor of Technology in Civil Engineering from IIT-Madras, a Master of Environmental and Resource Engineering from Syracuse, and a PhD in Water Resources and Environmental Systems Engineering from Harvard University.

Preeti Bharti, IRRI

Representing the International Rice Research Institute, she is an associate scientist with the Agricultural Research and development in international Rice Research Institute. Her primary background is in rural management and agriculture. Her work experience includes development, promotion and deployment of digital agricultural advisory services, tools and applications for improved farm oriented crop management and she has worked extensively with researchers, app developers, and extension and training specialists. She leads the project component rice crop management on training, deployment, institutionalization and governance of digital tools.

Sonali Chiddarwar Daniel, Ex-consultant UNICEF/WHO

She is a doctor and MD in community medicine and is an expert in climate change, public health and nutrition and she works with evidence based, data driven and technology embedded solutions and she has more than 20 years of experience in advocacy, policy formulation, implementation, research and data analytics for program design and implementation. So she has worked extensively with UN agencies like UNICEF, WHO and UNFPA in South Asia. She has worked in India with the Directorate of Health Services, Department of Women and Child and providing technical assistance to UN agencies, big four companies like Deloitte, Ernest and Young, KPMG, PwC and also for international for profit organizations in India, Sri Lanka and Nepal.

Sourav Kumar Dubey, WorldFish

He's represented worldfish and Dr. Dubey is an applied research professional with over a decade of experience in the environmental research and development sector. His areas of expertise include fisheries and aquaculture, climate change, mangrove waste livelihood and coastal zone management. He has a strong track record of working with highly reputable national and international organizations and he has held several research roles and has successfully implemented at several local and national scales, contributing to his extensive knowledge in the field. He has also authored numerous research papers and book chapters highlighting his deep understanding and expertise in the subject matter.

Sudip Mitra, IIT Guwahati

He's a founding head of the center for Disaster Management and a core faculty at the School of Agro and Rural Technology at IIT Guwahati. He is a Nehru Fulbright Fellow and visiting professor at University of California Davis and Kyo University, Japan. He's a faculty member in the international joint Masters and PhD program in Food Sciences Technology at Kifu University, Japan. He is an elected member of the National Academy of Sciences in India. He has guided four PHDs and presently eleven scholars are working under him. He serves as an editorial board member of Plus Climate journal. He has edited two books by now, both, and already published more than 50 papers in journals and reports of international repute. He has also served as a task force member of the Ministry of Rural Development, DST TIFAC on Climate Change and Agriculture.

Sumit Sen, IIT Roorkee SAADRI

He is the Head at Centre of Excellence in Disaster Mitigation and Management and Professor of Ecohydrology at Indian Institute of Technology, Roorkee.

Surajit Ghosh, IWMI

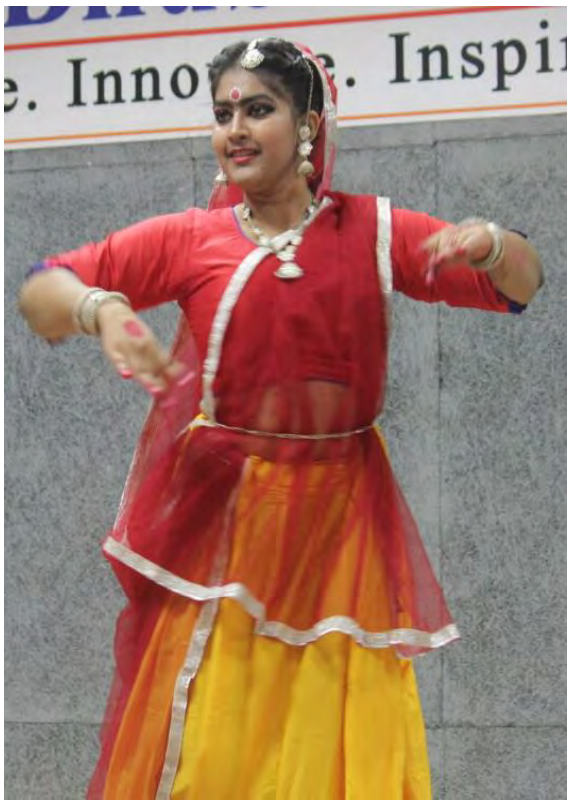
He is an experienced researcher with a demonstrated history of working in the environmental services industry with application of special techniques in forestry, water resource and agriculture. He is skilled in machine learning, geo-big data analytics and cloud computing. He is experienced in hydrological and ecological modeling. He worked for various profit and nonprofit organizations such as ICADA, IORA and also presently with IWMI. He represents IWMI here and also represents the CGIAR Consortium for Spatial information. He's a certified

chartered engineer from the Institute of Engineers and is a member of the Geospatial Information Sectional Committee. Surajit's current research focuses on multi-sector, multi sensor data integration to develop special decision support tools to mitigate climate risk, specifically floods and droughts. He's a member of the science Application team of upcoming NASA project SWAT and has several projects with the World Bank, IFAD and other international agencies. He's an avid publisher with over 50 scientific articles, policy briefs, technical reports, et cetera. He and his team at IWMI received the World Geospatial Award in 2020, the GeoSDG Awards in 2020 and the National Project Management Excellence Awards in Sri Lanka in 2023.

Susmita Ghosh, Jadavpur University

Dr. Ghosh is a professor with the Department of Computer Science and Engineering, Jadavpur University. Her research interests include genetic algorithms, neural networks, image processing, pattern recognition, soft computing and remotely sensed image analysis. She teaches courses on soft computing, machine learning, artificial intelligence, bioinformatics, and introduction to computer practice, microprocessors, computer graphics, computer programming and numerical methods. She has authored many research papers in internationally reputed journals and refereed conferences and has edited three books.

Annexure 10: Cultural event



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