ISG-ISRS
National Symposium

GeoDiscover: Unravelling India's Spatial Frontier

28-30th November 2023

Symbiosis International (Deemed University), Lavale Campus,
Pune. MH, India

GEOSPATIAL ECOSYSTEMS

EMERGING TRENDS

INNOVATIONS

DATE
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NATIONAL SYMPOSIUM
on

GEODISCOVER:
UNRAVELLING INDIA'S SPATIAL FRONTIER

November, 28-30, 2023

SOUVENIR *cum* ABSTRACT VOLUME

Organized by
Indian Society of Geomatics
Indian Society of Remote Sensing

Hosted by
Symbiosis International (Deemed University)
Centre for Development of Advanced Computing (C-DAC)
Indian Society of Geomatics (ISG)
Indian Society of Remote Sensing (ISRS)

MESSAGE FROM CHAIRMAN ISRO

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MESSAGE

It gives me immense pleasure to know that the Indian Society of Geomatics (ISG) and Indian Society of Remote Sensing (ISRS) are jointly organising the ISG-ISRS National Symposium 'GeoDiscover: Unravelling India's Spatial Frontier' during 28th – 30th November 2023 at Pune.

The rapid advancements in Earth Observation technology and Geoinformatics have extended the reach and impact of Remote Sensing, Geographical Information System (GIS), Artificial Intelligence (AI) and Machine Learning (ML), across a wide spectrum of human activities, from addressing essential needs to propelling technological development and aiding space exploration. The challenges and opportunities in these sectors need to be deliberated, especially in light of changing policy environment in these domains.

I am happy to note that the focal theme of this National Symposium is 'Exploring the Geospatial Ecosystem, Trends, and Innovations'. I am sure that, the Symposium will serve as a testament to the collective pursuit of knowledge and innovation in the ever-evolving field of Geospatial Sciences.

I convey my best wishes to all stake holders and organizers, who are part of ISG-ISRS National Symposium- 2023 for making it a success and warm greetings to all the delegates.

Dated: November 13, 2023

(सोमनाथ. एस / Somanath. S)

MESSAGE FROM PRESIDENT, ISG-ISRS

MESSAGE

Dear Esteemed Members of the Indian Society of Geomatics (ISG) and the Indian Society of Remote Sensing (ISRS),

It is my pleasure to welcome you all for the ISG-ISRS National Symposium – 2023: GeoDiscover: Unravelling India's Spatial Frontier, themed "Exploring the Geospatial Ecosystem, Trends, and Innovations," being held during 28th – 30th November 2023 at Symbiosis International (Deemed University), Pune.

The Indian Society of Geomatics (ISG) was established in 1993 by a group of professionals from government, academia, and industry with the main objective of promoting the Geomatics so that it becomes an integral part of the information management and decision-making processes. It is a premier and vibrant professional society with about 2380 life members spread across India under 28 regional chapters. ISG Chapters celebrates Science-day, GIS-day and Technology-day every year as the mandatory activities of the society apart from various outreach activities throughout the year. A peer-reviewed "Journal of Geomatics" from ISG covers all aspects of Geomatics. ISG also give awards in various categories to renowned professionals in the field of Geomatics.

Indian Society of Remote Sensing (ISRS) with its establishment in 1969, is one the leading professional scientific society in the field of remote sensing and allied technologies. ISRS has played a key role for the advancement and dissemination of remote sensing technology in the fields of mapping, planning and management of natural resources and environment by organising seminars/symposia and by publishing a monthly journal (JISRS), bulletins, and proceedings in these 54 years. It has over 6207 members and 27 chapters spread all over India. The official journal of society i.e., JISRS which is published by Springer, has one of the highest impact factor of 2.5 among all the scientific journal of country. ISRS is an active member of the International Society of Photogrammetry and Remote Sensing (ISPRS) and Asian Association on Remote Sensing (AARS).

ISG and ISRS, two of the leading professional scientific societies in the field of geomatics and remote sensing jointly conducts their annual convention and national symposium each year. This year symposium being led by ISG and it Pune chapter, in collaboration with SIG, Pune, has main objective of providing an enriching experience to all geospatial professionals, government officials and academia to share their geomatics related project highlights, research outputs and showcase recent advances in big data, AI and ML related technologies. I am sure this symposium will lead fruitful discussions, active participation, new learning, unique and new opportunities for collaboration among all the participants, including emerging geospatial industry, working professionals and academia.

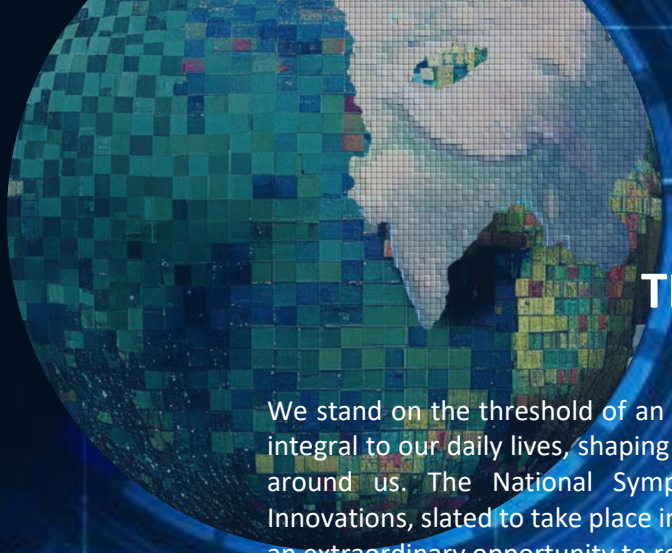
As President of ISG and ISRS, I appreciate the sincere efforts and dedication of ISG and ISRS, along with all local and national committees for organising this symposium. I believe it will be a pivotal moment in our collective journey to explore, harness, and leverage the Geospatial ecosystem for the greater good of humanity.

I look forward to engaging with all of you, sharing insights, and together, charting a path toward a more informed and enlightened future.

I wish the symposium a grand success.

(Prakash Chauhan)

President, ISG and ISRS



PREFACE FROM TECHNICAL ADVISORY COMMITTEE

We stand on the threshold of an era where geospatial sciences and technologies have become integral to our daily lives, shaping the way we perceive, understand, and interact with the world around us. The National Symposium on Exploring Geospatial Ecosystems, Trends, and Innovations, slated to take place in Pune from November 28th to November 30th, 2023, provides an extraordinary opportunity to reflect upon and celebrate the remarkable advancements in this field.

As members of the Technical Organizing Committee, we are honored to present this symposium, a collaborative effort between the Indian Society of Geomatics (ISG) and the Indian Society of Remote Sensing (ISRS). Our goal is to create a platform for professionals, educators, researchers, and students actively engaged in the domains of Remote Sensing, Geographic Information Systems (GIS), Artificial Intelligence (AI), and Deep Learning algorithms. Together, we aim to explore the latest breakthroughs, exchange knowledge, and address the diverse challenges that permeate our diverse domains.

The symposium is designed to facilitate comprehensive discussions, deliberations, and presentations on emerging concerns, state-of-the-art technologies, inventive methodologies, and the tangible implications associated with Earth observation and Geospatial sciences. It serves as a tie for collaboration, a forum for sharing insights, and a springboard for collective progress.

The technical sessions, keynote addresses, paper presentations, and interactive discussions during the symposium will provide a panoramic view of the dynamism and scope of geospatial sciences. From the limitless possibilities of remote sensing to the limitless horizons of GIS, AI, and deep learning, we will delve into a realm where innovation knows no bounds.

This symposium is more than an event; it's a journey of discovery and collaboration, an opportunity to broaden horizons, and a chance to leave an indelible mark on the geospatial landscape. It's a celebration of knowledge and innovation that will have a lasting impact on our community and beyond.

We express our heartfelt gratitude to the organizing committee, sponsors, delegates, volunteers, and all those who have made this symposium possible. We look forward to your active participation and the invaluable contributions you will bring to this event. Together, let us explore the geospatial ecosystems, trends, and innovations that shape our world.

Welcome to the National Symposium on Exploring Geospatial Ecosystems, Trends, and Innovations. Together, let us navigate new horizons, exchange knowledge, and shape the future of geospatial sciences

MESSAGE FROM ORGANISING COMMITTEE CHAIRMAN

The Indian Society of Geomatics (ISG) and the Indian Society of Remote Sensing (ISRS) extend heartfelt thanks to the Chancellor and Pro-Chancellor of Symbiosis International University for graciously hosting the symposium. The event also receives substantial support from the Centre for Advanced Computing (C-DAC), and we are profoundly grateful to the Director General of C-DAC for the invaluable support provided.

The symposium, themed "Exploring Geospatial Ecosystem, Innovation, and Trends," is dedicated to the practical implementation of geospatial policies at the grassroots level and delving into innovations and trends in spatial technology. Emphasis will be placed on understanding the geospatial ecosystem in the context of national infrastructure, with a particular focus on advancing geospatial science in assistive technology.

Our goal is to organise an exceptional exhibition featuring multi-domain displays and poster presentations. Thematic talks and plenary sessions will guide participants through the diverse sectors emerging in the geospatial world. We are confident that the three-days' discussion will culminate in the creation of a policy document, contributing to shaping the future trends in this field.

Special acknowledgments go to ISRO and its centers, SOI, Jal Shakti, ESRI, and other sponsors for their crucial support in terms of generous financial contributions. We express our gratitude to the Chief Guest and Guest of Honour for accepting the invitation to inaugurate the symposium. The National and Local Organizing Committees are deserving of thanks for crafting a well-balanced program through their thoughtful guidance and enthusiastic support.

A special mention of appreciation goes to the Technical Program Committee and the Design and Publication Committee for their dedication in producing this abstract volume. Sincere thanks are extended to all committee members who have tirelessly worked day and night to address various challenges related to technical and logistical requirements.

Dr. T.P. Singh

ACKNOWLEDGMENT FROM ORGANISING SECRETARY

This event would not have been possible without the tireless efforts of our dedicated organizing committee, the generous support of our sponsors, the valuable contributions of our delegates, and the selfless commitment of our volunteers.

To our Organizing Committee: Your unwavering dedication, meticulous planning, and countless hours of hard work were the driving force behind the symposium's success. Your commitment to creating a platform for knowledge exchange and collaboration is truly commendable.

To our Sponsors: Your financial support and resources played a pivotal role in making this event a reality. Your belief in the significance of geospatial sciences and its applications is deeply appreciated.

To our Delegates: Your active participation, thought-provoking discussions, and the sharing of your expertise enriched the symposium and contributed to its success. We hope that you found this event both enlightening and inspiring.

To our Volunteers: Your selfless contributions, from managing logistics to assisting with technical aspects, were invaluable. Your dedication ensured that the symposium ran smoothly and efficiently.

In conclusion, I would like to extend my sincere thanks to each and every one of you for your role in making the National Symposium on Exploring Geospatial Ecosystems, Trends, and Innovations a memorable and enriching experience. The knowledge shared, the connections forged, and the innovations explored during this symposium will undoubtedly have a lasting impact on the geospatial community.

We look forward to continued collaboration and the exciting advancements that will emerge from the seeds sown during this event. Thank you once again for your invaluable contributions.

Dr. Yogesh Kumar Singh

INDIAN SOCIETY OF GEOMATICS (ISG)

The Indian Society of Geomatics (ISG) was formed by a group of professionals from government, academia, and industry with the main objective of promoting the technology and applications of Geomatics so that it becomes an important part of the information management and decision making processes.

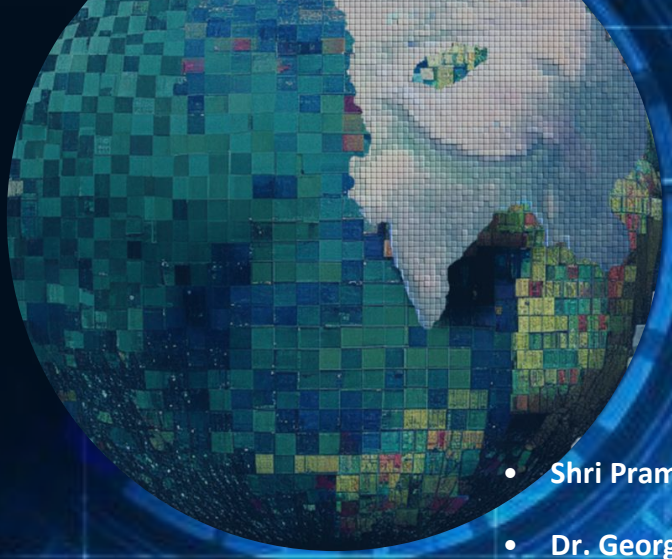
Indian Society of Geomatics (ISG), established in 1993, is a premier society of professionals and institutions involved in promoting and popularising Geomatics in India. It has about 2252 Life Members, 34 Patron Members, 2 Sustaining Members as on December 2020. It has 25 very active Regional Chapters located at Ahmedabad, Ajmer, Bhagalpur, Bhopal, Chennai, Dehradun, Delhi, Hisar, Hyderabad, Jaipur, Jammu & Kashmir, Kharagpur, Lucknow, Ludhiana, Mangalore, Mumbai, Mysore, Nagpur, Puducherry, Pune, Ranchi, Surat, Shillong, Trichy, Thiruvananthapuram, Vadodara and Visakhapatnam.

ISG regularly brings out a quarterly newsletter (ISSN: 0972-642X) for circulation to its members. ISG has recently published many special issues on various themes such as Agriculture, Urban Planning, Coastal and Marine Environment, Space-based Cartography, GIS: Education and Training in India, Water Resources, Location-based Services, Geomatics in India: Retrospect and Prospects, Infrastructure, Mountains etc.

Taking into account the persistent demand from members, the Society has launched a peer-reviewed journal named "**Journal of Geomatics**" on the 08th of March 2007. The journal covers all aspects of Geomatics- geodata acquisition, pre-processing, processing, analysis and publishing. Broadly this implies inclusion of areas like GIS, GPS, Photogrammetry, Cartography, Remote Sensing, Surveying, Spatial Data Infrastructure and Technology including hardware, software, and algorithms and modelling. It endeavours to provide an international forum for rapid publication of developments in the field – both in technology and applications.

ISG's website www.isgindia.org contains all pertinent information about the Society and its activities. This site is updated every three months for the benefit of its members and anyone interested in Geoinformatics. Indian Society of Geomatics has also instituted two National Geomatics Awards to be given each year: a) for original and significant contribution in the field of Geomatics, b) for innovative applications in the field of Geomatics. Each award comprises a medal, a citation and a sum of ₹25,000. The guidelines for these awards are available on ISG website. Apart from these awards, ISG has also instituted Best Chapter of the Year & Presidents' Medal for Contribution to the Society Award for promoting the chapter activities and encouraging chapters to conduct various regional events. A senior level award namely, Geomatics Excellence Award is also going to be instituted from this year onwards.

ISG Chapters also celebrate Science-day, GIS-day and Technology-day every year as the mandatory activities of the society. For this ISG provides funds to the tune of ₹15,000 once in a year to the chapters on request.



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- **Dr. Prithvish Nag**, Varanasi
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- **Shri Rajesh Mathur**, New Delhi
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- **Prof. Dr. Ramasamy**, Trichy
- **Dr. (Mrs) P. Venkatachalam**, Mumbai
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- **Prof. (Dr.) Anjana Vyas**, Ahmedabad

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P-3 Commissioner, Mumbai Metropolitan Region Development Authority, Bandra-Kurla Complex, Bandra East, Mumbai -400 051

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P-6 Chairman, Indian Space Research Organization (ISRO), ISRO H.Q., Antariksha Bhavan, New BEL Road, Bengaluru 560 231

P-7 Director General, Forest survey of India, Kaulagarh Road, P.O. I.P.E., Dehra Dun- 248 195

P-8 Commissioner, Vadodara Municipal Corporation, M.S. University, Vadodara – 390 002

P-9 Director, Centre for Environmental Planning and Technology (CEPT), Navrangpura, Ahmedabad-380 009

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P-11 Director, Gujarat Water Supply and Sewerage Board (GWSSB), Jalseva Bhavan, Sector-10A, Gandhinagar-382010

P-12 Director, National Atlas and Thematic Mapping Organization (NATMO), Salt Lake, Kolkata-700064

P-13 Director of Operations, GIS Services, Genesys International Corporation Ltd., 73-A, SDF-III, SEEPZ, Andheri (E), Mumbai -400 096

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P-15 Director, Institute of Remote Sensing (IRS), Anna University, Sardar Patel Road, Chennai-600 025

P-16 Managing Director, Tri-Geo Image Systems Ltd., 813 Nagarjuna Hills, Punja Gutta, Hyderabad-500082

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P-18 Secretary General, Institute of Sustainable Development Research Studies (ISDRS), 7, Manav Ashram Colony, Goplapura Mod, Tonk Road, Jaipur-302 018

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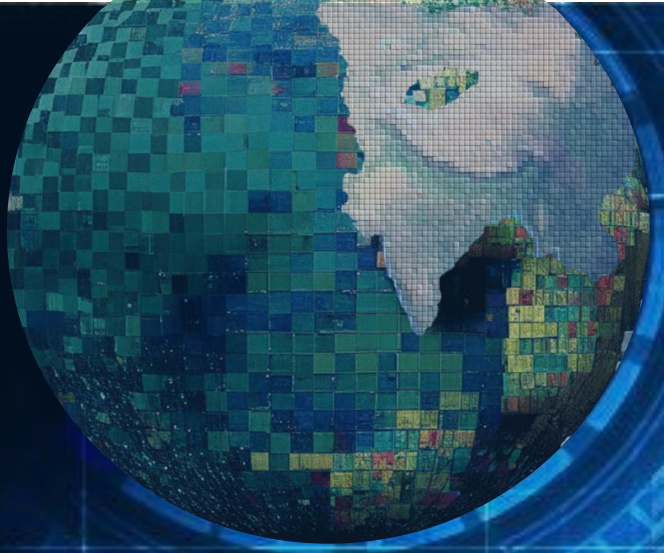
P-20 Vice President, New Rolta India Ltd., Rolta Bhavan, 22nd Street, MIDC-Marol, Andheri East, Mumbai-400 093



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P-21 Director, National Remote Sensing Centre (NRSC), Deptt. of Space, Govt. of India, Balanagar, Hyderabad-500 037

P-22 Managing Director, ERDAS India Ltd., Plot No. 7, Type-I, IE Kukatpalli, Hyderabad-500 072

P-23 Senior Manager, Larsen & Toubro Limited, Library and Documentation Centre ECC Constr. Gp., P.B. No. 979, Mount Poonamallee Road, Manapakkam, Chennai-600 089.

P-24 Director, North Eastern Space Applications Centre (NE-SAC), Department of Space, Umiam, Meghalaya 793 103

P-25 Programme Coordinator, GSDG, Centre for Development of Advanced Computing (C-DAC), Pune University Campus, Pune-411 007

P-26 Chief Executive, Jishnu Ocean Technologies, PL-6A, Bldg. No. 6/15, Sector-1, Khanda Colony, New Panvel (W), Navi Mumbai-410 206

P-27 Director General, A.P. State Remote Sensing Applications Centre (APSRAC), 8th Floor, "B" Block, Swarnajayanthi Complex, Ameerpet, Hyderabad-500 038

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P-31 Chairman, OGC India Forum, E/701, Gokul Residency, Thakur Village, Kandivali (E), Mumbai-400 101

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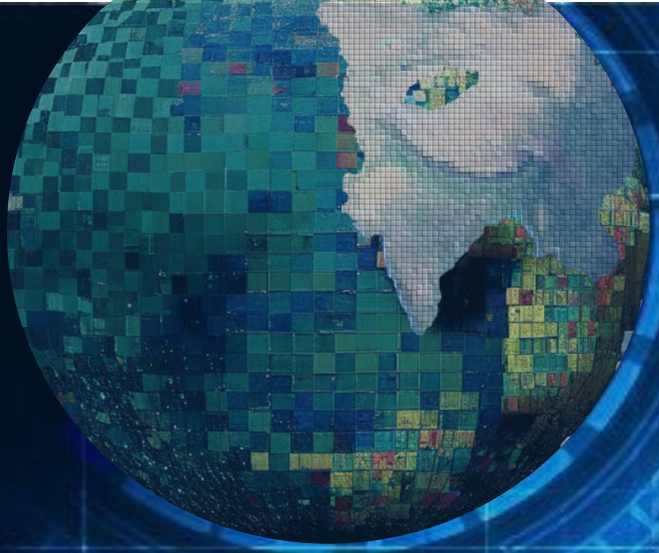
P-34 Director, State Remote Sensing Applications Centre, Aizawl-796 012, Mizoram

P-35 Principal, Govt College Kasargod, Government College Kasargod, "Vidyanagar, Kasargod Kerala India. PIN: 671123



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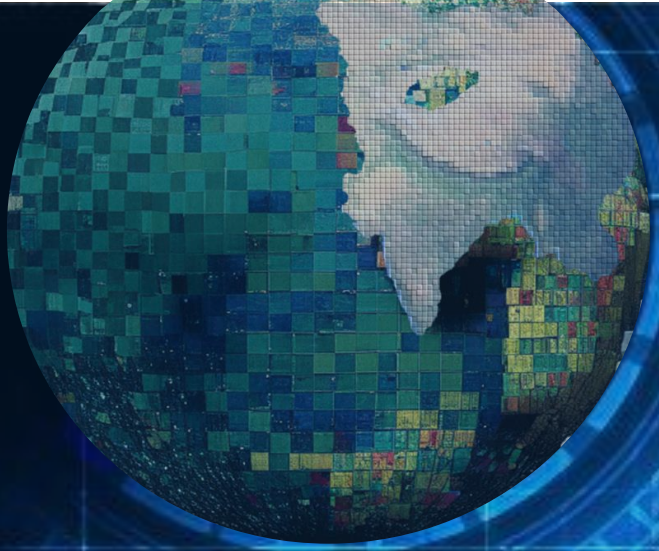

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Mr. Bishwarup Banerjee
Director, Program & Project Management, LTIMindtree, Pune

ISG AWARDS 2023

Fellow of Indian Society of Geomatics

Shri Nilesh M. Desai, Director, SAC, ISRO, Ahmedabad
Dr. Sultan Singh, Director, HARSAC, Hisar

National Geomatics Award for Excellence

Dr. Narayan Panigrahi
Scientist G, CAIR (Centre for Artificial Intelligence and Robotics, DRDO, Bangalore
Email: *npanigrahi7@gmail.com , pani@cair.drdo.in*

National Geomatics Awards – Technology

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Scientist/Engineer- SG & Head, Land Hydrology Division, SAC, ISRO, Ahmedabad -380015
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Email: *pkgupta@sac.isro.gov.in , praveensacisro@gmail.com*

National Geomatics Awards – Applications

Dr. C. Sudhakar Reddy
Scientist-SG & Head, Forest Biodiversity and Ecology Division,
Project Director, DBT-DOS Biodiversity Project,
National Remote Sensing Centre, ISRO, Hyderabad -500 037
Ph: 040-23884210 (Office); Mob: 09490485239
E-mail: *drsudhakarreddy@gmail.com , sudhakarreddy_ch@nrsc.gov.in*

Prof. Kakani Nageswara Rao Endowment Young Achiever Award

Dr. Ropesh Goyal
Research Establishment Officer
National Centre for Geodesy
Indian Institute of Technology Kanpur
Email: *rupeshg@iitk.ac.in , ropeshgoyal2809@gmail.com*

President's Appreciation Medal for Contribution to ISG

Shri Jayaprasad P.
Scientist/Engineer-SG,
Space Applications Centre, ISRO
Ahmedabad, Gujarat
Phone: 079-26914335, Mob: 8238165366
E-mail: *jayaprasadp@sac.isro.gov.in , jayaprasadpallipad@gmail.com*

ISG Chapter Award for Best Performance 2023

ISG Ahmedabad Chapter
Chairman: Dr. Nitant Dube, Group Director, SAC, ISRO, Ahmedabad
Vice-chairman: Prof. Dr.-Ing. Anupam K Singh, Adani University, Ahmedabad
Secretary: Shri. Manish Parmar, Scientist, SAC, ISRO, Ahmedabad
Jt. Secretary: Dr. Shaily Gandhi, CEPT University, Ahmedabad
Treasurer: Ratheesh Ramakrishna, Scientist, SAC, ISRO, Ahmedabad

INDIAN SOCIETY OF REMOTE SENSING (ISRS)

The Indian Society of Remote Sensing was established in 1969 and got registered during 1973-74 vide Reg. No 1357/73-74. The main objective of the society is to contribute towards advancement and dissemination of remote sensing technology in the fields of mapping, planning and management of natural resources and environment. This objective is achieved by organising seminars/symposia and by publishing a monthly journal (JISRS), bulletins, proceedings, etc. With a modest beginning of 56 members, the Society has now grown into a premier professional body with membership of over 6208 life members, 15 honorary members, 51 Fellows, 61 Patron Members and 8 Annual Members.

International Linkages: The society has many active international linkages. ISRS is a member of the International Society of Photogrammetry and Remote Sensing (ISPRS) and Asian Association on Remote Sensing (AARS). And has been active in supporting international societies in promoting international co-operation, co-ordination and advancement of Geospatial technology and related sciences to improve quality of mankind by sustainable natural resources development and environmental management. India has been awarded Chairmanship of Technical Commission V: Education and Outreach for the period 2016-2020. India has successfully chaired Technical Commissions during 1996-2000, 2000-2004, 2004, 2008 and 2012-2016. ISRS has successfully hosted ISPRS TC V Mid Term Symposium 2018 during November 20 23 at IIRS, Dehradun. Around 450 delegates participated globally (website: http://isprstc5india2018.org).

ISRS is also member of Asian Association of Remote Sensing (AARS). ISRS has successfully hosted ACRS2017 during October 9 13, 2017 at New Delhi. India had earlier opportunity of hosting the ACRS twice in the past.

National Events: The society has been organizing annual conventions, national symposia preceded by pre symposium tutorials for the students regularly, giving opportunities to the remote sensing community in the country to present their research papers and discuss the problems and methods of applications of remote sensing in development and management of natural resources. The society also takes initiative to spread awareness in the field of remote sensing by conducting various activities such as National Remote sensing Day, Earth Day, World Environmental Day, National Technology Day, Space Week, Ozone Day, GIS Day etc.

Chapters: Presently Society has 28 chapters located in five zones across the country. ISRS chapters are located in Ahmedabad, Ajmer, Allahabad, Bangalore, Bhopal, Bhubaneswar, Chandigarh, Chennai, Dehradun, Delhi, Guwahati, Hisar, Hyderabad, Indore, Jaipur, Jodhpur, Kolkata, Lucknow, Ludhiana, Mumbai, Nagpur, Pune, Shillong, Tiruchipalli, Thiruvanthapuram, Vishakhapatnam, Aligarh and Raipur.

The registered office of the society is located in Indian Institute of Remote Sensing Campus, Dehradun.

ISRS AWARDS 2022-23

ISRS recognize individual in the form of awards in order to encourage and motivate the individual who are promoting the aims and objectives of the society. These awards are of different categories subject to their individual contributions. Awards are conferred every year by the ISRS under various categories. Some of the prestigious awards of the society are as follows:

Bhaskara Award (2022)
Prof. Manoj Kumar Arora

Satish Dhawan (2022)
Dr. Bimal Kumar Bhattacharya and Dr. K.H.V Durga Rao

National Geospatial Awards for Excellence (2022)
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Indian National Geospatial Award (2023)
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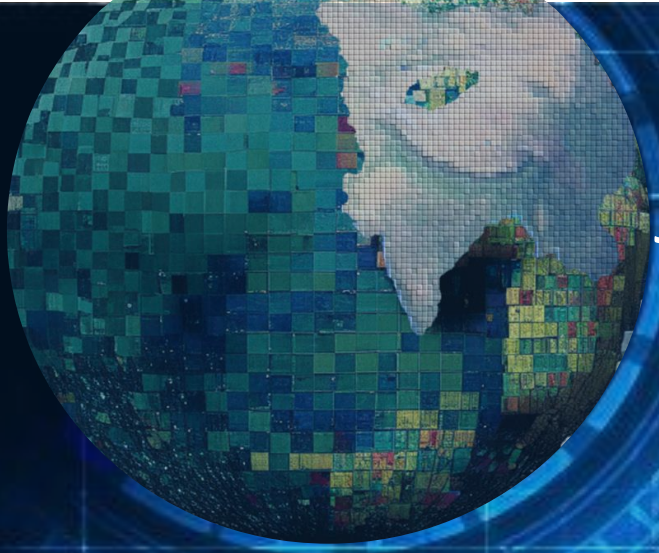


JOURNAL OF INDIAN SOCIETY OF REMOTE SENSING (JISRS)

One of the significant contributions of ISRS to meet the objectives of the society is the publication of national peer reviewed journal on Remote Sensing called *Journal of Indian Society of Remote Sensing (JISRS)*. The Journal of Indian Society of Remote Sensing is a monthly journal that publishes original research contributions in all the related filed of remote sensing and its applications. JISRS has gained Impact Factor from 1.894 in 2021 to 2.5 in 2022. Members of the society have facility to access the JISRS online from website (*http://isrs-india.org).*

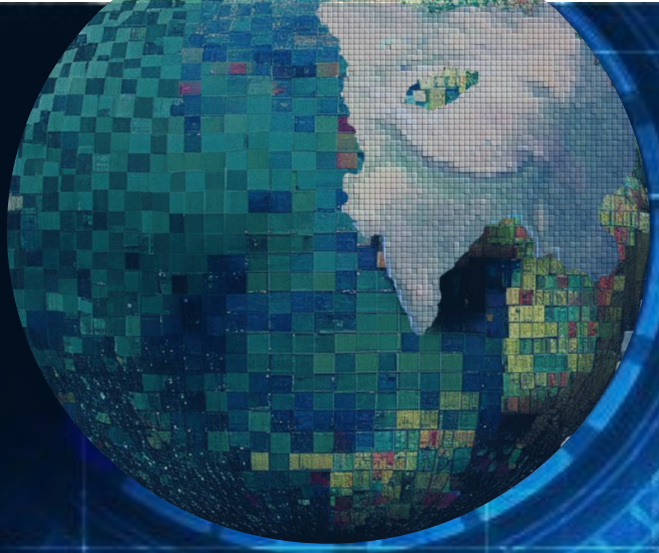
JISRS Best Paper Awards (2022)

TRI-SU-L ADWT-FCM: TRI-SU-L-Based Change Detection in SAR Images with ADWT and Fuzzy C-Means Clustering- Jakka Thrisul Kumar, Mallikarjuna Reddy Yennapusa & Bhima Prabhakara Rao
(Category- Emerging Areas of Geoinformatics)

Internet GIS-Based Air Quality Monitoring and Forecast System for the Indian Region Using FOSS4G - Kapil Oberai, Sameer Saran, Ashutosh Kumar Jha, Charu Singh, Yogesh Kant, Shuchita Srivastava, Sanjeev Kumar Singh, Debashis Mitra & Prakash Chauhan
(Category- Emerging Areas of Geoinformatics)

Seven Decades of Dimensional and Mass Balance Changes on Dokriani Bamak and Chhota Shigri Glaciers, Indian Himalaya, Using Satellite Data and Modelling- Smriti Srivastava, Purushottam Kumar Garg & Mohd. Farooq Azam
(Category- Remote Sensing)

Identifying Rip Channels Along RK Beach, Visakhapatnam Using Video and Satellite Imagery Analysis- Sivaiah Borra, T. M. Balakrishnan Nair, Sudheer Jospeh, Surisetty V. V. Arun Kumar, T. Sridevi, R. Harikumar, K. Srinivas, G. Yatin, B. Gireesh, K. Venkateswararao, Ch. Venkateswarlu, A. Anjaneyulu & K. V. S. R. Prasad
(Category- Remote Sensing)



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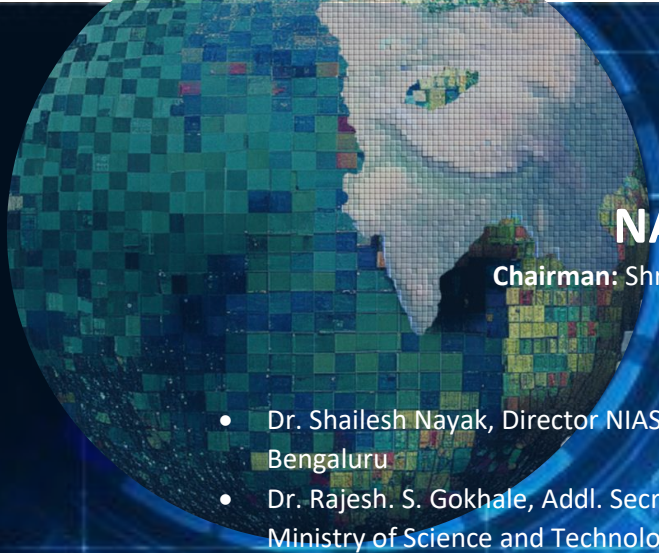
The Indian Society of Geomatics (ISG) and the Indian Society of Remote Sensing (ISRS) have joined together to orchestrate a national symposium with a central theme of "Exploring the Geospatial Ecosystem, Trends, and Innovations". This symposium's main objective is to explore, examine and highlight the rapid advancements in the field of Geospatial sciences and their numerous applications in areas of human needs, technological development, space exploration, Earth monitoring, and their practical uses.

In recent times, there has been a notable surge in the development, evolution and application of Earth observation technology and Geoinformatics. This rapid advancement has significantly broadened their purview and applicability, exerting a substantial influence across virtually all facets of human life and activities.

The primary objective of this symposium revolves around establishing a collaborative platform for professionals, educators, researchers, and students actively engaged in the domains of Remote Sensing, Geographic Information Systems (GIS), Artificial Intelligence (AI), and Deep Learning algorithms, along with their practical implementations. This platform is envisioned to foster the exchange of knowledge, sharing of ideas, and sharing of experiences pertaining to the latest breakthroughs and challenges encountered in various domains. The symposium will facilitate comprehensive discussions, deliberations, and presentations that encompass emerging concerns, state-of-the-art technologies, inventive methodologies, and the tangible implications associated with Earth observation and Geospatial sciences



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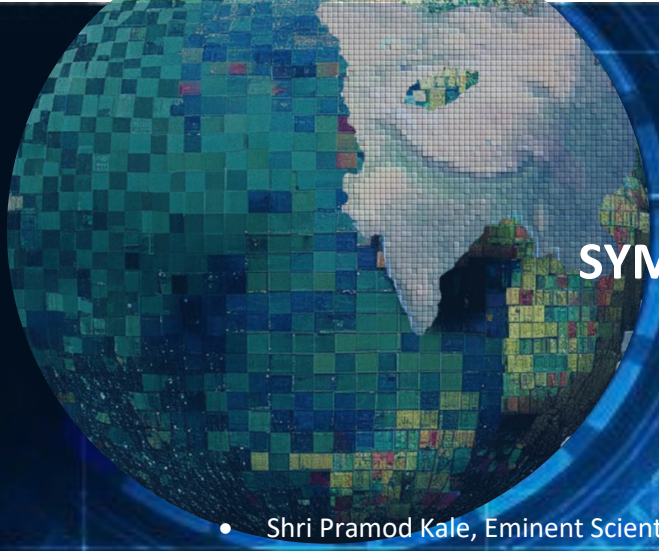

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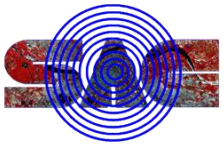

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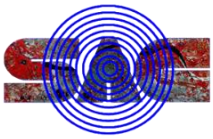

Abstract Volume

Annual ISG-ISRS National Symposium, Pune
28|29|30 November 2023

CONTENTS


ORAL PRESENTATIONS

SUB THEME -1: HPC AND MACHINE LEARNING

AUTOMATED GRAPE (*Vitis vinifera*) CROP DISEASE IDENTIFICATION AND CLASSIFICATION USING MACHINE LEARNING TECHNIQUES IN REMOTE SENSING ENVIRONMENT

Sahil K. Shah, Shubham Kalokhe, Vidya Kumbhar and T. P. Singh

Symbiosis Institute of Geoinformatics, Symbiosis International (Deemed University), Pune, India

Abstract

Grape is a major crop in horticulture, but its production is often hampered by diseasesthat affect both the quality and quantity of the crop. While machine learning (ML) anddeep learning (DL) have been proposed as solutions for detecting and classifying grape diseases, implementing these models in real-time settings can be challenging due to issues such as generalizability and processing time. To address these challenges, this study proposes an innovative approach for identifying and classifying grape crop diseases in a geospatial environment. The study has two objectives: the first is to use Random Forest to classify the study area into grape and non-grape fields,and the second is to use K-means clustering to identify healthy and nonhealthy regions within the identified grape fields. To train the model, the study utilizes satellite imagery data obtained through a combination of Synthetic Aperture Radar (SAR) and Multispectral Imagery (MSI) over a study area in Maharashtra, India. This aids in mitigating the drawbacks of cloud coverage in MSI and achieves an accuracy of97% which is comparable with existing techniques in grape crop disease identification using satellite imagery in the Indian context. Overall, this approach offers a practical solution for accurate and efficient detection and classification of grape diseases. By identifying and addressing disease outbreaks in a timely manner, this approach hasthe potential to improve grape production and ultimately contribute to sustainableagriculture.

Keywords: Random Forest, Kmeans Clustering, Remote Sensing, Machine Learning, Synthetic Aperture Radar (SAR), Google Earth Engine (GEE)

COMPARATIVE ANALYSIS OF GROUND FILTERING METHODS FOR 3D LIDAR POINT CLOUDS

Titiksha Bhatia, Rohit Rajput, Salil Goel and Aditya Medury

Department of Civil Engineering, Indian Institute of Technology Kanpur –208016, India

Abstract

Ground filtering is a fundamental step in 3D perception using LiDAR (Light Detection andRanging) sensors, serving various applications, including road and footpath extraction for network analysis and object detection. To address this challenge, numerous ground-filtering techniques have been developed. However, selecting an appropriate method can be complexdue to variations in 3D point cloud patterns and the point cloud density when acquired by different LiDAR sensors. This study aims to systematically compare the performance of variousground filtering methods for classifying 3D point clouds into ground and non-ground points. Specifically, the evaluation focuses on three methods: Cloth Simulation Filter (CSF), Patchwork++, and deep learning-based method (GndNet). The datasets used in this study arecollected using Velodyne VLP-16 and Faro Focus LiDAR sensors in two distinct environments:static, with the sensor fixed at a single location, and dynamic, with the sensor mounted on a moving bicycle platform. The methods are also tested over an open-source large-scale outdoor-scene dataset, SemanticKITTI, collected using a Velodyne sensor. The results consistently showed that CSF outperformed the other methods, as revealed through evaluation using visualization tools like CloudCompare and quantitative analysis over SemanticKITTI data with 96% recall. The performance of the CSF method is highly influenced by the threshold of the point cloud above the simulated cloth, mainly when applied to the Farosensor dataset. Patchwork++ demonstrated satisfactory results, particularly when processing static data compared to dynamic data. GndNet demonstrates that the algorithm's performance improves when background filtering is applied. In conclusion, this comparative analysis study provides valuable insights for researchers and practitioners seeking to select suitable ground filtering techniques for specific LiDAR applications, as they shed light on the most effective approaches.

Keywords: LiDAR, Ground Filtering, 3D Point Cloud, Cloth Simulation Filter, Patchwork++, Deep Learning, Velodyne VLP-16, Faro Focus

AN UNSUPERVISED LEARNING-BASED APPROACH TO IDENTIFY ROAD OBJECTS FROM VLP-16 LIDAR DATA IN INDIAN TRAFFIC

Rohit Rajput, Titiksha Bhatia, Salil Goel and Aditya Medury

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Abstract

Cameras are typically used at road intersections to collect data to perform object detection, provides high-resolution image but struggling in low-light andharsh weather. Nowadays, LiDAR (Light Detection and Ranging) is widely beingused for performing 3D object detection. LiDAR gives the 3D point cloud, which includes accurate depth information, but its resolution is costdependent, with higher resolutions being more expensive. Deep learning-based method requires large, labelled dataset which increases the cost, time and accuracydepends on the model trained on labelled dataset. Furthermore, to perform object detection in point cloud data is a difficult task due to the incomplete representations, data sparsity and unavailability of training data. In comparison, unsupervised machine-learning-based method seek to reveal latent patterns in data, which in part can be due to differences in object shapesand sizes. In this work we propose an unsupervised machine learning approachto identify road objects from low resolution 3D lidar sensors such as VLP-16. This work incorporates three modules i) data collection using VLP-16 LiDAR ii)ground truth data generation, and iii) object identification. Data is collected attwo types of road intersections (4-legged, 3-legged) and preprocessed to remove background points. Background point filtering is a critical step for LiDAR data processing, which significantly enhances quality and efficiency by removing ground point and outlier point. Cloth simulation filter (CSF) is used for ground point segmentation with the model parameters identified based onsystematic parameter tuning. Density-based spatial clustering of application with noise (DBSCAN), an unsupervised machine learning-based method, isused to perform a clustering analysis on the estimated non-ground points. Approximate 68 % of background points are removed in background filtering. The remaining ~31% points are clustered and identified as non-ground objects (trees, car, building, pedestrians etc.), in which ~7% clustered points are identified as a road objects (car, pedestrian, auto, statue etc.) by using height threshold parameter and achieved average precision (AP) ranges from 92-94 %. For future work, the non-ground points will be further processed to identify and track dynamic objects (e.g., road users) using unsupervised machine-learning-based approaches.

Keywords: Roadside VLP-16 LiDAR, Ground Segmentation, CSF, DBSCAN,Object Detection

DEEP LEARNING AND INSTANCE SEGMENTATION ON INDIAN REMOTE SENSING DATA

Jai G. Singla

Space Applications Centre, Ahmedabad

Abstract

Presently, deep learning and convolutional neural networks (CNNs) are widely used in the fields of image processing, image classification, object identification and many more. In this work, we have implemented convolutional neural network based Yolo V5 and V7 models to automatically count number of objects (aeroplanes, trees) from satellite imagery captured using high resolution Indian remote sensing satellites and then performed change detection over two different time zones datasets. In this paper, Cartosat 2S (~1m spatial resolution) datasets were used and deep learning models were implemented to count number of aeroplanes with an accuracy of 88% to 98%. Similar approach when implemented on more complex problem of "individual tree count in urban area" resulted in to accuracies of around 71%. Change detection was further performed on different time's data for change in tree canopy. In another experiment, CNN models were trained over high resolution DEMs and satellite imagery (Novel approach) to classify residential and non-residential buildings structures. Here, our models correctly classified the residential and non-residential building structures from satellite data with an accuracy of more than 99%. In all the cases, model generated results were tested using ground truth. Total three different problems "Counting of aeroplanes and change detection using satellite data", "Tree level change detection in urban areas using deep learning" and "classification of building as residential or non-residential from satellite data" were attempted using deep learning CNN models and IoU accuracies in the range of 71% to 99% were achieved depending on the degree of complexity.

Keywords: Instance Segmentation, Deep Learning, Satellite Data, Object Detection, Change Detection

ASSESSING THE NOWCASTING CAPABILITY OF THE UNET DEEP LEARNING MODEL OVER NORTH EAST INDIA USING SEASONAL HOURLY PRECIPITATION

Gourav Jyoti Kalita[1], Hidam Kumarjit Singh[1] and Ritu Anilkumar[2]

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Abstract

Precipitation is an important climate variable that plays a vital rolein various socioeconomic sectors including, but not limited to agriculture, water resources, travel and disaster management. With the increasing availability of time series geospatial data, deep learning has gained much attention in recent times for weather forecasting and prediction. In this study,we assess the predicting capability of the U-Net deep learning model for different forecast times. Hourly ERA5 Reanalysis precipitation datasets over thenorth-eastern states of India for June, July, August and September from 2000 to 2022, have been employed as inputs to the U-Net model. The model is trained separately for each of the leading hours (1 to 6 hours) and deployed onthe testing datasets. The outputs of the model are exported as images for eachtime step. In this study, we have found that the best RMSE, MAE and R2 score is 0.00056 meters, 0.00022 meters and 0.69 respectively, when the lead time is1 hour. From the study, it is found that the R 2 of the model decreases while the RMSE and MAE increase consistently with an increase in the leading time.However, in the current study only historical rainfall data is used for training the model, the performance can be improved by using more predictor input features along with the historical rainfall data. The evaluation metrics can be expected to perform better when accounting for the large number of zero rainfall data points which results in an imbalanced dataset. Further, complex architectures that utilize temporal and convolutional connections to accountfor the effect of monsoon and local orographic influences are expected to improve the performance for time series predictions.

Keywords: Deep Learning, Hourly Precipitation, Lead-Time, Nowcasting, Seasonal

COMPLEX VALUED U-NET FOR SEGMENTATION OF SAR IMAGES

Saumya Vilas Roy[1], Haripriya S.[2] and Deepak Mishra[3]

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[1]Scientist/Engineer 'SE' - SARDPD/MDPG/DPA, National Remote Sensing Center (NRSC), Indian Space Research Organization (ISRO).
[2]Professor (Avionics Department), Indian Institute of Space Science and Technology (IIST)

Abstract

Deep learning (DL) techniques have emerged as a great tool in natural language processing (NLP), remote sensing, computer vision, etc. In general, all these applications demand real valued data processing. But for certain fields like Radio Frequency (RF) communications and synthetic aperture radar (SAR) imaging, where the data is in a complex domain, it is not well handled by real-valued DL techniques as the correlation between the phase and the magnitude is lost. In this research, we propose the usage of a complex valued neural network (CVNN) for the processing of data in complex domain. The proposed complex valued U-NET model is used for semantic segmentation of Polarimetric Synthetic Aperture Radar (PolSAR) using the Pauli representation matrix as the labels. The SAR sensorcollects signals in different polarization to identify the target which causes it develop a complex character because both phase and magnitude are collected, we have generated four- and two-class segmentation masks by thresholding the values of the Pauli matrix. After training the model on the given masks, the testing accuracies were 55.07% for the 4 class problem and 67.10% for the 2 class semantic segmentation problem. We even did an analysis of different dropout rates in the convolutional layers in the U-NET and the effects on model training and overfitting. Our analysis points to the dropouts being inconsequential and ineffective in the convolution layers in Complex Valued U-NET.

Keywords: Deep learning, Semantic Segmentation, Complex Valued Neural Networks (CVNN), SAR Images

AUTOMATIC BUILT-UP EXTRACTION USING MACHINE LEARNING TECHNIQUES AND MULTI SENSOR COMPOSITE DATA

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Abstract

Urbanization is one of the world's primary concerns, which poses significant challenges to sustainable development, disaster resilience, climate change mitigation, and the environment. Spatial information on urban built-up areas is important to understand urbanization patterns. Mapping of large scale urban areas and monitoring their dynamic changes have emerged as important challenges for governments and also gained significant attention among researchers. At large scales urban extent areas are essential for policymakers to understand better about urbanization and its socioeconomic drivers and impacts. Towards this satellite imagery and machine learning algorithms can play a significant role in extraction of urban builtup areas at different time periods at different scales. Urban built-up area extraction using satellite data is challenging due to significant intra-city heterogeneity and spectral overlap with other land covertypes. To address this, the current study focuses on extraction of urban builtup area using Machine Learning techniques from open source multi sensors data (Landsat, Sentinel-2) by augmenting a pseudo additional band generated using upsampled night time coarser resolution data from Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB). It highlights the urban built-up areas from non-urban built-up areas by intensifying with pseudo- weights drawn from nighttime lights data intensity values. The proposed method is automated with less human intervention for the extraction of built-up areas using the Global Human Settlement Layer (GHSL) as a reference for training samples by fine tuning sample withdifferent threshold values of NDVI, SAVI. A comparison analysis was made with the conventional approach, which does not incorporate night-time data as an input. The findings demonstrate that the proposed method outperforms the conventional approach in extraction of built-up areas by effectively eliminating false positives from non-built-up areas of suburbs.

Keywords: Builtup, Machine Learning, Training Data, Nighttime Light, Multi Sensor Data

DEVELOPMENT OF A WEB-BASED GUI FOR DEEP LEARNING BASED SEMANTIC SEGMENTATION

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Abstract

Semantic segmentation is a computer vision task where the goal is to label each pixel from a collection of labels representing various classes. In recent times, with the development and advancement in deep learning techniques, there are many segmentation models available among which UNET and its variants are widely popular viz. UNET, UNET-Attention (UNET with Attention mechanism). Using these models for various segmentation problems is cumbersome and requires a lot of time in data preparation and establishing the data trainingprocess. Therefore, an attempt is made for web deployment of deep learning based segmentation models. Web deployment of deep learning models is crucial nowadays to complete the machine learning operations (MLOps) lifecycle and it provides a web interface to control training and evaluate already trained models with prediction on uploaded unknown images. A web-based graphical user interface (GUI) is developed which provides not only pre-trained segmentation models but also facilitates training of new models based on pre-supplied/user-supplied network architectural hyperparameters with training data. The GUI allows users to upload images, perform data pre-processing operations such as image tiling, data normalization and augmentation and split data into training, testing and validation sets for model training. The model training process is visualized live on the web using training and validation loss plots. In the end, the web interface automatically saves thebest model which can be used for on-the-fly segmentation of user provided images. The segmentation results along with original uploaded images of multiple trained models can bevisualized with model performance metrics for inter-comparison of trained models.

Keyword: Semantic Segmentation, Web Deployment, ML Operations, UNET, Deep Learning

DL BASED TECHNIQUE FOR SUPER-RESOLVING SATELLITE IMAGE AND GENERATING LARGE IMAGE MOSAIC

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Abstract

Super-resolution involves generation of higher resolution image from a coarser resolved image orset of multi-temporal coarser images. Multiple observations, although coarser, of the same area over a period of time can be collected from remote sensing satellites and can be combined to generate a super resolved image. This paper presents an approach to generate a super resolved image assuming one image at 5m resolution and the adjacent image resampled at 10m ground resolution along with an overlap of minimum common pixels. Using the overlap area in these twoinputs, the model is trained and then the kernel is applied to generate super resolved images of theuncommon area at higher resolution of 5m. To further improve the trained model, another input isused which is the previously generated image of the same area at 5m resolution. The main purposeof this dataset is to provide for the high frequency details that may not be available from the coarseresolution using deep learning method from AI domain. As long as enough training data is there, a deep learning network can in principle learn very complex non-linear relationships. To recover the finer details related to frequency, the use of blind SR model KernelGAN and blind image denouncing model, the estimation of degradation kernel of image pairs through GAN andestimation of distribution of degraded noise is also achieved. The initial results show the successfulgeneration of finer resolution image at 5m using 10m inputs and validated using Resourcesat-2A LISS4 images as input. The image fidelity from both radiometric and geometric aspects is validated with the available reference images of the same area across similar imaging conditions.The future scope is generation of geophysical parameters and validation.

Keywords: Super-Resolution, GAN, Deep Learning, AI Domain, ResourceSAT

A SYSTEMATIC REVIEW OF POTHOLE DETECTION USING DEEP NEURAL NETWORKS

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Abstract

Detecting and addressing road accidents become notably intricate and challenging problem. Various factors, such as road deterioration, potholes, cramps, inadequate maintenance of infrastructure, and faulty speed bumps, can lead to tragic outcomes including the loss of lives and property. Historically, pothole detection primarily relied on labor-intensive methods that were often inefficient in accurately identifying potholes. Consequently, an automated pothole detection system was created, which involved installing accelerometers and gyroscopes on vehicles. This system evaluates potholes by observing the gyroscope's deflection caused by the intensity of impact vibrations when a vehicle passes over a pothole. If no such deflection or impact is detected, the system does not acknowledge the presence of a pothole. This paper investigates several deep learning-based methods designed to detect potholes in images and videos at an early stage, with the primary goal of reducing accident risks. The images are sourced from various devices like dashcams, smartphones, drones and airborne platforms. The study explores the applicability of various deep neural networks, including the Single Shot Detector (SSD), Res-Net, Inception model, Regions with Convolutional Neural Networks (R-CNN), U-Net, and You Only Look Once (YOLO), for the task of pothole identification on road surfaces. Deep learning models are evaluated using metrics like accuracy, precision, recall, and the F1 score, while their performance is further examined throughthe analysis of confusion matrices. The research also includes a comparative assessment aimed at identifying the most effective model for achieving both precise and swift pothole detection. It also considers the trade-off between prediction accuracy and time complexity, which may suggest the potential for introducing a proactive guidance system using an appropriate deep learning model.

Keywords: Pothole Detection, Deep Learning, Convolutional Neural Network, Image Segmentation, Transfer Learning

PIXEL QUALITY LAYER GENERATION FOR REMOTE SENSING DATA PRODUCTS USING DEEP LEARNING

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Abstract

The revolutionized remote sensing technology plays a vital role to monitor and understand planet's surface, atmosphere and environment. The huge data generated by remote sensing (RS) satellites presents both an opportunity and a challenge for effective analysis and interpretation. Optical RS images are hindered by clouds and cloud shadows for feature extraction. Similarlyhill shadows and zero-fills may impact the classification accuracy. Snow and clouds need additional attention. It would be a good practice to delineate these pixels and to provide the classified information in separate pixel-quality layer for more accurate geo-physical parameter retrieval. It is also mandatory to have a pixel quality layer for next-generation Analysis-Ready- Data(ARD) products to maintain the interoperability among global sensors. Presently the deep learning techniques have emerged as a potential tool for automatic classification of RS images with significant advantages over traditional state-of-art methods. Resourcesat-2/2A multispectral sensors AWiFS and LISS-3 data products are widely being used for various national level projects. A Deep- Convolution Neural Network (CNN) based U-Net model is customized and implemented to generate a quality layer which comprises pixel-level delineation of cloud, cloud shadow, snow, land and zero-fill from AWiFS and LISS-3 standard data products. Comprehensive and temporal data sets of images from diverse geographical regions are utilized for training and evaluation. Data sets are processed to represent Top-of-Atmosphere (ToA) reflectance. Semi-automated methods are used for training data preparation. Further preprocessing steps like data augmentation, normalization and filtration is carried out to improve the accuracy. The model is optimized by implementing and tuning various hyper parameters. Achieved validation accuracy is around 94.3 % for the images acquired over Indian terrain. Transfer learning techniques are being implemented to generate quality layer from other sensors over global terrains.

Keywords: CNN, U-Net, Top-of-Atmosphere (TOA), Analysis-Ready-Data (ARD), Resourcesat-2/2A

DEEP LEARNING BASED SOLAR PLANTS EXTRACTION USING REMOTE SENSING SATELLITE DATA

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Abstract

Globally, solar energy is one of the most promising freely available renewable energy sources. India plays a crucial role in promoting and utilizing it by installing solar plants across the country. With the availability of high-resolution remote sensing satellite data, it is possible to monitor existing and newly developed solar plants at national level. For extracting these solar plants from satellite images, deep learning technology has been effective in computer visiontasks of image segmentation. In this study, we use Sentinel-2 satellite data with red, green, blue and near infrared data with spatial resolution of 10m. The state-of-the-art UNet architecture withthe backbone of VGG16 and RESNET50 is used for extracting solar plants for comparing the results. The model is trained for solar panels installed on desert regions of Rajasthan, lands of Gujarat, near riverine in Madhya Pradesh and southern regions of India in Karnataka. Forvalidation of models, accuracy, jacquard Index (intersection over union), F1-score is used for independent sets of data having the same characteristics as training data. The mean accuracy achieved of the best model is 94.67% and IOU of 87% with F1-score of 0.84. The model is able to delineate different kinds of solar panels with varied contextual information of terrain type.

Keywords: Solar Plants, Computer Vision, Remote Sensing, Deep learning

AUTOMATIC EXTRACTION OF FOREST BURN SCAR USING MACHINE LEARNING TECHNIQUE IN TROPICAL DECIDUOUS FOREST

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Abstract

The recurrent occurrence of fire is one of the most complex problems facing deciduous forests as it causes extensive damage in the forest ecosystem. Detecting and assessing the spatial extent and distribution of burn scars can support forestry services for pre and post-fire management. A considerable variation exists between exact area burnt and the area reported by ocular method by forest staff. Most of the fire information available online in Indian region is point location information on active fire and information on forest burnt area and fire frequency data is not available. In the present study, tropical deciduous forests of the Vidarbha region of Maharashtra were taken as the study area for burn scar extraction using Landsat-7 & 8 datasets. This study proposed a two-step approach for precise burn scar extraction. First, discrimination capabilities of eight spectral indices (SIs) as Burn Area Index (BAI), Burned Area Index Modified-lSWIR, Burned Area Index Modified-sSWIR (BAIMS), Normalized Burn Ratio, Normalized Difference Vegetation Index, Normalized Difference Moisture Index, Mid Infrared Burn Index, Modified Soil-Adjusted Vegetation Index (MSAVI) and their weighted fusion along with change vector analysis were examined in multi-temporal domain. Secondly, by using U-Net segmentation model developed a robust methodology to automatically extract burn scars using best-suited SIs or weighted fusion difference, whichever giving best result. Result shows that feature weighted fusion using BAI, MSAVI and BAIMS is the best-suited method for burn scar delineation compared to other SIs examined. Output of feature weighted fusion has given advantage of creating precise training samples for the segmentation model, which has offered an overall accuracy of 88.94% with 4.92% commission and 11.27% omission error. The proposed method can overcome the disadvantages of traditional methods by selecting fixed thresholds, considering localized fire events and can serve as an automatic environment to extract burn scars globally.

Keywords: Forest burn scar, spectral indices, feature weighted fusion, U-Net, segmentation model

A NOVEL APPROACH FOR IMPROVED FEATURE EXTRACTION IN AN URBAN ENVIRONMENT

Atulya Dhar

Abstract

Deep Learning and Object-based Image Analysis (OBIA) play a pivotal role in various fields such as urban planning, environmental monitoring, and remote sensing. They have emerged as a powerful tool for automatic feature extraction from remotely sensed imagery. Our study leverages the capabilities of various Convolutional Neural Networks (CNN's) and Objectbased Image Analysis (OBIA) to extract meaningful spectral and spatial features from NAIP Aerial Imageries which have been obtained from the USGS Earth Explorer for which features like Freeways, Runways, Sparse residential, Medium residential, Storage Tanks, Tennis Court, Chapparals, Intersections, etc. have been identified. Existing CNN architectures are first tested like DenseNet201 of 50 epochs which reported an accuracy of 0.95; A ResNet architecture of 50 epochs reported an accuracy of 0.96 and EfficientNetB7 reported an accuracy of 0.9638. The OBIA based accuracy is also expected to attain an accuracy of over 0.90. A Novel hybrid OBIA-CNN Model is built by testing various fusion techniques like Weighted Fusion, Averaging and Late Fusion and the most appropriate fusion technique is chosen for model development. The hybrid model is expected to attain an accuracy of greater than 0.80. Previous studies have focused on classifying broad-based land use land cover feature classes like Vegetation, Buildings, Water Body, Bare Soil, etc. This work focuses on extracting more advanced and complex features in these broad classes, which have been listed previously. Future work can focus on building advanced machine learning and deep learning algorithms for combining OBIA and CNN for Disaster Monitoring and Response, Smart Cities Development, Space Exploration, Defence, Infrastructure Management and Ecological Conservation.

Keywords: Convolutional Neural Networks, Deep Learning, Feature Extraction, Machine Learning, Object-based Image Analysis.

FOREST FIRE SIMULATION MODELING USING FIRE DYNAMICS SIMULATOR (FDS) IN SIKKIM HIMALAYAS

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Abstract

Forest fire poses formidable challenges to fire control authorities. By using region-specific calibrated fire risk mapping and fire spread models, authorities can prioritize effective resource management for forest fire prevention and suppression. Our study delves into the utilization of Fire Dynamics Simulator (FDS), a Computational Fluid Dynamics (CFD)-based simulation modeling software on High-Performance Computing (HPC) platform for modeling vegetation fires. FDS with proper parameterization and validation emerges as a robust tool for CFD-based modeling of forest fires, offering enhanced visualization capabilities through its accompanying Smokeview package. This allows for the comprehensive visualization of plume behavior and heat release during fire simulations. Input files for FDS simulations were prepare using GIS software's. Satellite remote sensing images were utilized for preparing fuel map inputs and for burnt area validation. This investigation shows that the Sikkim vegetation fuel characteristics results are in excellent agreement with the burned area. The simulated results and the satellite burned area image accord qualitatively in the initial fire point to an extent of 70%. Our research marks a pioneering effort in this regards in India, where the integration of FDS and HPC is employed for forest fire simulation modeling. Leveraging current HPC capabilities, simulations with substantial computational demands can be distributed efficiently through parallel computing platforms, enabling faster presentation of results. This proactive approach empowers fire managers to anticipate and assess the potential impacts of management strategies well in advance, aiding them in making more informed and effective decisions.

Keywords: Forest fire, HPC, Remote Sensing, FDS, GIS

MACHINE LEARNING BASED CROP DISCRIMINATION & BIOPHYSICO-CHEMICAL PARAMETER ESTIMATION USING AIRBORNE HYPERSPECTRAL DATA

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Abstract

The study utilized airborne hyperspectral sensor (AVIRIS-NG) with continuous spectral bands spanning from visible to shortwave wavelength regions of the electromagnetic spectrum. These sensor offers unique advantages in discriminating crops and estimating critical biophysico-chemical parameters, essential for assessing crop condition and production. The research aimed to identify specific wavelengths influencing the discrimination of morphologically similar crops. Additionally, various combinations of machine learning (ML) classifiers, coupled with data dimensionality reduction techniques, were assessed for their potential in discriminating multiple crops and retrieving crop biophysico-chemical parameters. Different narrowband indices related to crop condition and vigor were correlated with in-situ field observations, including Leaf Area Index (LAI), Chlorophyll a and b (Cab), and Fluorescence yield-II (F'v/Fm), to identify suitable narrowband indices. Our results indicated the effectiveness of AVIRIS data in discriminating visually alike crops, particularly Maize and Sorghum. Among diverse ML classifiers, the combination of Random Forest and Principal Component Analysis, termed RF-PCA, exhibited superior performance, achieving an overall accuracy of 84.09% in crop mapping. Furthermore, the performance of various ML algorithms in retrieving maize biophysical parameters was specific to each parameter. Gaussian Processes Regression with Partial Least Square (GPR-PLS) showed better performance in Cab retrieval with an R^2 of 0.75 and RMSE of 9 µg/cm². Random Forest with Minimum Noise Fraction (RF-MNF) was effective in accurately retrieving LAI and @anopy Cab with an R^2 of 0.78 and RMSE of 0.64, while Partial Least Square Regression with Principal Component Analysis (PLSR- PCA) outperformed other methods in estimating F'v/Fm' with an R^2 of 0.85 and RMSE of 0.09. This study showcases the invaluable role of hyperspectral data in offering objective insights into crop health, thus enhancing informed decision-making in agricultural practices.

Keywords: Hyperspectral, AVIRIS, Crop Classification, Crop Parameter

AUTOMATED HYPER-PARAMETER TUNING OF LSTM NEURAL NETWORKS FOR NDVI IMAGE PREDICTION

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Abstract

Normalised Difference Vegetation Index (NDVI) is a remote sensing indicator which quantifies vegetation condition. Prediction of NDVI is important as it provides an insight into crop anomalies and future yields. NDVI prediction has been attempted with multiple statistical approaches such as auto-regressive integrated moving average (ARIMA) and Seasonal ARIMA. These models poorly capture non-linearity in NDVI time series resulting in poor prediction performance. Recently LSTM based models have been successfully used for NDVI prediction. Building and training LSTM based models involve optimizing hyper-parameters, which is time and resource intensive. These hyper-parameters include parameters which define network structure (number and type of hidden layers, activation function, network weight initialiser etc.) and training process (optimiser, learning rate, mini-batch size, number of epochs etc.). In this work, we demonstrate successful application of automated hyper-parameter tuning using Hyperband and Bayesian Optimisation techniques for building LSTM based NDVI prediction models. The model is trained to predict maximum NDVI composite image of next fortnight using most recent 24-months' data which comprises 48 fortnightly maximum composite images. We have used MODIS data from 2012 to 2018 of Indian subcontinent to train and evaluate our model. The best models found using each method after 15 days of hyperparameter tuning were retrained and were able to give mean absolute error of 0.0629 and 0.0601 on the validation set for Hyperband and Bayesian Optimisation respectively. Bayesian Optimisation was able to discover a more efficient model (3,753 vs 27,905 trainable parameters). Further, 90% of the predicted values in the hold out samples had an error of less than 0.1 NDVI. Bayesian optimization is a viable approach for discovering optimal hyper-parameters for building LSTM based neural networks for NDVI prediction. This approach can also be possibly used for building similar prediction models in other problem areas.

Keywords: Machine Learning, Geo-AI, NDVI, LSTM, Bayesian Optimisation, Hyperband

SUB THEME-2: UAV APPLICATIONS

RETRIEVING 3D REPLICA FOR FOREST DIGITAL TWIN: INSIGHTS FROM BROADLEAF AND NEEDLELEAF FOREST VEGETATION

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Abstract

Digital twins are being used in the industry to boost the efficiency of manufacturing processes. However, the concept has a wide range of applications in forest ecosystem studies. The forest digital twin framework provides a systematic way to create a virtual forest by integrating state variables at the tree level and forest level. The information generated in the virtual world enables ecosystem risk and ecosystem service modelling for the advancement of science and sustainable management practices. The twining is first achieved at individual tree level, thereby allowing the twining of the entire forest using forest scale information from remote sensing and flux towers. While, IoT-based methods for monitoring biotic and abiotic variables in the near tree environment under development. This study explores various techniques for retrieving virtual 3D models of broadleaf and needleleaf forests using laser scanning. Although different laser scanning technologies are available in the market, terrestrial laser scanning provides the densest point cloud with the highest precision. Both single tree and plot-level scans can be used to generate the 3D model required for Forest Digital Twin. However, single- tree scans lack terrain information and precise relative positional information of the trees whereas plot-level scans require multiple processing steps for the segmentation of individual trees. Moreover, accurate individual tree segmentation from plot-level scans in dense canopies is a difficult task. Therefore, combining high-resolution single tree scans and low-resolution plot-level scans provides a 3D replica without compromising canopy details. Other challenges from dense undergrowth and uneven terrain have been discussed.

Keywords: Forest Digital Twin, Laser Scanning, Ecosystem Services, Forest Management

WEED IDENTIFICATION USING UAV-BASED MULTISPECTRAL IMAGING IN CITRONELLA (*Cymbopogon winterianus Jowitt*.) CROP FOR PRECISE MANAGEMENT

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Abstract

Weeds compete with crops for nutrients, sunlight, and space, which leads to loss of the quality and yield of beneficial crops grown by farmers. These losses ultimately reduce the profits and results in loss of interest for adopting agriculture as an occupation. Moreover, removal of the weeds is time as well as money consuming activities. Site-Specific Weed Management allows to manage the weeds using implements and weedicides. Thus identification of weeds and thereby applying specific weedicide is a challenge in itself. Now a days Unmanned Aerial Vehicles (UAVs) and robotic All-Terrain Vehicle (ATVs) mounted with imaging sensors (RGB (red-green-blue), multi-spectral, and hyperspectral) coupled with machine learning/ artificial intelligence algorithms can detect the weeds from the adjoining crops easily. In this study, we have attempted to detect common weeds growing along with Citronella crop grown in a total area of 0.2 Ha using UAV mounted with MicaSense Altum multispectral camera. This study was performed at CSIR-Central Institute of Medicinal and Aromatic Plants research farm Pantnagar, Uttarakhand. The spectral reflectance of the weeds where used to identify weeds from Citronella plants. A classified map having accuracy of 95.31% was obtained which can be used further to spray appropriate weedicide using the spraying drone.

Keywords: Unmanned Aerial Vehicles (UAVs), Multispectral Imagery, Remote Sensing, Weeds, Citronella

ASSESSING THE PERFORMANCE OF SEGMENT ANYTHING MODEL (SAM) BASED LABELS FOR TRAINING MACHINE LEARNING MODELS IN UAV DATA CLASSIFICATION

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Abstract

Labelled datasets are critical to train machine learning models with higher confidence especially in supervised learning tasks. However, generating sufficient labelled data for feeding into machine learning models remains a cumbersome task. The quality and accuracy of labels significantly impact the performance and the reliability of the model in the classification of unknown scene. Segment Anything Model (SAM) is a recently developed AI- assisted labelling tool that can automate the segmentation of complex and intricate image structures in RGB images. This model is expected to significantly reduce the manual workload for annotators. In this paper, the efficiency of SAM to annotate geospatial data obtained from UAV (unmanned aerial vehicle) is assessed. Further, the efficiency of SAM annotated labels to train machine learning models for supervised learning tasks such as Support Vector machine (SVM) and Random Forest (RF) is assessed. Results are compared with the machine learning models trained with manually annotated labels. Results indicate that machine learning models trained through SAM annotated labels have better performance in classification tasks for UAV geospatial data. This widens and opens up the scope of using SAM for broader geospatial image classification tasks thus reducing manual cumbersome human efforts.

Keywords: SAM, Labelling, Geospatial, Meta, AI

DETECTION OF LEAF MINER INFESTATION IN MANDARIN ORANGE USING UAV BASED MULTISPECTRAL IMAGING AND MACHINE LEARNING

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Abstract

Mandarin orange (*Citrus reticulata*) cultivation is plagued with various problems due to limiting growing conditions, limiting water resources and the high occurrence of pests and diseases. Pest surveillance programs such as field scouting are often expensive, time-consuming, laborious and prone to error. Geospatial techniques can be vital in managing pests and diseases of orange orchards. UAV based multispectral and hyper-spectral, along with spectro-radiometer data, will help to identify pests and diseases of orange plantations using AI/ML techniques. The present study envisages identifying leaf miners (*Phyllocnistis citrella*) of orange orchards using UAV based multispectral data through AI/ML techniques of selected orange-growing regions of Central India. Machine learning techniques' accuracy is highly dependent on the quality and quantity of the training dataset. The present study describes and implements a three-step method for generating high-quality training data for the detection of pests and diseases of orange orchards. First, using the AI/ML (U-Net) model performed acreage estimation of orange and to create the mask for further assessment. Training samples for the U-Net model are created using UAV and Cartosat-2 data, offering an accuracy of 0.897 and an IOU (Intersection over union) of 0.783. Then, after applying the mask, the infestation symptoms were collected on the ground with the help of a spectro-radiometer in the UAV image to make samples and at last, annotated the similar signatures of infestation on the image to create more training samples. These training samples train the U-Net model to segment images into infested and non-infested regions with an accuracy of 0.865 and an IOU of 0.715. This three-step approach to generate training data is a promising method to streamline machine-learning approaches for leaf miner detection.

Keywords: Orange, Leaf Miner, UAV and AI/ML Techniques

MACHINE LEARNING BASED CLASSIFICATION APPROACH FOR DELINEATION OF MUGA HOST PLANTS WITH UAV SURVEYS

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Abstract

Muga silk, derived from the silkworm *Antheraea assamensis*, is a valuable and culturally significant commodity in the north eastern region of India and its sustainable production heavily relies on the availability of suitable host plants. Multi-spectral UAV data having a GSD of 8 cm were collected from a Muga conservation site in East Jaintia Hills of Meghalaya were collected for delineation of two primary Muga host plants; the *Som (Persea bombycina)* and *Soalu (Litsaea monopetela).* Four selected machine learning algorithms viz., K-Nearest Neighbour (KNN), Support Vector Machine (SVM), Random Forest (RF), and Naive Bayes were deployed. Accuracy, precision, recall, and F1-score were calculated to evaluate the relative efficiencies of performance of these four approaches. While KNN, SVM, and RF demonstrated competitive performance, Naive Bayes exhibited the highest classification accuracy of 88.13% in classifying Muga host plants, SVM had the lowest overall accuracy of 80.63%. The results indicate the advantage of using very high resolution UAV data in delineating silkworm host plants at species level by using appropriate machine learning based classification approach, which will support in efficient management and monitoring of the conservation site.

Keywords: Machine Learning, UAV Surveys, Muga Host Plants, Classification, Accuracy Assessment

SUB THEME-3: OPEN GEOINFORMATICS (DATA & TOOLS)

IMPROVING 3D ACCURACY OF GLOBAL DEMS AND KH9 DEM USING ICESAT2 ATLAS DATA

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Abstract

Topographic height information is essential for many scientific, research, and engineering fields, such as geosciences, geology, geomorphology, natural disasters, hydrology, and water resources monitoring and management. Many global DEMs, viz. SRTM, ASTER, and ALOS World 3D are publicly available. Declassifying Corona and Hexagon (KH9) data by the United States provided an opportunity to derive DEMs using satellite stereo photographs, which are 45 years old. The accuracies of these DEMs are in meters and can be used for global or regional applications only. However, improving the accuracy of these DEMs can be used for various local applications. The recently launched Ice Cloud and Land Elevation Satellite (ICESAT2) carrying Advanced Topographic Laser Altimeter System (ATLAS) provides highly accurate terrain height profiles. In this study, validated ICESAT-2 ATLAS LiDAR data using airborne LiDAR data and showcased utilization of ICESAT-2 data in improving the positional and vertical accuracy of global DEMs (SRTM, ASTER, and AW3D) & KH9 DEM. It is found that IceSat2 ATLAS is accurate to 0.14 m to 1.17 m in open areas and hilly area with dense forest respectively and improved global DEMs accuracy 2-5 m using ICESAT2 ATLAS data.

Keywords: SRTM DEM, ICESat-2, ATLAS, Airborne LiDAR DEM, ALOS World DEM, ASTER DEM, Global DEM, Hexagon, KH-9

CLASSIFICATION OF INDIA'S LARGE WETLANDS BASED ON OPTICAL WATER TYPES

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Abstract

Wetlands play a crucial role in maintaining ecological balance, providing habitats for diverse species, and serving as essential water resources. However, these ecosystems are increasingly threatened by eutrophication, which can have detrimental effects on their health and functions. Therefore, effective monitoring of wetlands and eutrophication is of paramount importance for their conservation and sustainable management. In this study, we employ a robust optical water type (OWT) classification system to assess the eutrophication status of 49 large wetlands in India, each exceeding 10,000 hectares in size. Our approach leverages the high-frequency, high-resolution Sentinel-2 optical data and the computational capabilities of Google Earth Engine. The heart of our analysis lies in the 13- class OWT classification system, meticulously designed to capture the increasing degrees of eutrophication within these wetlands. Through this classification, we gain valuable insights into the intricate water quality dynamics of these vital ecosystems. Our results reveal compelling seasonal trends in OWT values. Notably, the peak eutrophic conditions, characterized by the highest OWT values, consistently occur in the last week of May. Conversely, the mid-November period witnesses the lowest OWT values, indicative of reduced eutrophication. These findings shed light on the temporal variability in water quality within Indian large wetlands. When considering the collective data for all wetlands, we observe distinct percentages of OWT occurrences. Approximately 16.8 percent of the wetlands exhibit oligotrophic characteristics, 31.3 percent display mesotrophic attributes, 31.1 percent are classified as eutrophic, and 20.8 percent exhibit hyper-eutrophic conditions. This distribution underscores the prevalence of various eutrophication levels, emphasizing the need for tailored conservation and management strategies. In conclusion, our study demonstrates the significance of monitoring eutrophication in Indian large wetlands for their preservation and sustainable use. The application of the OWT classification system using Sentinel-2 data in Google Earth Engine provides a powerful tool for assessing water quality dynamics in these ecosystems, ultimately supporting informed decision-making and environmental stewardship efforts.

Keywords: Wetland, Remote Sensing, Optical Water Type, Google Earth Engine, Sentinel-2

SCALABLE AND DEMAND DRIVEN GEOPORTALS FOR THE APPLICATIONS OF SATELLITE REMOTE SENSING

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Abstract

Web GIS refers to Geographic Information System (GIS) operating accessible through web platform (Yang et al. 2005). It is a product of the federation between GIS and the web driven by protocols viz. Hyper Text Transport Protocol. Functionality and performance of Web GIS portal commonly known as geoportals varies with the targeting science application. This makes performance and theme based customisation, the prominent challenging issues. Custom application are driven by demand based development of geoportals that vary in terms of information sources, target science application, area of interest, analysis techniques etc. For instance, Early Warning System geoportal for disseminating extreme weather alerts related to Heavy Rain and Cloud Burst would require the statistics generation and hit/miss ratio of past alerts and controls for current alerts. Island monitoring geoportal for change detection would require high-resolution imageries and controls for change detection, time series of multiple parameters. This paper deals with these issues by proposing schematics and demonstrating the custom applications in line of targeting science applications. The highlighted challenges are different from the ones found in data-centric mashup, a typical mashup. Proposed solution targets; 1) spatial data storage, indexing and fast access, 2) data organisation for long term analysis 3) making data, analysis available as a service 4) Loosely coupled, configurable and modular front end components. These points provide a technological base towards more intelligent geoportal to fulfil more complex users' demands beyond data level. This allows quickly configuring and releasing a geoportal based on desired configuration. Open source tools and techniques are combine in an effective way to enhance the scalability and management of overall solution. Techniques used for improved scalability of geoportal are: i. Pyramid and data volume reduction through caching and tiling, ii. Progressive transmission, iii. Asynchronous transmission through HTTP 2.0, vi. Spatial indexing. Tools and techniques used for the development of demand-driven geoportals are: i. Information sources: raster - satellite images, model outputs for forecast, Nowcast and wind vectors. ii. Spatial Data stores: Spatial databases for queryable datasets, NetCDF for forecasts., iii. Analysis: Data cubes, in-memory computation for long term time series and anomaly detection This paper demonstrates schematics to support development of scalable and demand driven geoportals. It includes View component library and APIs library built on the principle of reuse. Each View component is mapped to at least one API backend library that in turn can be a combination of multiple plugins. These API endpoints are built as micro services and run in serveless environment. API endpoint are independent of underlying technological stack and hence offers advantages of abstraction. Further, backend processing includes open source tools and techniques that deals with data organisation, querying and serving. These includes:

- Geoserver: Publishing data from spatial data sources using open standards. It provides implementation of OGC WMS, WFS, ECS standards.
- Open Data cube (ODC): Data first converted to Analysis Ready Data (ARD) and then ingested to ODC infrastructure with Data cube core APIs and Indexing mechanism. It is best suited for long-term analysis of satellite data.
- Thredds Data Server: Web server that provides metadata and data access for satellite data omitting the need of data pre-processing. It is best suited for high frequency satellite data products.

In conclusion the work has yielded a number of significant lessons such as data organisation decision is heavily dependent on its application; metadata is the core to the publishing process. Solution that tries to automate the development of intelligent geoportals must evolve continuously with the advancement of science applications and data analysis techniques. The work is primarily motivated by the huge need of state of the art geoportals and advancement of data organisation techniques. Adoption of new techniques such as data cube, in-memory computation provides tremendous advantages in terms of faster computation and information retrieval. Integration of these techniques is crucial for the new generation geoportals and our work demonstrates a possible and effective way of such integration and mapping them to view components. This increases the scope of traditional mashup based developments.

Keywords: WebGIS, Early warning systems, Location based services, Forecasts

DROUGHT MONITORING USING MODIS DERIVED INDICES AND GOOGLE EARTH ENGINE PLATFORM FOR VADODARA DISTRICT, GUJARAT

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Abstract

Drought is considered to be the most complex but least understood of all natural hazards, affecting more people. Its reappearance in drought-prone areas every few years is almost certain. Also, they lack sudden and easily identified onsets and terminations. Under the background of global climate change, the impact from drought exhibits the characteristics of complexity and multi-process. It has significant impact on the water resources, agriculture, society, and economy hence needs attention.
Vegetation Condition Index (VCI) is used for observing the change in vegetation that causes agricultural drought. Since the land surface temperature has minimum influence from cloud contamination and humidity in the air, so the Temperature Condition Index (TCI) is used for studying the temperature change. Dryness or wetness of soil is a major indicator for agriculture and a comprehensive assessment of vegetation and temperature stress is achieved from MODIS satellite data in Google Earth Engine (GEE) platform for pre and post monsoon season from 2008 to 2022 (15-year period). Vegetation Condition Index (VCI) is used for observing the change in vegetation that causes agricultural drought. Since the land surface temperature has minimum influence from cloud contamination and humidity in the air, so the Temperature Condition Index (TCI) is used for studying the temperature change. The research also incorporates precipitation data from WorldClim to investigate its influence on Vegetation Health Index (VHI). Mann Kendall trend analysis is employed to examine spatio-temporal variations in drought severity, for both pre-monsoon and post-monsoon seasons. The results emphasize the sensitivity of VHI to shifts in rainfall patterns, providing valuable insights for drought monitoring and management. In essence, this study enhances understanding of drought dynamics and emphasizes the significance of Remote Sensing data and climate information for effective drought assessment and mitigation strategies.

Keywords: Drought Monitoring, Drought Indices, Google Earth Engine, MODIS, WorldClim

TOWARDS EFFECTIVE CROP HEALTH MONITORING AND PRESCRIPTIVE ANALYTICS FROM MULTISPECTRAL DRONE IMAGERY

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Abstract

Drones are increasingly becoming integral to agricultural crop monitoring, particularly in the assessment of crop health, disease detection, phenotyping, and crop counting. Multispectral imagery unveils insights about crops that remain hidden from the human eye. This valuable information finds its application in precision agriculture, offering farmers site-specific guidance on crop health. This, in turn, empowers them to efficiently oversee, strategize, and manage their farms for enhanced productivity and yield. The paper focuses on processing of multispectral drone imagery, generate vegetation indices and build a user interface framework for performing prescriptive analytics for immediate advisory to the farmers. The study employs multispectral images of pineapple crops captured by the Micasense RedEdge-MX sensor across multiple dates to evaluate crop health. A processing pipeline rooted in open-source tools is devised to convert raw RedEdge data into radiance and reflectance maps. These reflectance maps serve as the foundation for deriving various vegetation indices like the Normalized Difference Vegetation Index (NDVI), Normalized Difference RedEdge Index (NDRE), and Optimised Soil Adjusted Vegetation Index (OSAVI). The RedEdge band, positioned between the Red and NIR bands captured by the sensor, holds significance in accurately assessing plant chlorophyll content. The resulting vegetation indices are then harnessed to create prescription maps, enabling individual farmers to treatments on specific affected zones based on nutrient-deficient crop areas across the field.

Keywords: Multispectral, Precision Agriculture, Analytics, Crop Health Monitoring

SIMULATING THE WARD-WISE AIR POLLUTION (PM 2.5) CONCENTRATION USING SATELLITE DATA AND GROUND OBSERVATIONS ALONG WITH THE REDUCTION TARGETS AND ASSOCIATED HEALTH BENEFITS FOR AHMEDABAD CITY, INDIA

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Abstract

Air Pollution is posing a very high risk to human health and all steps should be taken for its abatement. The present first-of-its-kind study presents a novel methodology of quantifying the health benefits due to air pollution reduction. It uses remotely sensed Aerosol Optical Depth (AOD) for simulating the ground level PM2.5 concentration of the city, spatially averages and estimates the ward specific concentration and computes the respective target based on the limiting concentration of 40 µg/m3 and finally translates this reduction into health benefits in terms of avoidance of premature deaths using BenMAP-CE. The study is done for Ahmedabad city of Gujarat, India for the year 2021. 16% premature deaths (which is 8,715 premature deaths of the total 56,123 deaths) could have been avoided in Ahmedabad city if the National Ambient air pollution targets are achieved with respect to the year 2021. The premature avoidable death rate by achieving the air pollution limiting concentration varied between 7.5 – 16 persons per 10,000 across the 48 wards of the city. The study would be of great significance to Central Pollution Control Board, Gujarat Pollution Control Board and Ahmedabad Municipal Corporation for strengthening the Air Action Plan which will have far reaching benefits to the community at large.

Keywords: Air Pollution, Aerosol Optical Depth, Ahmedabad, MODIS, BenMAP-CE, Mortality, Premature Deaths

SWOT HYDROLOGY SIMULATOR ESTIMATED DISCHARGE OVER NARMADA RIVER

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Abstract

Recently launched SWOT mission (December 15, 2022) has opened up a new era in the field of satellite hydrology. Although existing nadir altimeters have proven their capability as one of the best sensors for land hydrological applications, still one of the major limitations was that it only covers water bodies on the track of mission. The SWOT mission will provide two dimensional surface elevation maps over inland water bodies, an important information first of its kind that was missing earlier. The mission consists of a Ka band interferometer (KaRin) payload along with the traditional nadir altimeter in the centre. This will provide water elevation, slope and river discharge information along the 120 km swath over the study areas. Some of the test dataset from the nadir instrument is available in the scientific community but interferometry data is still under processing. In this work, we have setup the SWOT Hydrology Simulator over one of the important river of western indian river basins, i.e. Narmada River. SWOT simulated dataset is equivalent to its actual dataset in the form of river water level, river width, slope and discharge with known amount of sensor and instrument biases/errors. To generate the input SWOT like information, river water level was retrieved from Sentinel-3A/3B altimeters and river width was derived using Sentinel-1A/1B SAR dataset, and further used to initialize the simulator. In total, the toolbox was set up over the 20 locations along the stretch of nearly 600 km of Narmada River. The virtual stations (VS), location where altimeter track intersects the river, were selected over the tracks of Sentinel-3A (9-VS) and Sentinel-3B (10-VS) radar altimeters or based on the availability of water level information from Central Water Commission (CWC) dataset. For each VS, the river reach was defined as a length of river approximately 10 km over which a time variant single value of water level and extent was assigned. The altimetry retrieved water levels over the VS close to Hoshangabad (Narmada River) were found to be fluctuating between 281.76 meter to 287.97 meter. SWOT simulated discharge at Narmada river close to Hoshangabad during 2016-2022 derived river discharge close to altimeter VS was observed to be in the range more than 4000 m3/s in August 2021. Further friction parameters and cross-sectional area are the two important variables that are difficult to estimate using remote sensing dataset but estimating river discharge from observed surface water elevations, river width and slope is central to this mission. Quantification of seasonal and inter-annual variability of freshwater discharge will represent information for the climate research community.

Keywords: SWOT, Interferograms, Water Elevation, River Discharge, Radar Altimetry

SNOWED-IN: AN INTERACTIVE WEB-BASED PLATFORM FOR UNDERSTANDING SNOW COVER DYNAMICS OF SIKKIM AND ARUNACHAL PRADESH

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Abstract

Snow serves as a primary source of perennial water, but can also be a cause of disaster such as avalanches and floods in mountainous region. In-situ measurement of snow characteristics for the states of Sikkim and Arunachal Pradesh are hindered by complex terrain, necessitating satellite based analysis. Snowed-In, an interactive web portal has been developed that generates snow cover maps and aids assessment of snow cover dynamics in the states of Sikkim and Arunachal Pradesh. The Google Earth Engine platform was used to facilitate state-wide analysis from 2000-present using Landsat 5, Landsat 8 and Sentinel 2 satellite data. To ensure that the most effective snow cover classification technique is selected, a set of models including three snow indices (Normalized Difference Snow Index, Normalized Difference Forest Snow Index and S3 index) and three machine learning algorithms (Support Vector Machine, Gradient Tree Boosting, and Random Forest), are evaluated. Using these advanced land cover classification techniques, a snow cover map has been generated at a 30m/pixel resolution. The final snow cover maps were represented in the form of a user friendly web portal that can provide decision-makers access to critical snow cover data. It enables dynamic queries where users can input their choice of state, district, satellite data, year and month to generate the corresponding snow cover map. Thus the web portal serves the critical needs of water resource management and disaster risk reduction while also enhancing our understanding of climate change impact in ecologically sensitive region.

Keywords: Snow Cover, Spectral Index, Machine Learning, Web Portal

SUB THEME-4: TIME SERIES DATA APPLICATION

JOB VOLUME FORECASTING MODEL IN FREIGHT FORWARDING: AN ENSEMBLE APPROACH WITH LSTM AND TIME SERIES MODELS

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Abstract

This study presents a data-driven approach to optimize operational efficiency in the freight forwarding industry by employing time series models to predict job volumes for sea exporting accurately. By gathering and pre-processing historical data, including forward freight information, job numbers, and spatial data from the Logi-Sys system, a software used by the logistics industry to manage data, valuable insights are derived. This study employed time series models such as ARIMA and Holt-Winters and an ensemble model. This ensemble model combined the aforementioned two traditional models with a deep learning model, LSTM (Long Short-Term Memory), to accurately predict job volumes for sea exporting. LSTM, known for its ability to capture sequential dependencies, played a pivotal role in enhancing the accuracy of the predictions, offering valuable insights for data-driven decision- making within the dynamic logistics sector. The performance of the models is thoroughly evaluated, and insightful recommendations are provided to facilitate data-driven decision- making within the freight forwarding industry. This research underscores the potential of leveraging data analysis techniques, particularly time series modeling, to enhance operational efficiency in the dynamic logistics sector, offering substantial benefits to industry practitioners seeking to optimize their performance.

Keywords: Freight Forward, Time Series Forecasting, Ensemble, LSTM

INFLUENCE OF ENVIRONMENTAL AND METEOROLOGICAL FACTORS ON FOREST PRODUCTIVITY AND CLIMATE RESILIENCE IN TROPICAL DECIDUOUS FOREST

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Abstract

In the face of unprecedented climate change, terrestrial forest ecosystems are pivotal for both preservation and mitigation purposes. Their role as nature's foremost carbon sinks, absorbing atmospheric carbon dioxide, and their influence on microclimatic regulation, including temperature and precipitation, make them critical subjects of climate change research. This study examines the impact of environmental parameters, including Soil Moisture (SM), Mean Maximum Precipitation (MeanMaxPPT), Land Surface Temperature (LST), incoming Photosynthetically Active Radiation (PAR), and Net Surface Solar Radiation (Avg_NSR) on physiological processes, specifically Gross Primary Productivity (GPP) and its functional proxy, Far-red Solar-Induced Fluorescence (SIF), from 2019 to 2022 in the Simlipal Biosphere Reserve, Odisha, India. All the datasets are organized into aggregates representing the winter, pre-monsoon, monsoon, and post-monsoon seasons. A comprehensive time-series analysis is conducted to gain insights into the relationships between the biotic and abiotic factors in the dry and moist deciduous forests of the region. Initial findings show expected trends between the environmental variables and OCO-2 derived Global SIF (GOSIF) and GPP (GOSIF_GPP). While fluctuations of SM and MeanMaxPPT are highly coincidental with that of GOSIF and GOSIF_GPP (high R^2), LST, PAR and Avg_NSR seems to have a temporally staggered relationship with them (low R^2). While LST and PAR peaks faster, Avg_NSR shows delayed peaking w.r.t GPP and SIF across the different seasons. Such a relationship is worth noticing and focusing on, to find out the underlying relationship between SIF/GPP and the environmental variables using various data decomposition techniques. Such trends indicate a compelling area for further investigation. While the study provides valuable insights into these relationships, future research should explore the underlying mechanisms behind these trends and their implications for climate change mitigation and forest conservation.

Keywords: Climate Change, Gross Primary Productivity, Solar Induced fluorescence, Land Surface Temperature, PAR

CHANGES IN LAND USE/LAND COVER AND ATMOSPHERIC CO2 AND CH4 CONCENTRATIONS OVER THE SUBURBAN REGION OF INDIA (SHADNAGAR)

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Abstract

The land use land cover (LULC) changes impact on atmospheric carbon dioxide (CO_2) and methane (CH_4) concentrations using were studied over suburban region. The primary classes namely forest, crop and built area were considered while remaining classes are listed under others category to evaluate the impact of LULC changes on atmospheric CO_2 and CH_4 emissions at the suburban site of India. The continuous measurements of atmospheric CO_2 and CH_4 concentration were collected using high precision Greenhouse Gas analyzer during the period 2013-2022 were used in this study. Diurnal and seasonal variation of atmospheric CO_2 and CH_4 were studied. Consistent diurnal and seasonal variation is observed in GHGs at the study site. The results LULC analysis around the study site indicated that built up area and agricultural area were increased from 2005 to 2021 where as other LULC category decreased by 30 % thereby increasing emissions of CO_2 and CH_4 by 6% (26 ppm) and 6.5% (140 ppb) respectively at the study site. Thus, the present study emphasized the changes in land use land cover by utilizing the India's long-term atmospheric CO_2 and CH_4 concentrations from the semi-arid site.

Keywords: Land Use Land Cover, Atmospheric CO_2, Atmospheric CH_4, Seasonal Variability

USE OF MANGO LIBRARIES FOR HYPERPARAMETER TUNING OF ARIMA IN MODELLING OF NDVI TIME SERIES

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Abstract

Predicting agricultural outcomes helps farmers and stakeholders make better decisions for improved productivity and resource management. Remotely sensed vegetation indices, such as the Normalized Difference Vegetation Index (NDVI), are widely used to detect greening and browning trends, especially in time-series analysis. NDVI time series analysis is computed over a period to understand the vegetation pattern. Jalandhar District was identified as the study area where the derived NDVI product MOD13Q1.061 Terra vegetation dataset (16-day composite) was used for the analysis of the period from 2018 to April 2020. In this study, the NDVI time series was forecasted with greater accuracy using a Machine Learning Model. The Auto-Regressive Integrated Moving Average model was chosen to forecast the time series data with the input values of Autocorrelation and Partial autocorrelation functions. The process of determining the optimal values for the hyper parameters of a machine learning model involves finding the parameters that govern the learning process of the model. These hyper parameters are typically not learned from the data. Further, Auto ARIMA and Bayesian optimization algorithm using Mango Libraries techniques were used to automate the hyper parameter tuning. The study reveals that Mango offers a promising approach for automating the hyper parameter tuning process of machine learning classifiers. This is particularly beneficial for users seeking to streamline the hyper parameter tuning process. Additionally, the study successfully employed Mango to forecast the time series data. NDVI time series forecasting is a valuable tool that can be used to better understand the environment and make more informed decisions about its management.

Keywords: ARIMA, Bayesian Optimization, Mango Libraries

STATISTICAL ASSESSMENT OF METEOROLOGICAL DROUGHT INDICES IN SAURASHTRA REGION, GUJARAT

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Abstract

Drought stands out among natural disasters due to its exceptional significance, characterized by its intensity, duration, areal extent, economic damages, and lasting impacts when compared to other events. Several indices are developed to monitor and quantify the severity of drought. Saurashtra is prone to drought events owing to its arid and semi-arid climate. The rainfall distribution has exhibited marked disparities and irregularities. The annual dry seasons in the region substantially elevate the likelihood of drought occurrence. The Standardized Precipitation Index (SPI) and Standardized Precipitation Evapotranspiration Index (SPEI) were employed to assess drought conditions spanning the period from 1961 to 2020, utilizing the WorldClim dataset with a spatial resolution of 10' x 10'. Both indices are capable of identifying an intensification in the severity of drought due to reduced precipitation. The analysis includes assessments at different timescales, including 3, 6, 9, 12, 18, and 24 months. The calculation of PET (Potential Evapotranspiration) employed the Hargreaves equation, which utilizes the monthly difference of Tmax and Tmin to estimate net radiation. The study utilized the Pearson Correlation Coefficient and Simple Linear Regression to assess the associations between SPI and SPEI. Strong Correlations were observed at all the timescales, with the highest and lowest R^2 found at 12 (0.9762) and 3 (0.5842) months, respectively. In addition, this study employs Innovative Trend Analysis (ITA) to evaluate the trends, revealing an upward trend across all timescales except for the SPEI 3, which exhibits a declining trend. The study outcomes will help identify the futuristic strategies for drought mitigation and climate change adaptation with simple and reliable analysis, especially under limited data availability.

Keywords: Meteorological Drought Indices, SPI, SPEI, PET, and ITA

CHARACTERISATION OF OUTDOOR THERMAL COMFORT IN URBAN ENVIRONS – A CASE STUDY OF HYDERABAD

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Abstract

Urbanisation, its unprecedented population growth and drastic anthropogenic transformations are the major concerns which hold on to the metropolitan cities. These permutations cause ecological imbalance by proliferating the intensity of Land Surface Temperature (LST) which eventually contributes Urban Heat Island (UHI). This serves as a fulcrum for deteriorating the well-being of the denizens. The current study revolves around the living conditions and comfortability level of the people of Hyderabad. The study depends only on the outdoor parameters and investigates the effect of LST and land cover, especially water, vegetation, impervious and barren compositions located at different elevations, on thermal comfort. This study is carried out for the summer season (March) in as temporally for two decades (2001 -21) and spatially for the year of 2021. Temporal analysis with the inputs of Land Use Land Cover (LULC), LST and elevations depicts the trends of variations of the parameters. Spatial analysis with the inputs of Air Temperature (T_a) and Relative Humidity (RH) from Automated Weather Stations (AWS) along with the LULC, LST and elevation. The values of T_a and RH are utilised for the formulation of Discomfort Index (DI), which serves as proxy parameter for OTC. A formula is enforced for the computation of DI, which is about to act as the dependent variable in the regression analysis. The relationship is modelled using Support Vector Regression (SVR) between the independent parameters (LULC, elevation, LST) and the dependent parameter (DI) by considering a large number of samples spread across the study area. The analysis makes it evident that it is significantly correlated on the positive side with the impervious area but negatively correlated with water bodies and vegetation. Therefore, the study is very benevolent for the planners and policymakers to plan for a sustainable urban development that minimizes the loss of water bodies.

Keywords: Land Use Land Cover (LULC), Urban Heat Islands (UHI), Automated Weather Stations (AWS), Discomfort Index (DI), Support Vector Regression (SVR)

DEFORMATION MAPPING IN JOSHIMATH: A COMPARATIVE STUDY OF INSAR TIME SERIES ANALYSIS WITH LICSBAS, OPENSARLAB, AND STAMPS

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Abstract

Landslides commonly occur in regions characterized by steep topography, loose soil, and a combination of factors contributing to instability. The town of Joshimath, situated in the Chamoli district of Uttarakhand, India, has been facing the persistent natural hazard of landslides. Leveraging Sentinel-1 data for both ascending and descending passes, Synthetic Aperture Radar (SAR) methodologies, including Differential Interferometric SAR (DInSAR), Persistent Scatterer Interferometric SAR (PSInSAR), and Small Baseline Subset (SBAS), are being employed to map and monitor this land subsidence. In this study, open-source software tools such as ESA-SNAP, StaMPS, LiCSBAS, and OpenSARLab have been considered for both short-term (12-day) and long-term deformation analysis (January 2020 to April 2023), occurring in the Joshimath region. Distinct methodologies have been employed within LiCSBAS, OpenSARLab, and StaMPS to tackle atmospheric phase delays. These methodologies involve the application of GACOS, ERA5 datasets, and a linear tropospheric correction method, respectively. To illustrate the temporal evolution of displacement between January 2020 and April 2023, we selected four specific points within the study area and compared the results of SBAS and PSInSAR techniques. Ascending pass indicates displacement rates of 8 to 18 cm/yr, whereas descending pass shows 1 to 6 cm/yr displacement rates. The difference in the results between the ascending and descending passes could be attributed to variations in viewing angle, satellite pass, and data acquisition times. The LiCSBAS and StaMPS results indicate a linear displacement rate, whereas the OpenSARLab SBAS gives a non-linear displacement rate with a rapid increase in displacement after January 2022. This observation has occurred due to the various implementations of SBAS technique. Also, the 3D displacement maps reveal eastward and downward movement with a mean velocity of 40 cm/yr over the Joshimath area.

Keywords: Joshimath, Landslide, Cloud-Computing, Analysis-Ready Data, SBAS

SOCIO-ECONOMIC VULNERABILITY: AN INTEGRATED APPROACH TO DROUGHT MANAGEMENT

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Abstract

The Marathwada region of Maharashtra is one of the most drought-prone regions of India. The majority of the population in the district (82%) is dependent on rain-fed agriculture. The failure of monsoon in these regions results in severe drought-like conditions leading to direct-indirect impacts on the socio-economic life of the population. The current study focuses on recurring droughts and weather anomalies, particularly rainfall, in the Beed district of Maharashtra. Beed district has experienced extreme socio-economic vulnerability to drought, requiring urgent attention to drought management practices. In the first part of this study, a Combined Drought Socio-Economic Vulnerability Index was developed by combining nine physical, meteorological, and socio-economic parameters. The parameters were assigned weights according to their influence on socio-economic vulnerability. In the second part of this study, an attempt was made to understand the drought pattern and characterization based on weather anomalies, particularly rainfall. The mean monthly rainfall data for twelve years (2010-2021) for the months of May to September, for both drought and non-drought/ normal years, was used to construct a rainfall deficit map. Four ranks (low, moderate, high, and very high) were assigned to the villages to classify them into moderate to high vulnerability drought categories. Results from the Combined Socio-Economic Vulnerability Index generated a Drought Socio- Economic Vulnerability map at the village level in Beed district. Results from the rainfall anomaly analysis showed that the Beed district faces 27% to 47% rainfall zonal village-wise deficiency indicating moderate drought conditions. Thus, using the Combined Socio-Economic Vulnerability Index and Rainfall Anomaly Analysis in conjunction can provide a better assessment of socio-economic vulnerability to drought, thus increasing the efficacy of drought management practices in the Beed district of Marathwada region of Maharashtra.

Keywords: Drought, Drought Management, Marathwada, Vulnerability Assessment, Socio-Economic Vulnerability, Rainfall Deficiency

SOLAR INSOLATION FORECASTING USING SATELLITE DERIVED PRODUCT AND PYRANOMETER DATA

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Abstract

Due to the depletion of fossil fuel resources and their adverse effects on the climate, demand for renewable energy resources like solar for electricity generation is increasing. Solar technologies use photovoltaic (PV) panels to convert sunlight into electricity. As solar energy is a highly fluctuating energy source, forecasting the solar insolation is required to maintain the demand for and supply of electricity in the energy market. To cater to this requirement, a deep learning based solar insolation forecasting model is developed to forecast every half hour solar insolation for the next 48 hours using the past seven days INSAT-3D derived solar insolation at the location of the Space Applications Centre (SAC), ISRO, Ahmedabad location with coordinates of 72.455, 23.041 degrees. The state of the art Long Short Term Memory (LSTM) based model is developed for this purpose. The LSTM model learns a function that maps a sequence of past observations as input to an output value. The solar insolation product estimated from INSAT-3D for the data period of 2016 to 2022 is used. Validation of the developed model is done for the winter, pre-monsoon, monsoon, and post-monsoon seasons using data obtained from pyranometer instrument installed at the same location and achieved coefficient of determination (R^2) of 0.88, 0.97, 0.66 and 0.95 respectively. The model is operationalized under New and Renewable Energy Applications in the VEDAS portal (https://vedas.sac.gov.in). This model can be further enhanced and deployed for solar insolation forecasting at various NIWE SRRA stations.

Keywords: Solar Insolation, Time Series, Deep Learning, LSTM, Satellite data, VEDAS

AN INDIAN LAND DATA ASSIMILATION SYSTEM (ILDAS) FOR IDENTIFYING HYDROLOGIC EXTREMES

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Abstract

Effective management of water resources requires reliable estimates of land surface states and fluxes, including water balance components. But most land surface models run in uncoupled mode and do not produce river discharge at catchment scales to be useful for water resources management applications. Such integrated systems are also rare over India where hydrometeorological extremes have wreaked havoc on the economy and people. So, an Indian Land Data Assimilation System (ILDAS) with a coupled land surface and a hydrodynamic model has been developed and driven by multiple meteorological forcings (0.1°, daily) to estimate land surface states, channel discharge, and floodplain inundation. ILDAS benefits from an integrated framework as well as the largest suite of observation records collected over India and has been used to produce a reanalysis product for 1981-2021 using four forcing datasets, namely, Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2), Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS), ECMWF's ERA-5, and Indian Meteorological Department (IMD) gridded precipitation. We assessed the uncertainty and bias in these precipitation datasets and validated all major components of the terrestrial water balance, i.e., surface runoff, soil moisture, terrestrial water storage anomalies, evapotranspiration, and streamflow, against a combination of satellite and in situ observation datasets. Our assessment shows that ILDAS can represent the hydrological processes reasonably well over the Indian landmass with IMD precipitation showing the best relative performance. Evaluation against ESA-CCI soil moisture shows that MERRA-2 based estimates outperform the others, whereas ERA-5 performs best in simulating evapotranspiration when evaluated against MODIS ET. Evaluations against observed records show that CHIRPS- based estimates have the highest performance in reconstructing surface runoff and streamflow. Once operational, this system will be useful for supporting transboundary water management decision making in the region.

Keywords: Land Data Assimilation System (ILDAS), Hydrodynamic Modeling, Terrestrial Water Balance, Transboundary Water Management

TIME SERIES ANALYSIS OF AMERY ICE SHELF USING SPACE BORNE MICROWAVE PLATFORM BY INVOKING SEMANTIC SEGMENTATION TECHNIQUES AND ARIMA MODEL

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Abstract

Amery Ice Shelf (AIS) is one of the largest glacier drainage basins in the world. Forecasting the expansion or shrinkage rate helps in understanding the ocean and atmospheric dynamic in a efficient way. Intensive surface snowmelt could accelerate ice loss and endanger the ice shelves under climate warming. Availability of many space borne sensors with high temporal resolution like Scatterometer eg. Scatsat-1, EOS-6 Scatsat etc., Radiometers, Synthetic Aperture Radar eg. EOS-04, Sentinel-1, Novasar etc., improves the scope for continuous and efficient monitoring of the AIS. But handling the large volumes of data samples always demands automatic methods to exploit best out of the availability data, and analyse the temporal variations for a large period. In our analysis, SAR data is processed with the help of Deep Learning techniques for the efficient extraction, interpretation and analysis of feature changes. In this study, datasets from 2018 to 2022 is used to analyse the temporal and spatial variability of AIS. The shelf extents are extracted from the microwave data by Segmentation Segmentation with the help of Pytorch. Several flow chains were attempted like ResNet, SegNet, PSPNet, EfficienNET, but a two-stage bayesian U-NET model performed bestresults in segmenting ice from sea. The predictions generated by the algorithm performed with around 87% accuracy with Intersection-Over-Union (IOU) of 0.78. These results are then used to generate subsets of the shelf extents. These subsets then allow us to generate shapefiles of shelf fronts and thus creating time series data to monitor seasonal ice shelf front fluctuations. To forecast the seasonal change patterns of the ice shelf, we trained several state-of-the-art forecasting models like LSTM, LightBGM, ARIMA on the shelf front shapefiles gathered from 2018 to 2022 and testing on the latest 2023 dataset. Among all, the seasonal ARIMA model outperformed others where the fitted data overlaps within 94% confidence band, which proves the performance and effectiveness of the model.

Keywords: SAR, Sentinel-1, Deep Learning, Pytorch, UNET, ARIMA, Time-Series-Analysis

CHRONICLES OF CHANGE: TIME SERIES EXPLORATION OF GUJARAT'S TREE SPECIES PHENOLOGY WITH PHENOCAM AND REMOTE SENSING

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Abstract

Time series data applications have become pivotal in ecological research, offering a dynamiclens into the temporal evolution of natural systems. PhenoCam, adept at capturing RGB and NIR imagery, have played a vital role for over a decade in estimating phenological matrices, specifically the Start (SOS) and End (EOS) of the growing season. In this study, we leveraged the power of time series analysis, seamlessly integrating PhenoCam and remote sensing data, especially Landsat and MODIS, to explore the temporal intricacies of Gujarat's tree species phenology. Our findings demonstrated the remarkable accuracy of our time series analysis, as we modelled the SOS compared to in-situ observations, courtesy of the scaled Phenocam NDVI data. Conversely, the strategic use of gap-filled Landsat and MODIS datasets, in tandem with both GCC and NDVI vegetation indices, enriched our insights with an estimated SOS duration, exceeding in-situ observations by approximately one week. These results highlight the immense potential of time series analysis in ecological research, enabling us to unravel the temporal dynamics of vegetation phenology with unprecedented precision. Our findings not only advance our understanding of vegetation phenology but also provide strategic insights for informed conservation practices and sustainable land management strategies. Furthermore, our findings suggest that tree species in Gujarat are very sensitive to changes in springtime temperature. This is a significant concern, as springtime temperatures in Gujarat are projected to increase in the coming decades due to climate change. Long-term monitoring of tree species phenology using PhenoCam imagery and other remote sensing tools is imperative to disentangle the complex interactions between climate change and vegetation phenodynamics. This information can inform the development of evidence-based climate change adaptation strategies to protect Gujarat's vital tree species and ecosystems.

Keywords: Time series data analysis, PhenoCam imagery, Vegetation phenology, Remote sensing data integration, Climate change impacts

MANGROVE EXTENT CHARACTERIZATION USING SENTINEL-1 AND SENTINEL-2 SATELLITE IMAGERY IN GOOGLE EARTH ENGINE: LEVERAGING THE ADVANTAGES OF BOTH SENSORS

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Abstract

Mangrove ecosystems play a critical role in coastal regions by providing various ecological services, including carbon sequestration, habitat for diverse wildlife, and protection against coastal erosion. Monitoring and characterizing mangrove extent are essential for understanding their health and the impact of environmental changes. The synergy of Sentinel-1 and Sentinel-2 satellite imagery, coupled with Google Earth Engine (GEE), offers a powerful and cost-effective approach to map and assess mangrove ecosystems. This study explores the advantages of these satellite missions and outlines the methodology for mangrove extent characterization. The combination of Sentinel-1 (SAR) and Sentinel-2 (optical) satellite imagery combines the strengths of the two sensors to provide valuable insights. Sentinel-1 is suitable for all-weather cloud-penetrating applications, while Sentinel-2 provides high-resolution optical data for detailed analysis. Fusing Sentinel-1 and Sentinel-2 data provides a comprehensive view of the study area, taking advantage of both radar and optical information. Google Earth Engine (GEE) offers various tools and capabilities for fusing Sentinel-1 and Sentinel-2 data, thereby combining the strengths of both sensors to create a single, comprehensive dataset for accurately characterizing mangrove extents and performing analysis. This along with Machine learning algorithms in GEE is trained to discriminate between mangrove and non-mangrove areas, facilitating change detection, and environmental monitoring. The workflow involves data acquisition, preprocessing, cloud masking (using QA60 band), data fusion, classification (employing a Random Forest classifier), and change detection to create monthly composite datasets for the year round time-series analysis of mangrove extents, irrespective of seasons and cloud cover. Using Sentinel-1 and Sentinel-2 satellite imagery in Google Earth Engine was found to provide an efficient, scalable method for determining mangrove characterization. The fusion increases the classification accuracy, and the year-round mangrove change detection provides valuable insights into mangrove dynamics. This approach ensures that changes are consistently monitored, allowing for more accurate assessments of mangrove health and trends, thus aiding sustainable management in coastal regions.

Keywords: Mangrove Mapping, Google Earth Engine, Sentinel-1 & 2, SAR Data, Optical Data, Supervised Classification, Change Detection, Coastal Ecosystems

SUB THEME -6: SMART GEOSPATIAL GOVERNANCE

INDICES –BASED MONITORING/ IMPACT ASSESSMENT OF MGNREGA (DROUGHTPROOFING) ASSET THROUGH SENTINEL-2 AND LANDSAT-7 DATA IN TELANGANA STATE, INDIA

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Abstract

Drought-proofing activities are integral components of Natural Resources Management (NRM) assets, an initiative implemented under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) by the Ministry of Rural Development, Government of India. The primary objective of this scheme is to ensure livelihood security for rural households by guaranteeing 100 days of wage employment in a financial year to adult members of registered households. The present study area in Telangana State is a leading creator of drought-proofing assets (NRM) in India under MGNREGA activities. These assets include afforestation, plantation, road/canal-side plantation, and more. Drought-proofing plantations employ various practices, such as selecting drought-resistant plant species, efficient irrigation systems, mulching, soil improvement, and companion planting. These techniques help conserve soil moisture, enhance root health, reduce water stress on crops during dry spells, and mitigate the impact of water scarcity. Ultimately, these measures secure agricultural productivity and promote ecosystem health, especially in the face of changing climate conditions. Monitoring and evaluating MGNREGA assets (NRM) using temporal remote sensing data involve the regular collection and analysis of satellite imagery over time. This data offers valuable insights into vegetation health, soil moisture levels, and plantation conditions. By tracking changes in vegetation indices and soil moisture content, land managers can identify early signs of drought stress and assess the effectiveness of drought mitigation measures. Timely responses to such data enable proactive adjustments in irrigation, soil management, and other practices, ensuring the long-term resilience and sustainability of plantations in water-scarce regions. Remote sensing technology supports informed decision-making and the optimization of drought-resistant strategies.

Key words: MGNREGA, Temporal Satellite Data, Indices Analysis, Monitoring, Natural Resources Management

GEOSPATIAL DATA ANALYSIS USING FUZZY ANALYTICAL HIERARCHY PROCESS FOR VILLAGE LEVEL GROUNDWATER SOURCE AND SUSTAINABILITY PLANNING IN DECCAN BASALTIC PROVINCE

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Abstract

Ever increasing dependence on groundwater has resulted in indiscriminate extraction without proper emphasis on aquifer potential and other geo-environmental factors. Delineation of groundwater potential zone (GWPZ) is fundamental to achieving sustainable development/management of groundwater resources. Conceptually, GWPZ is a very complex phenomenon, it varies both spatially and temporally due to the complex nature of basaltic aquifers and associated geo-environmental variables. GWPZ is an integrated effect of hydrogeological surface and sub-surface variables. Therefore, understanding the aquifer extension, flow pattern, and different flow layer formation are crucial. The hybrid approach of geospatial data analysis using fuzzy analytical hierarchy process (FAHP) at village/micro level using very high-resolution satellite imagery and improved ground interval field observations is a very potent application that can effectively delineate GWPZ. This Hybridization can solve complex groundwater-related problems of an interdisciplinary nature in a more object-oriented manner. The present research is carried out with an aim to evaluate the applicability of this hybrid method towards groundwater sustainability at the micro/ village level in the semi-arid basaltic terrain of Deccan Trap in Narkhed of Nagpur-Maharashtra. Hydrogeological and geo-environmental variables such as, geomorphology, lineament density (LD), lithology, landuse, groundwater irrigated area, slope, soil texture, topographical wetness index (TWI), drainage density (DD), and rainfall are used as controlling thematic variables. The derived result classified the study area into different distinct GWPZ, of which around ~5 % of the study area falls under very good GWPZ. Therefore, these precious natural resources should be preserved in a sustainable manner. Research authenticity is carried out by comparing well-yield data with GWPZ. Critical parameter overall quality percentage value demonstrated very good prediction accuracy (~83%). Further, the methodology and results will be crucial guidelines for groundwater resources sustainability management and planning for the policy makers for multipurpose use.

Keywords: Groundwater, Sustainability Planning, Deccan Basaltic Province, Geospatial Data Analysis, Fuzzy Analytical Hierarchy Process, Village/Micro Level

SEMANTICALLY ENRICHED GEOSPATIAL WEB SERVICE: RDF, ONTOLOGY AND GEOSPARQL

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Abstract

This study addresses the challenge of handling spatial data efficiently. It begins with the conversion of various forms of spatial data into RDF format, enhancing its semantic representation. The RDF data is stored in a database, allowing for streamlined retrieval and GeoSPARQL-based spatial queries. An ontology is developed to represent the data semantics. Open source web-based visualization tools developed which enable users to visualize the data graphically. The study delivers an intuitive web interface and informative web maps, significantly improving spatial data management and analysis. The significance of study lies in its use of RDF (Resource Description Framework), GeoSPARQL, and ontology, which profoundly impacts spatial data utilization. RDF enables smarter data representation, fostering seamless integration of information. Altogether, these developed tools enhance spatial data utilization, making it more understandable and insightful. The study streamlines data integration and retrieval, ultimately improving ability to study spatial data utilized/generated for natural resources and weather services.

Keywords: Geosparql, RDF, Spatial Data, Web Semantics, Ontology

ASSESSMENT OF LEARNING PEDAGOGY IN GEOSPATIAL TECHNOLOGY AND SPATIAL INFORMATION SCIENCE EDUCATION

Anjana Narendrabhai Vyas

Abstract

This article represents the result of a short-term research carried out to benchmark the present practices on a global scenario on geospatial education and capacity building. The research aimed to analyse the methods of assessment and evaluation systems used for performance measurement; develop a specific robust technique for assessment of the geospatial technology education and provides the corrective measures to the user of the technique, and derive a guideline to ensure significant improvements in course content, structure and teaching methodology. It elaborates over pedagogy used for teaching and training of Geo-Informatics. Through the various survey analyses, the major outcome for the study that has been acknowledged the importance of the geospatial education world-wide, influence in the various other fields of education, importance of relation of the study vs placement of the student and its career in this field is majorly discussed. Along with literature review on important choice of the parameters used for the study, AHP model has been used for scrutinising the statistical approach and to know the actual values and significance of each parameter used for analysis of the study. Furthermore, application of statistical data has been carried out, the robust technique has been derived for assessing the course. ANFIS architecture (Artificial Neural Fuzzy-Inference System) was used for derivation of general guidelines for improving the course structure, course content and teaching methodology. Summerizing, this research has brought out the importance of the geospatial education and capacity building is very much required for respective stakeholders: the corporate world, government sector, NGOs, academia and research to fulfil the “Global Vision for Local Action”.

Keywords: Geospatial education, Assessment methods, Pedagogy in Geo-Informatics, AHP model, ANFIS

GEOSPATIAL ANALYSIS FOR ESTIMATING EARLY NEONATAL, POST NEO NATAL AND INFANT MORTALITY THROUGH CHILD BIRTH AND INFANT DEATH TRACKING SYSTEM

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Abstract

Infant mortality estimates are regularly calculated at the national and state level. However, doing it at the district and sub-district level is a big challenge. At the same time, it is one of the most important issues that need to be investigated. The key findings highlight early neonatal, post neonatal and infant mortality estimates in the study area.
The steps were as follows:

1. Notification of birth and infant death by ANM/ASHA/AWW.
2. Information communicated by the front-line health worker to the field team through phone, at the earliest (24 hours in case of child birth and 3 days in case of infant deaths).
3. The field investigator collected the geotagged information in the mobile application developed for the purpose on a daily basis.
4. Data validation and data review (Add demography and compare using GIS based analysis)
5. Midterm data validation exercise - in this exercise, a half-yearly survey was conducted in villages where any infant deaths were recorded during the continuous enumeration procedure earlier.
6. Live births records with the Health Management Information System (HMIS) records for the same period.
7. Live births records with the Civil Registration System (CRS) records for the same period Infant deaths records with the Child Death Review (CDR) records for the same period.

IMR for male was found to be 45.2 and for female 32.5. 19% deaths were due to birth asphyxia, followed by low birth weight (14%) and premature birth (13%). The mortality risk due to congenital malformations accounts significantly was3%, 27%infant deaths reported were caused due to other infection and sepsis, which needs special treatment and attention.2 mothers who lost their infant in the study areas were less than 18 years of age, 15.9% mothers and 11.3 % fathers were found illiterate. In case of schooling, 17.2% mothers passed high school which was more than fathers with 15.2%. 3% deaths were due to lack of proper road connectivity.

Keywords: IMR, CRS, CDR

SYNERGIC USE OF WEB & GIS TECHNOLOGIES FOR MANAGEMENT OF ELECTRICAL TRANSMISSION INFRASTRUCTURE

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Abstract

The electricity transmission network in India, is a high voltage transmission network connecting power generators to the Distribution network. The preparation of geo-spatial data, dissemination of information and products are necessary in building a Web GIS Framework. Importance of Web-GIS is not only to accurately maintain an up-to-date information of the network assets but also in providing meaningful insights of the data by providing results based on various criteria wise selections, dynamic maps creation, analyzing data through Dashboards and various geoprocessing-based outputs. These results along with summarized reports help in management and planning of these infrastructures on a day-to-day basis. Additionally, to improve the visualization, the association between various network elements is essentially brought out in the web portal to make the decisions more relevant and actionable for the users. To further improve the system interoperability, the associated MIS information such as billing, material account, distribution analysis, outage reporting etc. are linked with the GIS which allows simultaneous assessment of technical, financial and environmental factors. Preparation of database adhering to the standards and development of user-friendly web portal for visualization and analytics are some of the important milestones in the endeavor of synergic utilization of web and GIS technologies. The efforts put and portals developed for the states of Maharashtra and Telangana are used effectively by over 10,000 users across the states. Thus, in short, GIS can be used for Energy Audit, Load Management, Network Planning and Analysis; determining the optimum, shortest, and most economic path for transmission lines; forecasting and predicting the amount of power needed in the future, and locating the faults and preventing disasters. The developed Web GIS can be effectively used to enhance the current systems by improving the data visualization, data interoperability and decision support in various management and planning tasks of the network infrastructure.

Keywords: Electrical, Transmission, GIS, Web, Infrastructure

CAPACITY BUILDING THROUGH SPACE SCIENCE AND TECHNOLOGY AWARENESS TRAINING (START) PROGRAM IN RURALVILLAGES THROUGH IIRS ISRO OUTREACH PROGRAM AND ISRS MUMBAI CHAPTER – A DESIGN THINKING APPROACH

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Abstract

After the launch of Chandrayaan 3 and Mangalyaan by Indian Space Research Organization, the importance of space science and its applications across various domains have attracted many young minds through schools, colleges, institutions, and universities across India. As per ISRO outreach survey, many students from rural villages in interior Maharashtra are highly interested in space science and its applications. Very few institutes support rural students to enhance their careers in space science. To overcome this, since July 2017, Pillai HOC College of Engineering and Technology, Maharashtra has played vital role in the field of capacity building through IIRS Outreach program and ISRS Mumbai Chapter activities. To date as per records this single institute has conducted 120+ courses and 16000+ students, teachers, and research scholars have registered. The objective of this paper states that by IIRS Outreach and NEP 2020, PHCET is bringing in change in rural areas by inspiring rural students to inculcate space science. In this regard, ISRO START program was initiated and got positive registration by many rural students wherein they understood space science in 360 degrees taught by ISRO scientists. The significance of this START course was to make the participants attend the online lectures from institute and interact with other students and clear their doubts after every lecture. Class assignments and tutorials enhanced their skills. It was seen that all the students cleared the final online exam which was conducted online with restricted time and negative marking. PHCET's Outreach Centre is bringing all these students together to work on space projects and motivate them to join internships at ISRO and inspire students to work on space startups and research. To summarise, Institutes like PHCET are working towards capacity building in line with ISRO mission and vision for the scientific development of our country and humanity.

Keywords: Capacity Building, IIRS ISRO Outreach Program, Indian Society of Remote Sensing, Rural Education, Space Science

SPATIAL DATA CLUSTERING FOR WATER ALLOCATION AND DEMAND ASSESSMENT: A CASE STUDY OF MSTG-RIVER INTERLINKING CANAL COMMAND AREA

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Abstract

Effective water resource management is a critical challenge in regions where water scarcity is a pressing issue. The Manas-Sankosh-Teesta-Ganga (MSTG) rivers interlinking canal command area in India presents a complex ecosystem with diverse water demands, making it essential to allocate water resources efficiently. This study focuses on taluk-wise spatial data clustering to optimize water allocation by considering population, agricultural, and industrial water demands. The primary objective of this study is to investigate the geographical clustering of water demand inside the MSTG-command area region using Moran's I index and Spatial- Autocorrelation (SA) techniques, which is commonly used to investigate spatial patterns of how closely a variable's value at one place relates to the same kind of value at neighbouring locations and provides a quantitative indicator that evaluates the spatial relationship such as clustered, dispersed, or random distribution among the samples. We methodically studied the numerous aspects of water demand, including the urban and rural domestic water demands, agricultural-irrigation requirements, and industrial water usage. This technique enables us to discover intricate patterns of water demand distribution, allowing us to make informed decision making. We developed a comprehensive framework using GIS methods that not only visualises but also systematically clusters water demand, exposing locations with different water consumption characteristics. Such insights help stakeholders and policymakers to build customised plans for optimising water management, allowing decision-makers to identify areas with critical water needs and effectively allocate resources.

Keywords: Spatial-Autocorrelation, Moran's I, Water Demand, MSTG

AUTOMATIC MULTI-SCALE SEGMENTATION OF BRICK KILNS USING YOLOV7 FROM EO DATA FOR INVENTORY CREATION

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Abstract

The Indo-Gangetic Plains, a region spanning across the northern part of Indian subcontinent are home to a burgeoning brick kiln industry that plays a pivotal role in the construction sector. The proliferation of brick kilns poses significant environmental and socio- economic challenges. Identifying and monitoring of these brick kilns becomes crucial in the context of sustainable land use planning, environmental conservation, and labor welfare. The study employs the use of state-of-the-art deep convolution neural network, You-Only-Look-Once version 7 (YOLOv7) to accurately delineate brick kilns from its dynamic surroundings. The single staged YOLOv7 uses Extended Efficient Layer Aggregation Network (E-ELAN) as the backbone structure to improve the learning capability of model by utilizing group convolution for object localization. Multi-scale resolution imagery provides a comprehensive view of brick kilns and supports regional and national-level planning by providing an overview of the distribution and density of kilns. The study utilizes datasets of varying resolution including Sentinel-2 (10 meter), PlanetScope-DOVE (3 meter) and Cartosat-3 MX (1.12 meter). The single staged YOLOv7 achieved an average precision of 0.94, 0.87 and 0.85 and F1-score of 0.912, 0.717 and 0.654 on Cartosat-3, PlanetScope and Sentinel-2 respectively. The high segmentation precision rate observed on the Carstosat-3 dataset can be accounted for its higher resolution and clarity in spatial and textural characteristics. The study further proposes creation of brick kiln inventory derived from the optimum segmentation results. Effective brick kiln inventory is crucial for complying with legal and environmental regulations including planning and optimizing resources and ensuring compliance with government requirements. The inventory helps authorities to identify suitable areas for kiln operations, plan for infrastructure development, and ensure sustainable resource management.

Keywords: Deep Learning, Brick Kilns, YOLOv7, Segmentation, Inventory

FUSION OF MULTI-SPECTRAL SATELLITE DATA WITH STATISTICAL TECHNIQUES FOR ESTIMATION OF SOIL NUTRIENTS

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Abstract

Accurate assessment of soil nutrient levels is pivotal for effective agricultural management and enhanced crop productivity. Traditional soil analysis methods are time-consuming and expensive, demanding extensive fieldwork and lab testing. This study targets the anticipation of nitrogen (N), phosphorus (P), and potassium (K) levels in the soil of Latur Taluka, Maharashtra, India. Leveraging remote sensing data from the Sentinel-2A satellite mission, captured in May, Vegetation, Soil and Water indices serve as proxies for soil quality, nutrient availability, and vegetation health, making them valuable markers for forecasting NPK levels. In May 2022, soil sampling established links between indices and NPK nutrient concentrations through analysis. To ensure consistency, the all indices underwent data normalization. A multi-linear regression model was then crafted, connecting normalized indices with NPK measurements. The evaluation of machine learning models using R2 and RMSE metrics occurred through cross-validation. The study's significance lies in its capacity to advance agricultural practices and nutrient optimization. This study enriches soil nutrient estimation, facilitating informed choices and sustainable agricultural practices.

Keywords: Soil Nutrient Estimation, Remote Sensing, NPK Levels Forecasting, Multi-Linear Regression Modeling, Agricultural Management Strategies

SUB THEME-7: SPATIAL ECONOMICS AND SUSTAINABILITY

A TWO-DECADE ANALYSIS OF CHANGES IN SUNDARBANS MANGROVES AND RESULTANT LOSSES IN CARBON SEQUESTRATION

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Abstract

Mangroves are one of the critical habitats that are facing unprecedented pressure owing to several causes- anthropogenic and natural, both. Mangroves are known to contribute in 'blue economy' and can sequester significantly higher rates of CO_2 and fix large amount of carbon below the ground. Sundarbans region is the largest contiguous patch of mangroves in the world. This paper presents an analysis of spatio-temporal changes in Sundarbans region in past 2 decades. Majority of spatio-temporal studies ignore the effects of changes on ecosystem. We therefore studied the effects of deforestation on carbon sequestration by the ecosystem. Using Landsat -7 and Sentinel-2 data for year 2001 and 2021 respectively, the study revealed net change of 186 sq km in the Sundarbans region in the two decades. We also studied the scenario across the international border. It was found that majority of the losses (140 sq km) are reported from Bangladesh region. Average annual forest loss rate was also higher in Bangladesh mangroves (6.75 sq km/per year). Annual Modis Gross Primary Productivity (GPP) product was used for assessing temporal changes in carbon sequestration during the 2 decades, using Google Earth Engine (GEE) platform which suggested that there is an overall reduction of 2.33% of GPP in Sundarbans as a result of losses in mangroves. The study thus underscores use of available products through GEE platform for holistic study of spatio-temporal changes in vegetation.

Keywords: Mangroves, Sundarbans, Spatio-Temporal Change, GPP

SUSTAINABLE APPROACH OF ESTIMATION AND MAPPING OF SAFE BEARING CAPACITY OF SOILS IN AN URBAN CITY LIKE MUMBAI BY USING OPEN-SOURCE QUANTUM GIS

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Abstract

Urban infrastructure expansion in megacities like Mumbai necessitates a comprehensive understanding of soil properties, particularly the safe bearing capacity (SBC) of soils, which is crucial for construction and structural integrity. The assessment of SBC in urban environments is paramount for informed decision-making in construction projects, ensuring the safety of structures, and urban planning. The heterogeneous nature of urban soils, often layered with anthropogenic modifications, poses a significant challenge. In the present study, a comprehensive geospatial dataset that includes 1272 borehole records spread over an area of approximately 390 sq.kms of Mumbai city covering 54 locations along with geological information and topographic data were processed and integrated within the QGIS environment. Statistical analysis of the collected data reveals log normal distribution of the spatial data. Standard Penetration Test (SPT-N) values obtained from the borehole investigations were correlated with the angle of friction and the bearing capacity factors were determined. Finally, the safe bearing capacity (SBC) of the soils was determined at different depths by using IS 6403-1981. Ordinary Kriging (OK) was applied to estimate SBC values at unobserved locations, using the spatial statistics toolbox. The semi-variogram model (SVM) was used to analyse the spatial autocorrelation of the SBC data. The cross validation gives RMSE value of 0.42, 0.50 and 0.51 for SBC at 2m, 5m, and 7m depth respectively showing the SVM's accurate predictability. The generated SBC maps can be a valuable and sustainable resource in terms of reduced costs, data reusability, long term monitoring, and improved planning. These maps can be used by planners, engineers, and policy makers, aiding in site selection, foundation design, and risk assessment. Additionally, the map contributes to disaster management and mitigation efforts, as knowledge of soil stability is vital during seismic events and heavy rainfall in Mumbai.

Keywords: Safe Bearing Capacity, Soil Properties, Kriging Interpolation, Quantum GIS, Urban Mumbai, Geostatistics, Spatial Analysis, Infrastructure Planning

ASSESSING ANTHROPOGENIC INFLUENCES ON THE VAMSADHARA RIVER'S MORPHOLOGY NEAR THE BAY OF BENGAL CONFLUENCE: A COMBINED SATELLITE IMAGERY AND FIELD-BASED INVESTIGATION

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Abstract

Globally, the morphology of river confluences experiences substantial alterations due to both natural processes and anthropogenic activities. This study effectively combines satellite imagery and field-based observation to illustrate how anthropogenic activities magnify the effects of natural events on river bank migration. The investigation focuses on the Vamsadhara River in India. The investigation spans the period from 1985 to 2023, employing a comprehensive methodology that integrates field-based observations and remote-sensing techniques utilizing Landsat 5 and Google Earth Pro imagery. A notable feature of this river is its braided form, characterized by two main channels as it approaches the confluence. This morphology is attributed to gentle slopes and reduced stream power, while tidal influences further attenuate river energy, resulting in sediment deposition near the confluence and subsequent channel shifts at the mouth. However, anthropogenic activities play a pivotal role in intensifying these natural dynamics. Following the 2010 flood event, the diversion of the main flow into the other channel, coupled with illicit obstructions introduced into the former main channel around 2012 for fish farming, gradually accelerated the rate of river migration. Commencing in 2015, the introduction of instream fish farming initiated significant disruptions to the river's natural equilibrium. These disruptions, even after government intervention in late 2019, have persisted and resulted in the transformation of the river's configuration. The most notable change is the shift into a single-channel system, wherein sediment accumulation has become pronounced, and the dynamics of the river's slope in the other channel have been altered. The study reveals that bank migration at critical locations accelerates 2 to 2.5 times faster between 2015 and 2023 compared to the period between 1985 and 2014, primarily attributed to instream fish farming. This study will continue to employ HEC-RAS 2D modeling to investigate sediment dynamics near the confluence and propose a semi-natural approach for riverbank protection.

Keywords: River Morphology, River Confluence, Satellite Imagery, Field-Based Observation, Instream Fish Farming

GEOSPATIAL APPROACH FOR LAND USE ASSESSMENT OF WORLD'S PRIMITIVE HILLS RANGE "ARAVALLI" IN CHANGING CLIMATIC SCENARIO

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Abstract

Globally, deforestation is occurring at a faster rate than afforestation, which upsets ecological systems and tries to change the climate. The world is on the cusp of climate change and is currently dealing with several issues, including species extinction, habitat loss, rising temperatures, quickly melting glaciers, species migration, and disruption of the equilibrium between the spheres of the earth. Additionally, migration, shifting of the treeline, changes in water discharge, and climate change have all occurred in the mountainous environment. The hills range also faces threats from alien species attacks, growing urbanization, fluctuating rainfall patterns, industry development, land degradation, and soil deterioration. With enough time, management and ecological and economic balance establish an "eco- sensitive zone" as a buffer zone along the edge of the protected area. One of the oldest hill ranges, "The Aravalli range," which is located in the western section of the Indian continent, has a mountainous hill range forest ecosystem typical of arid climatic conditions. focuses specifically on evaluating the eco- sensitivity of their central region utilizing a geospatial method and the climate; it has an ecotonal region and is home to numerous indigenous species. To date, decadal land use dynamics from 1975 to 2019 have been evaluated, as have spatiotemporal understandings of forest health with respect to climatic conditions between 2000 and 2019, and an explicit assessment of the region's eco-sensitivity using multiple variables under various themes, such as topography, socioeconomics, ecology, geohydrology, and energy. According to the findings, between 1975 and 2019, 3676 km2 and 776.8 km2 (or 4.86% and 1.02%, respectively) were transformed into settlements and barren land, while 5772.7 km2 (7.63%) of Aravalli's forest land has declined. A total of 16360.8 km2 (21.64%) of the forest will be turned into a habitation class by 2059. These subtle human interventions, including mining and settlement, cause ecological imbalances by violating environmental integrity and impeding the advancement of sustainability. Therefore, the changing land uses are very important for eco-sensitivity.

Key words: Eco-Sensitive Zone (ESZ), Deforestation, Aravalli, Climatic Change

EVALUATION OF THE SAARC REGION'S WATER AND CARBON USAGE EFFICIENCY FOR ECOLOGICAL RESILIENCE IN THE FACE OF CLIMATE CHANGE

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Abstract

The assessment report from UNICEF, which was published in 2021, stated that South Asian nations were among the most susceptible in the world to the consequences of climate change on future generations. Therefore, determining the ecosystems' resistance to these changes has become essential. The Combined Ecological Resiliency Indices Approach (CERIA), a unique method for assessing ecological resiliency status at different scales during hydroclimatic disturbances, was included in the current study. Indicators for the analysis of ecological resilience were water and carbon use efficiency (WUE and CUE, respectively). Meteorological drought is an example of the early stage of hydroclimatic disturbances that are measured using the Standardized Precipitation Index (SPI). Based on a resiliency analysis using combined Rd and Rd' indices (derived from WUE and CUE, respectively), it was shown that only 1.87% of the total 17 land cover classes in the SAARC (South Asian Association for Regional Cooperation) region were resistant to drought due to weather. Merely 16.58% of the 62 river basins in total were determined to be robust at the river basin level. On the Koppen climate classification scale, only 11 (27.46%) of the 21 climate classes were able to withstand the hydro-climatic disturbance period. High carbon utilization efficiency is not always correlated with an abundance of water supply. It is recommended to implement optimal techniques for water management and carbon improvement in open shrublands, croplands, and mixed woods. Similarly, the non-resilient classes that need to be addressed in order to improve the resilience of ecosystems include BSh (Arid-Steppe-Hot), BWh (Arid-Desert-Hot), Csa (Temperate-Dry Summer-Hot Summer), Cwa (Temperate-Dry Winter-Hot Summer), and Dwc (Cold-Dry Winter-Hot Summer). The Joint Ecosystem Resiliency Enhancement Programme (JEREP) should be implemented in land cover, river basins, or climatic classes of the SAARC area that were especially vulnerable to natural disasters in order to meet the Sustainable Development Goals (SDGs) of "No Hunger" and "Protect the Planet".

Keywords: Ecological Resilience, Climate Change, Drought, Standard Precipitation Index (SPI)

CHANGES IN OCEAN FLUORESCENCE FOLLOWING THE PASSAGE OF CYCLONE MANDOUS AND DEVELOPING A RELATIONSHIP BETWEEN CHLOROPHYLL CONCENTRATION AND FLUORESCENCE LINE HEIGHT (FLH) IN CYCLONE INDUCED BLOOMS

Debojyoti Ganguly and Mini Raman

Abstract

In this paper the change in chlorophyll concentration and fluorescence line height (FLH) following the passage of tropical cyclone Mandous and Biparjoy has been investigated using Sentinel- 3 Ocean and Land Colour Imager (OLCI) and Ocean Color Monitor (OCM-3) data. A technique was developed for estimating Fluorescence line height (FLH) from Level 2 normalized water leaving radiance (nLw) using the fluorescence peak band and 2 baseline bands on each side of the peak. OLCI daily Level 2 reflectance data from 1 December to 20 December, 2022 were processed for Fluorescence line height (FLH) estimation so as to analyze the pre-cyclone and post cyclone fluorescence. The chlorophyll concentration was also investigated before and after the cyclonic storm. It was observed that chlorophyll concentration increased by up to 10 times after the passage of cyclone Mandous. Before the occurrence of the cyclone Bay of Bengal was oligotrophic with chlorophyll concentration ranging between 0.2-0.5 mg/m^3 which increased to 2-3 mg/m^3 on December 20. Fluorescence line height product computed from normalized water leaving reflectance showed increase in chlorophyll fluorescence beginning from December 12 and continuing up to 20 December. Highly correlated linear relationship was observed between FLH and chlorophyll concentration which was then inverted to retrieve chlorophyll over coastal areas and bloom region. This relationship was then used for estimating the chlorophyll concentration following the passage of cyclone Biparjoy and showed promising results. FLH retrieval algorithm was also developed for OCM-3 satellite and the FLH before and after cyclone Biparjoy was also investigated from OCM-3. A significant increase in FLH was observed from OCM- 3 after the passage of cyclone Biparjoy. This study shows the potential use of FLH for chlorophyll retrieval in case 2 and optically complex waters where conventional chlorophyll retrieval algorithms fail.

Keywords: Fluorescence Line Height, Chlorophyll Concentration, Oligotrophic, OLCI, OCM-3

SPATIO-TEMPORAL SHIFT IN SURFACE URBAN HEAT ISLAND ACROSS MAJOR CITIES IN DIFFERENT AGRO- CLIMATIC REGIONS OF INDIAN PUNJAB

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Abstract

Prolonged exposure to extreme temperatures can increase the risk of temperature-related mortality and morbidity in vulnerable populations. In the absence of a dense network of meteorological stations to measure air temperature, satellite thermal infrared imagery is commonly used to estimate land surface temperature. The integration of locally sourced information coupled with satellite remote sensing can provide an effective way to assess current conditions and to monitor changes over spatio-temporal scale. Many studies have assessed the changes in land surface temperature using the satellite data, but there is no study in which the spatio-temporal shift in urban heat island in different agro-climatic regions of Punjab has been evaluated. The land surface temperature was retrieved for 13 municipal corporations in the five agro-climatic regions of Punjab during summer 1990–2022 at five year intervals from Landsat thermal infrared data using radiative transfer equation. The average land surface temperature in different agro-climatic regions of Punjab was in the order: Western Plain, Arid (1 city 24.40 0c) > Western Plain (1 city 23.86 0c)> Northern Plain, Semi-arid (3 cities 22.98 0c) > Northern Plain, Dry Sub-humid (6 cities 24.710c) > Western Himalayas, Sub-humid (2 cities 23.48 0c). However, the rate of change in land surface temperature over the years was highest in Western Himalayas, Sub-humid region followed by Western Plain and Northern Plain, Dry Sub-humid region. The rate of change of land surface temperature for different cities within an agro- climatic region was not similar. The highest change in Western Himalayas, Sub-humid region may be due to conversion of surrounding forest area to other landuse/landcover features over the years. This implies that cropping pattern soil moisture availability and the other landuse/land cover features in the surrounding areas besides built-up area and population density in a city affect the distribution of land surface temperature and the formation of urban heat island. These results may be helpful for the policy makers for framing policies to mitigate the effects of urban heat island and associated population vulnerabilities.

Keywords: Agro-climatic Region, Landsat, LST, Punjab, Surface Urban Heat Island

ENHANCED VEGETATION SPECIES CLASSIFICATION USING HYBRID GRAM-SCHMIDT FUSION OF HYPERSPECTRAL AND MULTISPECTRAL IMAGE

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Abstract

In the application of forestry, species-level discrimination of vegetation is a challenging task using only its spectral information, it also requires high spatial information to identify different species as well as demarcate the actual areal coverage of that species. However, it is difficult for a single remote sensing sensor to have accurate both spatial as well as spectral information at the same time, therefore, image fusion needs to be applied to improve the quality and utilization of remote sensing image information. Hyperspectral (HS) image has been employed for many studies i. e., mineral exploration, feature level extraction, and vegetation/tree and crop species identification for its broad-spectrum information. Many researchers used close-range hyperspectral, drone hyperspectral technique that is quite expensive, requires a highly efficient operator, and is also not capable of covering large area extinction. This study focuses on the fusion of hyperspectral and high spatial resolution Multispectral (MS) images based on Wavelength matrix elementary transformation. After fusion, the Spectral Angle Mapper multivalue threshold classifier was applied on the GS-fused image as well as on the original hyperspectral 50 bands image to compare the SAM evaluation matrix on both images. The study reveals that the GS-Fused image gives 92.31% overall accuracy over the original low spatial HS image which gives only 50.84% accuracy. The experimental result shows that the fusion of multisensory data enhances spatial and spectral information that can solve complex problems like identifying specific species.

Keywords: Forest species, Remote Sensing, Gram-Schmidt Fusion, SAM Classification

MACHINE LEARNING BASED METHOD FOR PADDY YIELD PREDICTION INTEGRATING WITH REMOTE SENSING AND WEATHER DATA

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Abstract

Machine learning serves as a pivotal decision support tool for predicting crop yields and supporting decisions related to crop selection and management throughout the growing season. Numerous machine learning algorithms have been employed in crop yield prediction research. This particular study emphasis on predicting paddy crop yields through the integration of satellite remote sensing and weather observations. Furthermore, we aimed to evaluate the effectiveness of three distinct machine learning methods in predicting paddy yields. These models were developed using block level paddy yield data of kharif season spanning from 2001 to 2020 and incorporating long-term derived satellite variables, including evapotranspiration (ET), vegetation condition index (VCI) land surface temperature (LST), soil moisture (SM), relative humidity (RH) normalized difference vegetation index (NDVI), and rainfall (RF), surface runoff, elevation. The three machine learning models were assessed for performance using Multiple Linear Regression (MLR), Support Vector Regression (SVR), and Random Forest Regression (RFR). Correlations between these variables and crop yield revealed that the performance of all three models were satisfactory. Furthermore, validation of the predicted yield was carried out using R-squared (R^2), root mean squared error, and mean absolute error through cross-validation techniques. The comparisons of the results show that random forest regression performed better than other methods with 0.82 (R^2), 0.25 (RMSE), 0.22 (MAE). This paper aims to offer a practical approach to assist farmers in addressing crop yield challenges and helping the decision makers for efficient crop management, insurance and mitigation strategies specifically during extreme events.

Keywords: Machine Learning, Paddy Yield Prediction, RFR, Weather Data

GROUNDWATER POTENTIAL ZONE MAPPING USING GEOSPATIAL AND MACHINE LEARNING APPROACH OF PUNE DISTRICT

Adeeba Mumtaz

Abstract

In this study, the influencing aspects of various groundwater prospects in Pune District are taken into account using remote sensing and GIS methodologies. For the purpose of creating the various groundwater potential maps using the frequency ratio (FR) technique, a number of contributing factors, including lithology, geomorphology, slope, soil, lineament density, drainage density, land use, and rainfall, are evaluated individually as well as collectively. All of the thematic layers in the ArcGIS Pro software are created utilising various satellite imageries and traditional data sets that are collected from various sources. Using the FR Technique, all of the maps are converted into a GIS environment with high-definition raster format. With the help of Frequency ratio model, we were able to detect the groundwater potential zones in the study area. Using Random Forest (RF) algorithm a classified map was generated showing the presence and absence of groundwater in the district. An accuracy of 80.311 percent was obtained (Kappa Statistics). With the help of several conditioning factors a dominant factor graph was generated based on the variable importance to show the potential zones. Validation is a crucial part of modelling the significance of the research from a scientific standpoint. The receiver operating characteristic (ROC) curve's area under the curve was used in this study to evaluate the models. The ROC, a graphical depiction, assesses the performance of the models in a diagnostic test. The Y-axis of the curve represents the true- positive rate (sensitivity), and the X-axis represents the false-positive rate (1 - specificity). Model predictions for the presence and non-occurrence of spring and wells were evaluated using the area under the ROC curve. The area under the curve (AUC), which ranges from 0 to 1, is a measure of how well the model is performing; the higher the value, the better. Graph showing the ROC curve for random forest model with AUC value of 82 percent was generated for validation purpose. An Artificial Recharge zone map has been generated with the help of the groundwater potential factors and other parameters.

Keywords: Groundwater potential mapping, Frequency ratio (FR) technique, Remote sensing and GIS methodologies, Random Forest (RF) algorithm, Receiver Operating Characteristic (ROC) curve

SUB THEME-8: GEOINFORMATICS FOR RENEWABLE ENERGY AND RURAL URBAN INFRASTRUCTURE

MONITORING OF IWMP WATERSHED PROJECT USING GEOSPATIAL TECHNIQUE – SAGAR DISTRICT, MADHYA PRADESH

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Abstract

The Integrated Watershed Management Project (IWMP), which concentrates on integrated land, vegetation, and water resource management, is an important initiative aimed at sustainable development in rainfed areas. The project uses Geographic Information System (GIS) methods and satellite technology to efficiently plan, monitor, and evaluate IWMP activities, with the main objective of creating an extensive monitoring system for watershed resource management in the state. The provision of crucial satellite data, GIS platforms, and software tools for planning is one of the project's main goals. It starts by providing all watersheds with baseline satellite images, which makes it easier to create Detailed Project Reports (DPRs) tailored to each watershed. The project incorporates regular satellite images to show temporal changes in these areas and also provides online Monitoring and Evaluation (M&E) for all identified watersheds. Resourcesat2 FMX and Cartosat1 PAN satellite datasets were used in the IWMP project monitoring and evaluation processes. These sharp satellite images make it easier to monitor the changes brought on by the implementation of IWMP and accurately assess its effects. The project further improves its monitoring capabilities by utilizing mobile Smartphone technology to gather Point of Interest (POI) data. The acquisition of micro watershed and project boundaries from pertinent authorities, the preparation of Land Use Land Cover (LULC) maps for project areas, the creation of change area maps and change matrices, and finally the creation of a comprehensive summary report are the key steps in the monitoring and evaluation process.

The study area falls in Sagar district of Madhya Pradesh. The project area is 8981.14 ha. Activities done are trench (02), field bunds (09), farm ponds (03), check dam /stop dam (57), nallah bunds (05) checks & plugs (03) etc. The LULC shows that increase in agriculture, water surface area and decrease in scrubland (based on available satellite data and field survey of this area). The major change is increase in cropland by 275.89 Ha, and waterbodies by 60.73 Ha.

Keywords: IWMP, Satellite Image, Watershed, Geospatial Techniques, GIS

SUSTAINABLE PRODUCTION AND INTEGRATION OF SYNTHETIC FUELS FOR MOBILITY

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Abstract

In today's era a quarter of total global CO_2 emission is caused by transport vehicles, in which passenger vehicles are the largest chunk of this releasing about 45% of CO_2, which can be significantly reduced by using synthetic fuel or Efuels. The aim of this research is to analyze and investigate the manufacturing and infrastructure challenges in the transition from non-renewable to renewable energy resources. Efuel is made by an expensive process which turn electricity into hydrogen which in turn is combined with CO_2 to produce liquid fuel that can be similar to petrol and diesel used in conventional engines. If renewable electricity is used and CO_2 is captured from air, then the e-petrol and e-diesel are climate neutral fuels that will also reduce pollution. Carbon capture and utilization (CCU) techniques, electrolysis-based hydrogen production, and innovative Fischer-Tropsch synthesis methods. These technologies are at the forefront of efforts to minimize carbon emissions. Our research explores factors influencing consumer choices, including cost considerations, environmental concerns, and vehicle compatibility. By examining the motivations and barriers to adopting synthetic fuels, we aim to provide valuable insights into strategies for promoting their acceptance. The result of our research is to provide valuable insights into the viability and sustainability of carbon-neutral synthetic fuels as a means of decarbonizing the transport sector.

Keywords: Efuel, Carbon Capture and Utilization (CCU), Carbon-Neutral Synthetic Fuels, Sustainability

SPATIAL AND TEMPORAL TRENDS OF DOWNWARD SHORTWAVE RADIATION OVER AHMEDABAD CITY, INDIA DURING 2013-2022

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Abstract

There is an intricate relationship between air pollution and Downward Shortwave Radiation (DSR). When aerosol loading is high, it scatters incoming solar radiation, leading to a reduction in DSR. Decreased DSR due to aerosol loading can impact solar energy generation and crop productivity. With this background the present study of assessing the changing DSR using satellite data was planned for Ahmedabad city MoEFCC has identified it as one of the 131 non attainment cities of India witnessing high level of air pollution. In this study, MODIS Terra and Aqua combined DSR data (MCD18A1v061) was considered for a period of one decade (2013-22). The spatial resolution of the dataset was 1 km × 1 km while the temporal resolution was every 3 hours. The annually averaged DSR at all 559 grid points of the study area was then analysed for 'trend' and 'rate of change' using Mann-Kendall Trend Test and Sen's Slope.

The overall estimates of the city reveals that the DSR has been decreasing at the rate of 1.95 W/m^2 per year during 2013-22 at confidence level below 90% (Z_{MK} = -1.61). The spatial analysis reveals that the decreasing trends in 5% and 10% area of the city was significant at 95% and 90% confidence level respectively while the decreasing trend in the remaining 85% was not significant. There was a sharp increase in the annually averaged DSR of 4% in the year 2020 with reference to previous year (2019) which might be because of the COVID-19 lead lockdown that reduced the aerosol loading of the city by 2.8%. The findings of the present study in terms of thematic spatial representation would greatly help the environmental regulators and city's civic body for strengthening their Air Action Plan which would lead to increasing the city's renewable energy generation potential.

Keywords: Ahmedabad, Downward Shortwave Radiation, MODIS, Renewable Energy, Aerosols

IMPACT OF URBAN BUILT UP SPACES ON THE GROWTH OF IMPERVIOUS SURFACE IN PUNE CITY

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Abstract

Urban development has led to increasing concrete built up structures in the city areas giving rise to impervious surfaces. The rapid growth in manufacturing and IT industries has led to increasing population density in the Pune city. The increasing demand for living spaces has changes agricultural land and barren land to extensive residential projects. Present research work is an attempt to bring about the sprawl in built up areas within the city limit. The research work involves collection and processing of satellite images (Landsat TM) for 1991, 2001, 2011 and 2023 as well as preparation of land use/land cover map of Pune municipal corporation. Supervised classification using maximum likelihood classifier was performed to obtain LULC, where accuracy of the classification obtained was quite promising. Built-up area in the city has been steadily rising. In 1992 it was 38.5 % and increased by almost two times 60.4 % in 2017 and almost 73% in 2023. Natural vegetation has decreased from 18% in 1992 to 12.1% in 2001 and has decreased further to 9.7% in 2023. ISA were computed for the entire study region using a regression model. Over the period of 40 years, it was observed that there is considerable amount of increase in the overall spread of impervious area. The overall percent ISA derived ranged from 0 to 70 % in 1991, which were further deteriorated and pushed into the impacted zones and degraded zone. By 2023 it was observed that the ISA had increased considerably and certain areas recorded almost 90% imperviousness in the area. They were in impacted zone in 1991 and appear to have gone into the degraded zone by 2023.

Keywords: Impervious Surface (IS), Land Use/Land Cover (LULC), Builtup (BU), Impervious Surface Area (ISA)

SUB THEME-9: EMERGENCY AND DISASTER MANAGEMENT

MODELLING AND QUANTIFYING THE EXTREME EVENT OF CLOUD BURST BY APPLICATION OF REMOTE SENSING AND GIS

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Abstract

Extreme events have been gradually increasing all across the globe since there is a shift in the behavioural patterns of environment and physical variables. This shift has a cascading effect on all the calamities which are governed by these variables. One of these events is cloud burst which is one of the most severe and devastating occurrences among all. It leads to huge loss of life and economic slowdown with a great hindrance to infrastructure services. Remote sensing and GIS can play a vital role in understanding the behaviour of this event. Through this work, modelling and prediction of extreme event of cloud burst was carried out. This was achieved by retrieval of extreme precipitation using Global Precipitation Measurement (GPM) dataset and quantifying it with variables of cloud, using Moderate Resolution Imaging Spectro-radiometer (MODIS) data, like top and bottom pressures, optical height etc to understand the susceptibility of its burst. This information will be utilized to relocate people and resources for minimum damage and life loss. Hence this work will be of utmost importance in creating real-time inventory of such events and track their presence over time.

Keywords: Cloud Burst, Calamities, MODIS, GPM, GIS, Remote Sensing

TREND ANALYSIS OF SO_2 OVER INDIA USING TROPOMI DATA

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Abstract

According to the report of World Health Organization (WHO) air pollution is a major threat for the human health. The present study will discuss the concentration of SO2 over India and multiple factors impacting SO2 levels using Sentinel 5P Tropomi. Sentinel-5P Tropomi data is available globally, for this study India shapefile is created and uploaded in GEE Assets and geometry is calculated using 'ee.FeatureCollection'.To showcase SO2 variation over India range from 0 to 0.0005 with palette "black, blue, purple, cyan, green, yellow, red" is defined. Visualizing SO2 concentration over India, monthly mean of SO2 is calculated from January to December for 2019 to 2023. Study shows drastic reduction of SO2 especially in hot spot area for April-2020 compared to April 2019 ref to fig 1A and 2A representing the SCCL with 48 mines. The reduction may be due to reduced mining activity due to covid lock down. Reduced urban transport and industrial activity has resulted in decreasing SO2 levels for the Year-2020. Study has observed increase SO2 concentration after year 2020 only over India but also globally. The present study is critically important and will be enhanced by DL based model for future investigations of SO2 and its impact on air quality and human health. Study has clearly stated that Covid lock-down has drastically improved the air quality. Increasing pattern of SO2 levels are seen during winter months (Nov to Jan). SO2 is showing decreasing pattern in 2022 may be due to strict pollution norms like BSIV and BSVI. Study results can be used by the policy makers to study air quality and making pollution free economy.

Keywords: Google Earth Engine (GEE), Bharat Stage Emission Standards 4 (BSVI), Bharat Stage Emission Standards 6 (BSVI), Sulphur Di Oxide (SO2), Tropomi

UNVEILING THE COMPLEXITY OF RELATIVE ACTIVE TECTONICS: A CASE STUDY OF THE MANDAKINI BASIN

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Abstract

In tectonically active regions, assessing seismic hazard risks is crucial. Geomorphic indices help to identify active tectonic, often used to create Relative Active Tectonic (RAT) maps. However, high RAT values do not always signify present active tectonics, and vice versa. This study, centered on the Mandakini basin, addresses this issue succinctly. Utilizing data from the Shuttle Radar Topography Mission (SRTM-30 m), we computed four tectonomorphic parameters- transverse topographic symmetry (T-factor), valley-width to valley-height (Vf-ratio), elongation ratio, and hypsometric integral. The T-factor measures drainage basin asymmetry, Vf-ratio distinguishes between incision-dominated V-shaped and erosion-dominated U-shaped valleys, elongation ratio characterizes watershed shapes transitioning from elongated to circular with decreasing tectonic activity, and hypsometry reflects watershed stages- young, mature, and old. This basin is intersected by thrusts like the Bhilangana thrust, Main Central Thrust (MCT), and Vaikrita thrust. We analyzed ten 3rd order watersheds, categorized as containing faults, epicenters, both and none of them. Watersheds with faults and earthquake epicenters showed high hypsometric values (0.47-0.56), indicative of a young and uplift-dominated stage. In contrast, catchments signifying an older stage dominated by erosion having low (0.36-0.37) hypsometric value does not have fault and epicenter. Elongation ratio revealed that the basin appeared more elongated (0.56-0.66) when a fault intersected the trunk channel; otherwise, it took on an oval or circular shape (0.71-0.86), potentially leading to RAT misinterpretations. Both the T-factor (0.03- 0.80) and Vf-ratio (0.03-1.06) exhibited significant variations, both between and within catchments, illustrating how fault locations influenced channel migration and valley morphology. Notably, very high (0.80) T-factor and low (0.06) Vf-ratio values in non-fault and earthquake regions suggested inactive faults that were once active, now dominated by erosion due to circular basin shapes (elongation ratio- 0.71) and low hypsometric values (0.37). Our study reveals how thrusts and earthquake epicenter locations affects RAT map parameters, offering valuable insights into seismic hazard assessments.

Keywords: Seismic Hazards, Relative Active Tectonic, T-factor, Thrusts, Channel Migration

MULTI-SOURCE ELEVATION EXTRACTION FOR IMPROVED HYDRODYNAMIC MODELING AND FLOOD SIMULATION

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Abstract

Accurate elevation data is crucial for hydrodynamic modeling and flood simulation, enabling precise water flow computation and identification of flood-prone areas. However, traditional hydrodynamic models support the use of only single-source elevation data. This single-source data often has limitations, including errors and incomplete coverage. In flood modeling, it is also important to use high-resolution terrain information to capture accurate hydrodynamics. However, high-resolution elevation data is often unavailable. In such cases, the gaps need to be filled with elevation data from multiple sources. The process involves resampling of elevation data & mosaicking. This is however, a time-consuming & memory-intensive process. Also in case of finer data set, it often fails with memory limitations. This study addresses both these challenges by employing a pre-processing approach using multi- source elevation extraction, that combines data from various sources and resolution to create a comprehensive and reliable representation of surface topography for hydrodynamic modeling. The process involves several key steps starting from collecting DEM data from various sources, creating a mesh file with ANUGA, extracting vertices, and transforming coordinates. It prioritizes elevation data to be used and if inaccurate generates a new one, iteratively improving accuracy with subsequent DEMs. Quality assessment is conducted to identify and correct any inconsistencies during the evaluation phase. Subsequently, the multi-source and resolution elevation data set is utilized in hydrodynamic modeling and flood simulation applications, providing a robust foundation for generating flow direction and accumulation maps, delineating watersheds, estimating drainage networks, and predicting flood-prone areas. Integration of multi-source elevation data improves the accuracy and reliability of hydrodynamic models, overcoming the limitations of individual data sets by comprehensively representing Earth's terrain through various data sources. This approach enhances flood event prediction and subsequent mitigation. It contributes to effective management and supports decision-making processes for flood risk assessment and resilient community planning.

Keywords: DEM, Coordinate Reference System, ANUGA Hydro, Open Source, Hydrodynamic Modelling

INVESTIGATION OF METEOROLOGICAL PROCESSES ASSOCIATED WITH THE INTENSE FOG EPISODE OF 2017 IN THE INDIAN REGION

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Abstract

Northern India experiences intense fog events in the winter season which severely impacts the socio-economic activities. They are hazardous and also a threat to the economy and health. Fog is a manifestation of near-ground level stratus cloud which is triggered by the underlying cold surface temperature, the availability of moisture, and suspensions in the air. These conditions are conducive during the winter season when the cold temperature close to the surface makes the air near the ground supersaturated and hence induces condensation on the suspended particles. Fog can also originate if there exists a moisture influx into an otherwise dry cold region. The atmosphere during the winter is usually stagnant which can minimize dispersal and hence prolong the fog episode. Delhi witnesses an increase in dust and aerosol particle concentration during the post-monsoon season every year when the neighboring states of Haryana and Punjab engage in stubble burning and the country celebrates Diwali. The cumulative effect of combustion particles and moisture can create smog. The Delhi fog event of November 2017 was an exceptionally severe fog event. Marked in the post-monsoon season, the air quality over the capital was declared severe and it provoked unrest among the city dwellers. This study aims to highlight the several meteorological parameters that could have significantly contributed to that event. The Aerosol Optical Depth (AOD), the Land Surface Temperature (LST), the air temperature, air pressure, moisture availability, and the wind intensity over Delhi were studied from 31st October to 15 November 2017. The results will be presented at the conference.

Keywords: Fog, Aerosol Optical Depth (AOD), Land Surface Temperature (LST)

QUANTIFICATION OF RAINFALL FROM BAY OF BENGAL CYCLONES: A GPM DATA ANALYSIS

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Abstract

The Bay of Bengal, known for its vulnerability to tropical cyclones, experiences significant precipitation during cyclone events. Incorporating tropical cyclone-induced precipitation into regional water balance assessments is crucial as it influences both groundwater recharge as well as flood risk mitigation. The advancement of satellite-based remote sensing technology has substantially improved our capacity to quantify the contributions of cyclone-related precipitation. The following study aims to analyze the precipitation contribution of tropical cyclones originating in the Bay of Bengal using Global Precipitation Measurement (GPM) data. The study investigates the spatial and temporal distribution of precipitation owing to tropical cyclones (TCs) over the Bay of Bengal as well as along the Eastern coast of India over a span of 21 years (2020 – 2021). The analysis has been carried out on different temporal scales, encompassing pre-monsoon, post-monsoon, seasonal, and annual variations. Preliminary investigations indicate an evolving trend in the intensity and frequency of tropical cyclones forming over the Bay of Bengal. The precipitation generated during a cyclone event decreases from the Bay of Bengal (15 – 21 mm) inland towards the Eastern Coast (6 – 15mm). Tropical cyclones occurring in the post-monsoon season account for about 6 – 15% of the total precipitation, while those occurring in the pre-monsoon have contributed to 2-6% of the total annual rainfall received by the region. This study will not only pave the way for evaluating the impacts of such contributions to surface and groundwater hydrological processes but will also help in the assessment of the impacts of these systems in altering the regional precipitation patterns observed over the Indian region.

Keywords: Tropical Cyclones, GPM, Precipitation Contribution, Seasonal Variations

AUTOMATIC OIL SPILL DETECTION USING RICIAN ESTIMATE IN SAR IMAGES

Swati Upadhyay

Abstract

Oil spills are posing major threat to the marine environment and coastal ecosystem. Satellite images from the Synthetic Aperture Radar (SAR) sensors have been used widely for oil spill detection due to their capability of all day, all weather imaging and wide area coverage. This paper proposes a novel automatic oil spill detection method in sea on SAR images based on thresholding on Rice factor. Rice distribution is the descriptor of an area where the dominant scatterer is present over incoherent background. It is extremely sensitive to small coherent signal present over a larger incoherent background. This feature is utilized in proposed method to locate the oil spill in sea by using the coherent scattering information received from a smaller foreground over the highly incoherent water background. Ocean appear bright in high resolution SAR images as compared to oil spill areas which appear smooth and dark, because of dampening of gravity capillary waves. Hence oil spill gets easily picked up using this approach over incoherent background. The present work is tested on many datasets acquired from X and C band sensors. Proposed method effectively detect oil spill of varied sizes at different orientations in sea with less false alarm rate and negligible miss rate. The proposed method is very effective in terms of processing time as well.

Keywords: Oil Spill, Coherent, Sensor, Rice Factor, SAR

GIS-BASED ASSESSMENT OF FLOOD-INDUCED ECOLOGICAL VULNERABILITY AND RISK IN FLOOD-PRONE AREAS: A STUDY OF DHEMAJI AND DIBRUGARH DISTRICTS, ASSAM

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Abstract

Disasters brought on by climate change include extreme weather occurrences including storms, droughts, floods, wildfires, and heatwaves that are occurring more frequently and severely. Understanding the possible effects of climate change on ecosystems and biodiversity depends on assessing ecological sensitivity and risk. It entails assessing how vulnerable ecosystems are to climate change, how exposed they are to associated risks, and how adaptable their environment is to these changes. Remote sensing data and GIS techniques are the proven approaches that provide geospatial data to meet the above requirement. Data such as satellite imagery provides information on vegetation cover, topography, and other environmental factors helpful for assessing vulnerability. In the present study, an attempt has been made to evaluate the ecological vulnerability and risk brought on by floods, concentrating on specific site features in Dhemaji and Dibrugarh Districts of Assam, India. The pairwise comparison method of the Analytical Hierarchy Process (AHP) was used to determine the weights for the defining criteria characteristics and creating the vulnerability map. The Disturbance Index, Temperature, Soil Adjusted Vegetation Index (SAVI), Vegetation Type, Biological Diversity, Slope, and Normalized Difference Vegetation Index (NDVI) were studied as significant contributors to increased flood vulnerability. Collectively, these elements affected how susceptible the study area was to flood disasters. According to the findings, a sizable percentage of the two districts showed high flood susceptibility and danger. The extent of flooding was also discovered to be the main factor in the study area's very high flood risk, underscoring its major influence on flood-related dangers. A potential exists for prioritizing areas for ecological restoration and conservation activities based on the examination of these data. Resources and actions can be targeted at places with high vulnerability and risk in order to improve their ecological resilience and reduce the potential effects of floods. The Brahmaputra sub-basin of India can benefit from the restoration and conservation strategies that decision-makers and conservationists can develop with the help of this prioritization strategy.

Keyword: Flood, AHP, Ecology, Environmental Sensitivity, GIS

IMPACT MEASUREMENT ANALYSIS OF CYCLONE SIDR OVER BAY OF BENGAL USING GEOSPATIAL TECHNOLOGIES

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Abstract

The captivating link between fluctuations in sea surface temperature (SST) and cyclone production in the Bay of Bengal has long piqued the interest of scientists and communities alike, as cyclonic events have far-reaching consequences. Leveraging geospatial data, the research involves data collection and analysis to map SST patterns and cyclone occurrences, followed by modeling to simulate cyclone behaviour in response to SST variations. The study assesses the consequences of cyclones on marine ecosystems, including changes in ocean currents and marine life distributions, and also examines their societal impacts, such as damage to coastal communities and economic disruption. This data symphony orchestrates a breathtaking performance, allowing authorities to organize their response with flawless accuracy and time, creating a lifesaving masterpiece while moderating nature's devastating forces. It is a stunning confluence of science and technology, a ballet of elegance and foresight that weaves a tapestry of resilience, protecting towns from the cyclone's stormy grip. The largest mangrove forest in the world, the Sundarbans, which stretches across Bangladesh and India, is routinely hit by cyclones of varied intensities. To determine the total effects of climate variability, cyclones, severe cyclones, storm surge height, and surface water temperature were measured. For performing the variability of cyclones and SST various tools were used like proximity analysis, hotspot analysis, con analysis, storm surge, and NDVI. Cyclone Sidr, a poignant chapter in the Bay of Bengal's meteorological tale, dances inextricably with the caress of sea surface temperatures (SST) and was a testament to the affectionate caress of the Bay's waters. The poetic narrative unfolds as warm ocean waters, their embrace like a nurturing lullaby, give birth to these tempestuous tempos. Their warmth fuels evaporation, the first notes of a symphony, orchestrating the delicate ballet of cyclone inception and intensification. This natural ballet is steeped in grace and fury and with profound implications in a world where the curtains are rising on a changing climate.

Keywords: SST, NDVI, Sundarbans, Cyclone Sidr, Geospatial Technologies

ASSESSMENT OF LIDAR DERIVED DEM FOR FLOOD INUNDATION MAPPING IN KARAMANA BASIN, THIRUVANANTHAPURAM

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Abstract

Urban areas are becoming more susceptible to floods, demanding precise flood models which will help to identify areas at risk and potential flood pathways. Incorporating accurate elevation data is a critical factor in hydraulic models as it forms the foundation for predicting and understanding flood behaviour. This work investigates the potential of high-resolution LiDAR derived DEM (1.0 m resolution) in generating flood inundation maps in the Karamana River basin of Thiruvananthapuram district. The hydrodynamic modelling was carried out using HEC-RAS software which was able to generate flood extent, flood depth and inundation patterns. Results are compared with the flood risk maps generated with global standard elevation models from SRTM (Shuttle Radar Topography) mission and ALOS (Advanced Land Observing Satellite) missions having a resolution of 30 m and 10 m respectively. Results indicate that detailed and accurate DEMs are needed, to represent specific properties that may obstruct and conduct the flow of water in the real world. Inaccurate topographic representation in a small-scale area would affect the simulation results, especially in urban areas; As the spatial resolution of the DEM decreases, the predicted flood inundation area and the maximum inundation depth deviates from the actual for all validated DEMs. This implies that the selection of a coarser DEM may lead to more errors in the inundation results. Nevertheless, the effect of spatial resolution on the difference of inundation results is much smaller compared to the choice of DEM in flooding simulation.

Keywords: High-Density Lidar Data, 2D Modelling, HEC-RAS River Analysis System, Flood Hazard Maps, Karamana Region

QUANTIFYING ROCK GLACIER DISPLACEMENT IN THE JHELUM BASIN, WESTERN HIMALAYA USING SENTINEL-1 SAR INTERFEROMETRY

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Abstract

Global climate change and the associated exponential increase in global temperatures can be observed most acutely in cryosphere processes due to its high sensitivity to changing thermal regimes. Rock glaciers are complex geomorphological formations that have rock debris frozen in interstitial ice and serve as a visual indicator of permafrost presence. Better understanding of rock glacier deformation velocities can lead to further insights about the multitude of process interactions and the resultant chain reactions that emanate as a consequence of accelerated displacement settlement in the slopes. This study aims to systematically quantify the displacement in rock glaciers occurring in the Jhelum basin, Western Himalaya, employing InSAR. The European Space Agency's C-band Sentinel-1A data is processed to yield velocity statistics at varying temporal baselines and to quantify the movement of rock glaciers under study. Multiple Sentinel-1 SAR open-access images covering the lower Jhelum valley were obtained at different time instances spread across 3 months (beginning from June-Aug 2022) corresponding to maximum seasonal displacement. The images were SLC products, captured in the IW mode out of which the temporal baseline pairs representing a temporal baseline of 24, 36, 48, 60 & 72 days were chosen. The SAR data processing workflow included co-registration of chosen pairs using S1-TOPSAR Split, followed by Interferogram and coherence generation, TOPSAR Deburst, Multilooking and Goldstein Phase filtering. The interferogram images thus generated were subjected to Snaphu Unwrapping, which post performing Terrain Correction, yielded displacement & coherence maps of the study area. There is a lack of field velocity data of rock glaciers in the Himalaya due to which an attempt will be made to validate rock glacier velocities from similar features across different parts of High Mountain Asia. Finally, possible reasons for the velocity variations will be proposed, coupled with potential impact on nearby regions.

Keywords*:* Rock Glaciers, Insar, Temporal Baseline, Interferogram, Velocity

SUB THEME-10: SUPER RESOLUTION AND IMAGE MAPPING

EFFECT OF MODULATION TRANSFER FUNCTION ON CLASSIFICATION ACCURACY OF MULTI-RESOLUTION REMOTE SENSING IMAGERY

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Abstract

The end users of remote sensing data often take the spatial resolution and spectral bands into account when choosing from an electro-optical camera for a particular study. Most of the time, the end user is unaware of additional sensor parameters such as Modulation Transfer Function (MTF) which might affect the accuracy of the analysis. This study emphasizes on how the MTF influences classification accuracy of multi-resolution remote sensing imagery. The MTF is one of the parameters to measure the spatial quality of an imaging system. Basically, MTF is the normalized spatial frequency response of an imaging system. However, the MTF characteristics may alter as a result of vibration during satellite launch. As a result, imagery quality may change. The focus of current research, however, is primarily on measuring MTF rather than examining how MTF affects the imagery quality. MTF generally affects the edge sharpness of the imagery which can further affect the segmentation quality. Therefore, the aim of the study is to explore and quantify the role of MTF on imagery segmentation and classification accuracy for various land cover features based on multi-resolution and temporal MTF estimates. In this paper Bi-Resolution method is used to derive the Kompsat-3 MTF. In this technique firstly, a high-resolution imagery is degraded by the low Gaussian filter and then MTF of coarser resolution imagery is estimated by taking the high- resolution imagery as reference. Then imagery segmentation is applied on both of the images with varying MTF values and classification accuracy is evaluated. The image segmentation quality decreased while the MTF was reduced for high spatial images. However, it should be seen that different land cover types could have varying MTF sensibilities.

Keywords: Modulation Transfer Function (MTF), Bi-Resolution Method, Spatial Frequency, Segmentation Quality, Low Gaussian Filter

SAMD: AUTOMATIC MAPPING AND 3D VISUALIZATION OF DRONE DATA CASE STUDY: MAPPING BUILDINGS AND TREES FOR KANCHIPURAM CITY

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Abstract

Segment anything Model (SAM) is universal segment model gained lot of popularity in recent times. The model has showcased the exceptional performance for delineating the objects in natural images, but the potential of SAM in the field of remote sensing (satellite and drone data) is still not much explored. This study will introduce "SAMD" ensembled model with U-Net, ResNet34 and SAM for generating robust solution for automate mapping of buildings and trees in Drone data and 3D visualization. SAMD has utilized capability of U-Net and ResNet by providing robust training to model and training data is generated with open data source drone imagery and vector files. Data preprocessing is done by creating 512 by 512 patches. The pre-processed data is labelled as training and test data with "geopandas" and "Solaris" is used for generating mask of training dataset.12000 training samples with batch size 16 and 40 learning cycle with early stoppage is used for training U-Net Model. Best trained model is saved and used for extraction of buildings in raster masks format. The raster mask generated from U-Net is converted to shapefile with SAM. The height component for 3d visualization is extracted using DSM and DTM and merged with merged with building layer extracted. Building layer with height information is input for open-source Cesium Library to generate of 3D view of the Kanchipuram town as shown in Fig1. The extract of tress from Drone data is interactively done threshold-based technique using SAM with 80% accuracy as shown in Fig2. Union of auto-generated tree and building shapefile file is created with "shapely" library to generate automatic map for drone data. The customized SAMD model is showcasing the satisfactory output for automatic mapping of buildings and trees for drone data but still improvements are required to operationalize the model.

Keywords: Deep-Learning (DL), SAM, U-Net, ResNet34, Automatic Mapping, Drone, 3D, Digital Surface Model (DSM), Digital Terrain Model (DTM)

INTEGRATION OF TERRESTRIAL LASER SCANNING AND CLOSE RANGE PHOTOGRAMMETRY FOR ESTIMATING HORIZONTAL DEFORMATION OF TALL HERITAGE STRUCTURE

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Abstract

Deformation measurements or of tall structures is one of the most important issues of surveying engineering. To analyze the stability of tall buildings the inclination of axis of the structure is one of the key parameters. The Qutub Minar, named as the world's tallest brick tower, has been leaning to one side for a few years now. According to the Survey of India the Qutub Minar has already tilted 65 cm away from its vertical axis. Hence, it is essential to measure the deformation of the Qutub minar. In this paper, we present a method for the estimation of inclination in Qutub Minar using integration of terrestrial laser scanning (TLS) and close range photogrammetry (CRP) derived point clouds. The range data for Qutub Minar was collected with FARO Focus 350S. Due to the height and multiple angular flanges of the minar, multiple scans were used to cover the entire structure. It was calculated that a point density of ~4mm could be obtained till height of 28.9m. Beyond this height the point density decreased considerable. Thus to to improve the point density of upper part of minar, terrestrial photographs were also integrated. In order to estimate the minar tilt, rings with the width of 25 mm were cut out of point cloud at every floor level. A circle was fitted into every ring with the use of the least squares method and then x, y coordinates of cylinder axes and mean error of adjustment were calculated. By comparing x and y coordinates on higher levels to coordinates on the lowest level, deviations of the minar's axis from vertical were calculated. The shift of plumb line from the central axis towards south-west direction was measured to be 64.30 cm which was 0.8cm less than the reported tilt of 64.5 cm. The measured tilt angle was $0^0 30' 34''$ as compared to $0^0 30' 7''$ as reported by ASI. The study proves that integration of data collected with ground based techniques such a TLS and CRP can be used effectively for monitoring of tilt of tall minars.

Keywords: Terrestrial Laser Scanning, Close Range Photogrammetry, Tilt Estimation, Deformation

SUB THEME-11: ADVANCED REMOTE SENSING AND NAVIGATION

A FULLY EMPIRICAL MODEL FUNCTION BASED ON STATISTICAL CHARACTERIZATION FOR RETRIEVAL OF OCEAN SURFACE WIND SPEED FROM GNSS-R OBSERVATIONS

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Abstract

Retrieval of Ocean surface scalar wind is done from CYGNSS GNSS-R observables of normalized bistatic radar cross-section (NBRCS) and leading edge slope of the integrated delay waveform, denoted by LES, using a fully empirical model function that is based on statistical characterization of the observable and the reference wind speed from ECMWF analyses. This technique is simple, computationally convenient and needs no collocation between the observable and the reference wind speed to generate a match-up database, as is done traditionally for empirical GMF of scatterometer wind. However, this technique requires monotonicity and large population of both the datasets to prepare statistics that is robust and stable. CDFs for CYGNSS observables are computed for different incidence angle and range corrected gain (RCG) values segregated into evenly spaced bins from the training data. CDF of ECMWF ENWS-10m is evaluated month-wise for the year 2017. Subsequently, inverse CDF is derived from the CDF of reference wind speed and retrieval is performed for CYGNSS observable from test dataset. For validation, the retrieved wind speed from test dataset of NBRCS (NBRCS-WS) and LES (LES-WS) are collocated with ECMWF ENWS-10m in 15 minutes and 12.5 km window. Bias, RMSE and correlation coefficient are computed for both NBRCS-WS & LES-WS as a function of wind speed, incidence angle and RCG. NBRCS-WS show better performance than LES-WS and the PDF of NBRCS-WS matches.

Keywords: CYGNSS GNSS-R Data, Ocean Surface Wind Retrieval, Empirical Model Function, Statistical Characterization, Validation Metrics

HYPERSPECTRAL IMAGE ANALYSIS FOR WATER QUALITY ASSESSMENT OF GANGA RIVER STRETCH AT BUXAR

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Abstract

The use of spectral signatures for identifying, discriminating and determining properties of natural features on the earth's surface has been used to a large extent in the field of earth observation and image analysis. This study has been done for Ganga river stretch at Buxar, Bihar. Dynamic, complex nature of turbid waters changes its spectral response mechanism which was recorded using a spectro-radiometer at different points. The spectral similarity of the signatures obtained are compared with hyperspectral imagery to classify turbid regions of the river into different intervals of turbidity. For spectral similarity analysis-based mapping, spectral angle mapper (SAM) technique has been used. AVIRIS-NG data collected through flight survey and concurrent spectroradiometer ground truth measurements taken at 18 points in the study area of the river were used to derive water quality of the whole stretch. The spectroradiometer data files were used to build spectral libraries for all the points. These libraries were grouped according to the turbidity value range and resampled. SAM was used to classify the pixels in the AVIRIS-NG bands. It showed better results at angles ranging between 0.2 to 0.3 radians when classified using multiple values rather than single radian values. Lower turbidity classes were better classified at higher spectral angles such as 0.3 and higher turbidity classes were identified at relatively lower angle (0.21-0.23). However, several other factors come into play while deciding the water quality in a flowing river such as velocity, depth, point of observation, pollution point source vicinity, etc. Further the study can be extended to compare different classification techniques like Spectral Feature Fitting, Binary Encoding and sub-pixel classification techniques like Linear Spectral Unmixing, Mixture Tuned Matched Filtering, etc. The results of this study can be extended to different inland water and turbidity values for study of degree of water pollution.

Keywords: Hyperspectral, Water Quality, Turbidity, Spectral Angle Mapper, AVIRIS-NG

RELATIVE ASPECT COMPUTATION USING ASTROSAT UVIT DATASETS

Sanjay K. Singh

Abstract

ASTROSAT is India's first dedicated astronomy satellite launched on September, 2015. The satellite is designed for the study of cosmic sources simultaneously over a wide range of the electromagnetic spectrum; from optical bands to high energy X-rays. It carries five payloads onboard, one of them is Ultra Violet Imaging Telescope (UVIT) that takes observations in Far Ultra-violet (FUV), Near Ultra-violet (NUV) and Visible (VIS) regions with 0.5-degree field of view. Accurate estimation of drift of the spacecraft is a key for formation sharp images from the instrument making it amenable for further scientific investigation. This paper describes the algorithm for estimation of relative aspect from the sky field images acquired from VIS channel at a high frame rate. It also covers methodology developed for computation of drift of the spacecraft using NUV/FUV data acquired in photon counting mode, in the absence of VIS images. Finally, it presents the corrected field high-resolution images produced by UVIT payload by utilising the estimated relative aspect series.

Keywords: ASTROSAT, Ultra Violet Imaging Telescope (UVIT), Spacecraft Drift Estimation, High-Resolution Image Correction, Electromagnetic Spectrum Observations

ASTROBROWSE: A GATEWAY TO ASTROSAT DATA

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Abstract

ASTROSAT, the first astronomical mission of ISRO has completed a long 8 years of voyage and still going strong. In this journey it has captured lots of celestial events happening in the deep sky. It's a proposal driven mission where the proposals submitted by scientist/researchers worldwide are grouped into observations and are observed as per the probable visibility periods of the celestial bodies. The instruments on board viz, Ultraviolet imaging telescope (UVIT), Cadmium Zinc Telluride Imager (CZTI), Soft X-ray Telescope (SXT) and Large Area X-Ray Proportional Counter (LAXPC) has collected enormous and unique data which is been used for various studies by the users across the Globe. To access this enormous data a web portal is hosted at ISSDC (Indian Space Science Data Centre, Bangalore) named AstroBrowse. The data products of Astrosat are archived and disseminated from ISSDC to the respective Payload Operation Centre (POC) immediately after the observation. POCs conduct a quality check and generate higher level data products and send them back to ISSDC for archival and dissemination and to Host on AstroBrowse. The users can download the data products as per the policies built in by SWG (Software Working Group). The proposer or principal investigator of the data can download during lock-in period and other users worldwide; after lock-in period. This paper talks about the services provided to the astronomical community through AstroBrowse namely visualization of archived data, requesting data and data download.

Keywords: ASTROSAT, Archival, Dissimination, AstroBrowse, Data Products

ESTIMATION OF DOWNWELLING RADIANCE IN THERMAL INFRARED REGION USING RADIATIVE TRANSFER MODEL FOR ECOSTRESS BANDS

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Abstract

Land Surface Temperature (LST) plays a pivotal role in climate monitoring and estimating the Earth's radiation budget. Accurate LST retrieval from remotely sensed Thermal InfraRed (TIR) observation is achievable. However, to ensure the accuracy of LST, atmospheric correction of TIR data is essential due to attenuation caused by atmospheric parameters. Accurate quantification of atmospheric variables including downwelling radiance, upwelling radiance, and transmittance plays a vital role in LST retrieval. Downwelling radiance is one of the key input variables in the Temperature Emissivity Separation (TES) method. Radiative Transfer (RT) models enable precise determination of critical atmospheric parameters. However, this approach has a drawback; it necessitates the availability of accurate atmospheric profile data and a Digital Elevation Model (DEM) at pixel resolution. Therefore, it's essential to investigate alternative methods for atmospheric parameter determination. Downwelling radiance constitutes the predominant component of atmospheric parameters and contributes significantly to the total incoming radiance on the Earth's surface. Upwelling and downwelling radiance are strongly interconnected in the atmosphere. Atmospheric parameters measured by a thermal sensor are also influenced by sensor characteristics and spectral geometry. Upwelling and downwelling radiance is a function of the angle at which the observations were made and atmospheric columnar water vapor. Downwelling radiance can be accurately estimated through the mathematical model considering the effect of viewing zenith angle and water vapor. This model was trained on ECOSTRESS bands, using 370,679 RT simulations comprised of 30 atmospheric profiles from SeeBor dataset, each characterized by distinct geometry and atmospheric contributions. The resultant model was tested on an independent dataset containing 215,621 simulations, consisting of 17 atmospheric profiles of SeeBor dataset. This model shows a good correlation between upwelling and downwelling radiance with an RMSE of ±0.4 w/(m²·sr·µm). The derived equation can be used as an alternative to the RT model for atmospheric parameter retrieval.

Keywords: Land Surface Temperature, Atmospheric Correction, Radiative Transfer Model, Downwelling Radiance,

DETECTION OF WATER QUALITY PARAMETERS USING HYPERSPECTRAL IMAGERY ALONG THE COCHIN COASTAL WATERS

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Abstract

Monitoring water quality along the coastal regions is vital for sustainable management of coastal ecosystems and resources. Several studies have retrieved water quality parameters using statistical and machine-learning approaches using site-specific in-situ datasets. However, when the scene is optically heterogeneous in terms of different optical types of water, e.g. open water, estuarine and backwater, the commonly used methods fail to model the spectral- functional relationship of water surfaces. The semi-analytical models retrieve the biophysical parameters through radiative transfer model inversion, offering the possibility of modelling broad-spectrum water quality and optical interactions. Combining the capability of direct search and physical inversion, the Downhill Simplex inversion algorithm is an objective function optimisation-based computational method for multidimensional unconstrained optimization without derivatives. This algorithm is highly applicable in optically complex waters like coastal waters, where open sea (case 1) and backwaters (case 2) exist in imagery cases. The objective of this research is the retrieval and quantification of water quality parameters over the Cochin waters using airborne and satellite hyperspectral data. We have adapted and implemented the Downhill Simplex inversion algorithm on airborne and satellite hyperspectral imagery to estimate critical water quality parameters such as phytoplankton, non- algal particles (NAP), and coloured dissolved organic matter (CDOM). The residuum is found using the Weighted least squares method. The estimated residuum is ≤0.005, and the number of iterations is around 200. The validation of detected water quality parameters is carried out using in-situ data collected during the imagery acquisition. The results reveal that phytoplankton concentrations are higher (>80 mg/m^3), especially in the river mouth region. Also, higher concentration of NAP (>40g/m^3) and CDOM absorption coefficient (>8m^{-1}) values are observed in the coastal waters of Cochin. Moreover, the validation with in-situ water quality data showed good accuracy for satellite-based hyperspectral imagery (PRISMA) rather than airborne hyperspectral imagery (AVIRIS-NG). The study demonstrates the utility of hyperspectral remote sensing in tracking changes in water quality over time.

Keywords: Water quality, Hyperspectral imagery, Algae, Coastal water, Remote sensing

DELINEATION OF ALPINE TREELINE ECOTONE IN SIKKIM HIMALAYA USING SPACEBORNE LIDAR DATA

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Abstract

Advanced remote sensing technologies, like light detection and ranging (LiDAR), can help us get closer to the definition of alpine treeline ecotone, which is defined by trees with a height of ≥ 3 m. However, in the treeline delineation studies, this tree height definition is generally overlooked for the want of data on tree height. To address this research gap, the present study focuses on the integration of LiDAR-derived absolute tree height data and elevation information to delineate the alpine treeline in Sikkim, India. The present study takes advantage of the recently launched Global Ecosystem Dynamics Investigation system (GEDI) data, and its accuracy was validated with *in- situ* measurements. When compared to the *in-situ* treeline data, the LiDAR-derived treeline has a root mean square error of approximately 70 meters. Additionally, the traditional treeline mapping method using the NDVI tended to overestimate the actual LiDAR treeline. These findings underscore the effectiveness of the LiDAR-based treeline method for accurately delineating alpine treelines on a landscape scale. This advancement improves our understanding of the alpine treeline ecotone and provides fundamental baseline data for future change detection studies.

Keywords: Alpine Treeline, Lidar-Derived Tree Height, Global Ecosystem Dynamics Investigation (GEDI), Change Detection

A NOVEL APPROACH FOR GPS, NAVIC & PSEUDOLITE COMBINED USER POSITION ALGORITHM

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Abstract

Integration of different types of sensors for navigation is essential to incorporate best of their features for more robust and accurate positioning. Global Positioning System (GPS) and NavIC being satellite based systems provide poor vertical accuracy. This can be improved by integrating Ground based navigation systems such as pseudolite with GPS and NavIC. Integration of GPS, NavIC & Pseudolite systems not only improve position accuracy & signals availability but also reduces geometrical errors especially Vertical Dilution of Precision (VDOP). Therefore, in this paper, a detailed analysis of positioning performance of combined GPS, NavIC and Pseudolite systems has been done using simulated data of GPS & NavIC generated from Spirent simulator combined with Pseudolite data from an identified location in India. Furthermore, Gaussian error with mean 10 m and variance 9 m was introduced into the simulated ranges of GPS, NavIC & Pseudolite to assess the effect on position accuracy in the presence of noise. It has been observed from the analysis that 3D position accuracy of combined GPS, NavIC & Pseudolite systems is reduced to 1.75 m from 10 m with NavIC only position. This is particularly useful for aviation applications where better vertical position accuracy is required.

Keywords: NavIC, GPS, Pseudolite, Position Accuracy, VDOP

PSEUDOLITE-BASED ROVER NAVIGATION FOR FUTURE INTERPLANETARY MISSIONS: AN AI-BASED APPROACH

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Abstract

Interplanetary missions have always been an area of special interest for both the space researchers and the general public. On Earth, we have a well formed navigation system unlike other planets. Thus, a Pseudolite based system for rover navigation will be a better option. Whenever a rover lands on the surface of any planet other than the Earth, the main challenges come in its navigational aspects and its motion planning. The rover should be in the line of sight of the lander so that it can continuously send the results of its scientific experiments done on board. If it moves away from the lander then it would be tragic in terms of efforts laid, finance, and the precious proofs which were collected by the rover. In this paper, we propose pseudolite based rover navigation for future interplanetary missions using Artificial Intelligence (AI) based approach. In our proposed scheme, we have laid focus on three aspects. Firstly, on the calibration of the pseudolite position on the extra-terrestrial surface using bidirectional ranging which is a pre-requisite for navigation on other planets, where any manual intervention is not possible. Furthermore, navigation system needs to be intelligent enough so that whenever required, rover may take decisions autonomously using its own intelligence. This is where AI plays a significant role. We would be positioning the rover using bidirectional ranging measurements. It is a conventional double differencing technique with triangulation to find the position. Finally, the path planning of rover. The path planning would be done by the rover on board using artificial intelligence which has been integrated with bidirectional ranging for accurate positioning of rover while it is moving over the extra-terrestrial surface. The position of the rover was found up to a centimeter level accuracy using 5 pseudolites while executing its motion planning algorithm.

Keywords: Rover, Pseudolites, Path Planning, Artificial Intelligence, Bidirectional Ranging

ANALYSIS OF THE POLARIMETRIC SCATTERING MECHANISMS AND SEMANTIC SEGMENTATION USING EOS-04 SAR

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Abstract

Synthetic Aperture Radar (SAR) is an active imaging sensor predominantly used for remote sensing applications due to its characteristic all weather, all-time operating capability and operates over microwave frequencies that are transmitted as pulses over the region of interest and the received backscatter is studied to derive vital information about the geo-physical properties of the target area. Polarimetric SAR or PolSAR is designed to send and collect signals in different polarizations while preserving the target phase history. PolSAR decomposition is used to describe and classify the scattering from man-made, natural targets, and landscapes by splitting the received signal into a sum of different scattering mechanisms representing specific polarimetric signatures. It has been proven that classification inaccuracies can be corrected with the help of using advanced machine learning algorithms and deep learning techniques. RISAT-1A / EOS-04 is C –Band SAR developed and launched by ISRO in 2022. The primary imaging modes are Fine Resolution Strip map (FRS1) Medium/Coarse Resolution ScanSAR MRS/CRS and High-Resolution Spotlight with resolutions varying from 1m to 50m with Single, Dual, Hybrid and Full Quad Pol capability. The SAR data is available at various processing levels like Single Look Complex product, Radiometric Terrain Normalized Product and Polarimetric data for varied remote sensing applications and research. SARPOLTool v2.1 is a SAR multi-mission polarimetric processing toolbox that has been developed in-house for ingesting both complex and other levels of SAR data formats and designed for generating Analysis Ready Information Products. It has been integrated with QGIS for ease of analysis. This work focusses on the polarimetric processing of EOS-04 quad polarimetric data and the derivation of the polarimetric coherency matrix from the target scattering elements. These coherency matrix elements are used for deriving the target scattering mechanism. The polarimetric decomposition techniques are implemented for arriving at the PolSAR descriptors. Coherent and Incoherent decomposition techniques like Pauli, GFU and Seven Component Scattering are carried out using SARPOLTool v2.1 and the results are compared for various land cover features like water body, urban region, farm lands, varied vegetation and ice cover at the C band. This study also explores the polarimetric backscatter analysis and the resulting target decomposition models. This work is also aimed at reducing pixel misclassification in target characterization and semantic segmentation of the EOS 4 SAR data using deep learning techniques.

Keywords: EOS-04, POLSAR, Semantic Segmentation, SARPOLTool

COMPARATIVE ANALYSIS OF VERTICAL WATER VAPOR DISTRIBUTION BETWEEN GNSS TOMOGRAPHY AND GFS REANALYSIS DATA

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Abstract

Precipitable Water Vapor (PWV) serves as a fundamental metric for evaluating the total water vapor content within a column of the Earth's atmosphere. Expressed in either kilograms per square meter (kg/m²) or millimeters (mm) of liquid water depth, PWV assumes that all water vapor in the column condenses and deposits as liquid water. This parameter offers a precise measure of atmospheric water content and is critical for investigating processes such as precipitation, cloud formation, and water vapor transport, making it indispensable in meteorology and climatology. It distinguishes itself from relative humidity by being an absolute measure unaffected by air temperature. PWV detection predominantly relies on remote sensing techniques, encompassing satellite-based radiometers and ground-based GPS receivers that utilize microwave radiation to estimate atmospheric water vapor quantities. Deviations between GNSS tomography and Global Forecast System (GFS) results have been examined to assess the precision of the tomography model. These deviations, ranging from -7 g/m³ to +8 g/m³, exhibit an average mean deviation of - 1.745 g/m³. Deviations display variations, with both positive and negative trends, suggesting polarization in the outcomes. The spatial distribution of these deviations can be further investigated through water vapor density iso-surfaces at various atmospheric layers. This analysis offers valuable insights into the accuracy of the GNSS tomography model and identifies areas for potential enhancement. Nevertheless, it is imperative to acknowledge the inherent limitations and uncertainties associated with modeling and measurement techniques. This study aids in refining our understanding of PWV precision and its relevance in atmospheric science and weather forecasting.

Keywords: Vertical Water Vapor Distribution, GNSS Tomography, GFS Reanalysis, Atmospheric Analysis

MACHINE LEARNING BASED SPATIAL-SPECTRAL-CONTEXTUAL-ANALYSIS FOR WATER QUALITY MAPPING USING AIRBORNE HYPERSPECTRAL IMAGERY

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Abstract

This study focuses on the assessment of turbidity, a critical water quality parameter in Chilika Lake, employing machine learning models and hyperspectral data from the AVIRIS-NG airborne sensor. Chilika Lake, a prominent coastal lagoon, faces water quality challenges due to anthropogenic pressures and climate variations, necessitating accurate monitoring methods. This research compares machine learning models with the spectral similarity approach for turbidity estimation. The AVIRIS-NG sensor, renowned for its high spectral resolution and spatial precision, serves as the data source for our analysis. We explore the Spectral Angle Mapper (SAM) classification technique and machine learning algorithms, including Random Forest, XG Boosting, Gradient Boosting, and a Voting Ensemble. Our analysis relies on statistical indicators such as RMSE, MSE, and R2 to evaluate model accuracy and precision across different turbidity ranges. We also emphasize the significance of scatter plots in understanding model behaviour, especially in high-turbidity zones. Additionally, we investigate feature importance to highlight spectral regions crucial for turbidity estimation, revealing variations in model preferences. In conclusion, this research offers promising insights for improving turbidity mapping in sensitive aquatic ecosystems. Machine learning models, when combined with proper ground sampling and an awareness of spatial variations, enhance water quality mapping. In cases where spectral libraries present challenges, machine learning emerges as a practical alternative for water quality parameter estimation. This research encourages broader adoption of machine learning in environmental monitoring and management practices, extending beyond Chilika Lake to safeguard global water resources and ecosystems.

Keywords: AVIRIS-NG, Machine Learning, Spectral Angle Mapper, Water Quality, Turbidity

DESIGN, DEVELOPMENT AND TESTING OF IN-HOUSE DEVELOPED POINTS TARGETS FOR NISAR DATA CALIBRATION

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Abstract

Active and passive point targets for the calibration of existing and upcoming Synthetic Aperture Radar (SAR) missions such as Radar Imaging Satellite (RISAT-1A/1B) and NASA ISRO Synthetic Aperture Radar (NISAR) have been designed and developed at Space Applications Centre, Indian Space Research Organisation (ISRO), Ahmedabad. The launch of NISAR, having dual frequency bands (L and S band), is scheduled in the first quarter of 2024. For the calibration of the L- and S-band SAR, point targets designed specifically to these frequencies are required. An innovative approach has been used to make the targets frequency-independent, that means a single device can be utilized for the calibration of SAR sensors operating at different frequencies with different resolution capabilities. A Wideband Polarimetric Active Radar calibrator, which can operate in the L, S, C and X bands and a Square trihedral passive target of 1.5 m size with detachable and scalable panels for using it for L-, S- and C-band calibration were designed and developed indigenously. These point targets were deployed in the calibration sites synchronous to the satellite overpass at Ahmedabad and their response in the SAR images were analysed. Well-calibrated Advanced Land Observing Satellite (ALOS-2), L-band, NovaSAR, S-band and RISAT-1A, C-band SAR data were utilized in the study to analyse the performance of the point targets. This paper highlights the design and development of Polarimetric Active Radar Calibrator (PARC) and multi-frequency CR, as well as the evaluation results of their performance in the SAR data. Response analysis in the SAR images show the difference between the estimated and the actual Radar Cross Section (RCS) to be within the specified values for these in-house developed calibration devices.

Keywords: SAR Calibration, RISAT, NISAR, Wideband Polarimetric Active Radar Calibrator, Point Target Calibration Devices

SUB THEME-12: BIOSPHERE, CRYOSPHERE AND HYDROSPHERE

ASSESSING THE IMPACT OF URBANIZATION ON YAMUNA RIVER DISCHARGE USING HYDROLOGICAL MODELING

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Abstract

Yamuna River basin in India, a major source of water for the national capital region, Delhi, and its surrounding areas, faces challenges due to climate change, urban growth, population growth and land use changes. This study leverages the techniques of artificial neural network multi-layer perceptron (ANN-MLP) based approach along with popular hydrological model i.e. soil and water assessment tool (SWAT) which incorporates geospatial components as part of its semi-distributed framework. The land use land cover (LULC) maps for the years 2017, 2019, 2021 and 2022 were used to predict the future land use of the year 2027. This was carried out using MOLUSCE (Modules for Land Use Change Simulations) QGIS plugin which utilises Cellular Automata (CA) - ANN technique to predict the land use class transitions between two different LULCs of known classes and thus future land use. The accuracy obtained in training phase of the model was 0.89, when the model was run keeping learning rate as 0.005, maximum iterations equal to 200 and with 1 pixel neighbourhood. During the validation step the overall Kappa coefficient was 0.90. The future LULC of the year 2027 thus predicted has slight overall changes in the classes. The built-up area and snow cover classes showed some notable increase while forest cover was decreased significantly. The impact of this scenario was seen on the annual average discharge values for the years 2022 and 2027 which came out to be 790.81 cumec and 873.12 cumec, respectively. The approach of the project is limited to its scope, however for better and accurate flood/streamflow scenario predictions more spatial variables and timeseries data is suggested for calibration and validation of the models. The project outcomes bear considerable implications for areas like water resource management, flood forecasting, disaster risk assessment and water availability for the river basins.

Keywords: Land Use Land Cover Change, Artificial Neural Network, MOLUSCE Hydrological Modelling, SWAT

MARTIAN GULLIES ARE FORMED BY TERRESTRIAL DEBRIS-FLOW LIKE PROCESSES IN THE PAST

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Abstract

Gullies are kilometer-scale geologically young (~10 Ma) features found on steep slopes polewards of about 30° latitudes on Mars. It comprises of an alcove, channel, and depositional fan. Since their discovery on Mars, they have been presented as 'special regions' as the overall morphology resembled water-carved channels on Earth. However, recent studies deny the role of liquid water because Martian gullies were changing even today, at locations where surface flow of water is impossible under the present-day temperature-pressure conditions. Therefore, it was postulated that the changes in Martian gullies is primarily due to the sublimation of dry carbon dioxide ice, and that this process formed the entire generation of Martian gullies. We propose that regardless of the role of liquid water or dry carbon dioxide ice in Martian gully formation, the Martian gully systems were likely formed by terrestrial debris-flow like processes. We show this based on the following lines of evidence generated from the analysis of High Resolution Imaging Science Experiment (HiRISE) images and digital elevation models of gullies in the southern mid-latitudes of Mars. (1) Gully systems originated from debris-flows have leveed channels and their fans are dominated by tongue-shaped lobate deposits. (2) The relationships between Melton ratio, alcove length and fan gradient of gully systems dominated by debris-flows are similar to the terrestrial gullies formed by the flow of water and entrained debris-flows. The gullies that change currently show a similar morphometric relationship between the Martian and debris-flow dominated terrestrial gully systems. Taken together, we bring to the notice of the science community a new gully forming mechanism on Mars that was previously not considered due to the lack of evidence. This study has significant implication for establishing the integral role of liquid water in gully formation on Mars during the last few million years.

Keywords: Mars, Gullies, Water, Debris-Flows, Lobate Deposits

ANALYSIS OF LANDSCAPE CHANGE AND LAND MOVEMENT IN LANDSLIDE-PRONE RUDRAPRAYAG, UTTARAKHAND USING INSAR DATA

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Abstract

This study focuses on the analysis of landscape transformations and terrestrial shifts in regions susceptible to landslides, specifically focusing on Rudraprayag, Uttarakhand, India. The research employs Interferometric Synthetic Aperture Radar (InSAR) data, accumulated over the preceding five years. Given the substantial risk that landslides present to this region, understanding the mechanics of land movement becomes crucial for effective risk management and mitigation. The methodology centres around the use of InSAR data, which provides high-resolution measurements of land surface deformation. In addition, the research aims to draw correlations between the findings and other variables such as rainfall patterns and geographical features. By examining the spatial and temporal patterns of land movement, the study seeks to pinpoint areas with heightened landslide activity and measure the magnitude and frequency of landslide movement in Rudraprayag. A significant aspect of this study involves comparing findings from InSAR data with historical data. This comparison serves to validate the findings and assess the accuracy and reliability of the adopted methodology. The implications of this study are substantial for landslide risk assessment and management in Rudraprayag. The evaluation is expected to offer valuable insights into land use planning, infrastructure development, and disaster readiness. By integrating the knowledge derived from this study, stakeholders can make well-informed decisions to mitigate the impact of landslides on local communities and infrastructure. The research findings will augment the existing body of knowledge on landslides and highlight the potential of InSAR data in monitoring and understanding landscape changes in regions prone to landslides.

Keywords: Landslides, Landscape Change, Land Movement, InSAR, Risk Assessment

CHANGES IN BIOSPHERE-ATMOSPHERE-HYDROSPHERE INTERACTIONS IN INDIA DURING RECENT DECADES

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Abstract

In recent decades, vegetation cover, photosynthetic activity and productivity across the globe show significant changes owing to climate change and frequent extreme events. Since India is in the tropical region of higher carbon uptake potential and is an agrarian economy, it is imperative to examine the changes in biosphere-atmosphere-hydrosphere interactions in recent decades. However, scarcity of data, extensive computational requirements and the complex biosphere-atmosphere-hydrosphere interactions pose great challenge to accurately monitor this. Here, we utilise remote sensing data, advanced statistical techniques and machine learning algorithms such as random forest and causal analysis to find the changes in biosphere- atmosphere-hydrosphere interactions in Indian land regions during recent decades (2000– 2019). Soil moisture is the predominant driver (around 30% each) of the changes in photosynthetic activity, carbon use efficiency (CUE) and water use efficiency (WUE) in India. A contrasting pattern is observed among photosynthetic activity, CUE and WUE in India. For instance, greening and increase in CUE is observed in the lower (< 0.3) CUE regions in northwest (moisture induced greening) and Indo-Gangetic Plain (IGP) (irrigation induced agricultural boom). However, browning is found in regions of higher CUE (> 0.6) and WUE (> 1.2) such as northeast, lower IGP (deforestation and extreme events) and south India (warming induced moisture stress) where WUE is increasing. This is also a concern that the high CUE regions are browning. The carbon-water cycle connection in India is strengthened in recent decades, particularly for the croplands. This study thus, sheds light on the application and utility of remote sensing big data and machine learning techniques, particularly for a region that has very limited ground-based estimates of carbon and moisture fluxes.

Keywords: Vegetation Dynamics, Carbon Use Efficiency (CUE), Water Use Efficiency (WUE), Remote Sensing Big Data, Machine Learning

INTRA AND INTER-ANNUAL GROUNDWATER STORAGE ASSESSMENT USING GRAVITY BASED TERRESTRIAL WATER STORAGE FROM GRACE AND GRACE-FO DATA IN GANGA-BRAHMAPUTRA RIVER BELT

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Abstract

Groundwater is the primary source for agricultural irrigation, domestic use, and industrial utilization. It is crucial to monitor and assess spatio-temporal characterization of groundwater and its related droughts at the basin scales. However, due to sparse observational data it's becoming difficult to account the loss of groundwater from large basins such as Ganga basin. Monitoring of the changes in the groundwater storages spatially is very difficult and time consuming from in-situ measurements: Here is the Opportunity for adopting the Remote sensing techniques to accurately quantify the ground water storage changes. GRACE and GRACE-FO (Gravity Recovery and Climate Experiment) are such missions having twin satellite launched by the NASA, and the German Aerospace Centre combined in March 2002 for tracking down the mass redistribution of the earth by monitoring changes in gravitational force, the observed monthly changes in gravity are caused by monthly changes in mass. In this study we have used GRACE CSR RL06 Mascon's for TWSA (Terrestrial water storage anomaly) of 0.25-degree resolution which represents change in Terrestrial Hydrological mass, along with these other hydrological parameters such as Soil moisture at different depths, Canopy water storage and Storm surface water from GLDAS NOAH Land surface model were used to extract the groundwater as a residual from the water-budget equation. The intra and inter-annual analysis has been carried out in three different time periods such as 2005-08, 2013-17 and 2018-21. The overall observations from this study revealed that there is sufficiently decrease in the Groundwater storage from 2005 to 2021 in the downhill side of chosen river buffer. We observed that in 2006 it's a dry year and the groundwater storages are very less i.e -9.19 to 16.160 cm/year throughout the study region and is maximum in the 2016- 17 accounting as -0.218 to 35.088 cm/year and -1.58 to 46.24 cm/year respectively. Data for Dehradun and other other places is also been validated with well data obtained from CGWB, showing the greater correlation coefficients around 0.75 with the same trend. Uncertainity in the GRACE TWSA is not accounted during the validation.

Keywords: GRACE and GRACE-FO, Mascon's, TWSA, Spatio-Temporal, GLDAS NOAH

ASSESSMENT OF BLEACHING STRESS VULNERABILITY OF LAKSHADWEEP ISLANDS USING GOOGLE EARTH ENGINE

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Abstract

Coral reefs, among the Earth's most diverse and valuable ecosystems, face unprecedented challenges due to climate change. Coral bleaching is a phenomenon wherein corals lose their symbiotic zooxanthellae owing to various stressors, leading to a whitening effect of the coral tissues. In recent decades, climate change has intensified coral bleaching events. Multiple stressors, including elevated Sea Surface Temperature (SST), extreme irradiance levels, and various biotic and abiotic factors trigger bleaching events. Coral bleaching is primarily driven by thermal stress caused by elevated SSTs. Climate change has worsened bleaching's frequency and intensity. Global bleaching events are often linked to planetary ocean-atmospheric circulation processes such as El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD). This study focused on assessing the vulnerability of coral reefs in the Lakshadweep region of India from 2016 to 2023 using National Oceanic and Atmospheric Administration's Climate Data Record Optimum Interpolation Sea Surface Temperature (NOAA CDR OISST) daily data. GOOGLE EARTH ENGINE (GEE) is a cloud computing platform which is used to collect and generate the base data for this study. The vulnerability assessment utilized two bleaching indices: SST anomaly and Degree Heating Week (DHW). Analysis of DHW data reveals that 2020 experienced the highest SST anomaly residence time due to IOD event of 2019, as compared to 2016 and 2023 which are known El Niño years. All Lakshadweep islands exhibited vulnerability, although in varying degrees across different areas. Based on the magnitude, intensity, and frequency of bleaching stress, the islands are categorized into different categories of vulnerability. This study identifies Baliyapaniyam, Cheriyam-Kalpeni and Suhelipar reefs as very highly vulnerable reefs in Lakshadweep. This study highlights the urgent need for monitoring and management measures to mitigate the impacts of climate change on coral reef ecosystems using spatial vulnerability patterns.

Keywords: Coral Bleaching, SSTA, DHW, GEE, Lakshadweep

MULTI-TEMPORAL INSAR-BASED DEFORMATION PATTERNS ACROSS GEOLOGIC FAULT: A POSSIBLE EARTHQUAKE PRECURSOR SIGNATURE PRIOR TO THE 2023 TURKEY EARTHQUAKE

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Abstract

Multi-slice and multi-sub-swath processing were carried out for interferogram generation using Sentinel-1 images of the pre and post Turkey earthquake of February 06, 2023 (04-01-2023 & 09-01-2023). An earthquake-associated interferogram was generated, and deformation was estimated. The data processing was carried out using a MATLAB based tool - EZ-InSAR, formerly named MIESAR (Matlab Interface for Easy InSAR) that uses the combination of open- source software ISCE (InSAR Scientific Computing Environment), StaMPS (Stanford Method for Persistent Scatterers) and MintPy (Miami InSAR Time-series software in Python). The post- earthquake deformation is prominently visible through interference fringes between images of January 04, 2023, and January 09, 2023, acquired in ascending geometries. The closely spaced denser deformation fringes near the epicentre suggest higher earthquake deformation. The unwrapped phase near the Fault zone suggests total LOS deformation (Maximum subsidence and upliftment) raging between -503 to 616 mm. In addition, Multi temporal-InSAR such as Persistence Scatterer and Small Baseline subset interferometry (PS-InSAR & SBAS-InSAR) approaches were applied to a small area near the epicenter to see the deformation pattern before the earthquake. PS-InSAR, SBAS-InSAR and PS-SBAS merged results were utilized for long- term deformation monitoring near the fault zone. SLC data in ascending mode from January 01, 2022, to February 05, 2023, were analysed for deformation monitoring before the occurrence of the earthquake (pre-seismic deformation) near the epicentre. The observations suggest abnormal changes in the deformation pattern a few months before the earthquake. The results indicate the possibility of identifying abnormal deformation changes before an earthquake using time series InSAR analysis that may be apossible precursor.

Keywords: PS-InSAR, SBAS-InSAR, PS-SBAS, Interferogram, 2023 Turkey Earthquake

THE SEASONAL DYNAMICS OF AQUATIC VEGETATION IN INDIAN RAMSAR WETLANDS

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Abstract

Aquatic vegetation plays a crucial role in the ecological balance of wetland ecosystems, contributing to biodiversity and water quality. This study presents a comprehensive analysis of the seasonal dynamics of aquatic vegetation in all Ramsar sites of India, employing multispectral optical remote sensing data and a classification tree model. We aimed to develop a robust framework for the classification of aquatic vegetation into three main classes: submerged vegetation, floating vegetation, and emergent vegetation. Our approach involved the utilization of dynamic thresholding techniques applied to various spectral indices, including NDVI (Normalized Difference Vegetation Index), NDWI (Normalized Difference Water Index), GNDVI (Green Normalized Difference Vegetation Index) and MNDWI (Modified Normalized Difference Water Index). Notably, we observed temporal variations in these threshold values, indicative of changing vegetation patterns over time. Furthermore, distinct seasonal patterns emerged in these threshold values, varying across different wetlands. The classification tree model, developed using these dynamic threshold values, exhibited high accuracy in classifying aquatic vegetation types. We found that each wetland had a unique seasonal pattern in the dynamics of aquatic vegetation. For instance, some wetlands showed peak submerged vegetation during the monsoon season, while others exhibited higher emergence of emergent vegetation during the post-monsoon period. Intriguingly, our study revealed a significant correlation between the dynamics of aquatic vegetation and meteorological parameters, such as rainfall and land surface temperature. These correlations suggest that changes in weather patterns influence the growth and distribution of aquatic vegetation in Ramsar wetlands. Overall, this research provides valuable insights into the temporal dynamics of aquatic vegetation in Indian Ramsar wetlands, aiding in the management and conservation of these critical ecosystems. The developed classification tree models, with their consideration of changing threshold values and seasonal patterns, offer a powerful tool for monitoring and understanding the behaviour of aquatic vegetation in response to environmental changes.

Keywords: Aquatic Vegetation, Remote Sensing, Seasonal Dynamics, Ramsar Wetlands, Classification Models

STUDY ON WRF-ELEC MODEL PREDICTIONS OF CLOUD TO GROUND LIGHTNING STRIKES OVER THE INDIAN REGION USING DIFFERENT INITIAL/BOUNDARY CONDITIONS.

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Abstract

Lightning strikes from Cloud to Ground (CG) is one of the natural hazards that damages property and causes life loss in many states of India during pre-monsoon, monsoon and post-monsoon seasons. In the current study, the assessment of WRF-Elec model performance and efficacy has been carried out during the months of monsoon, 2023. Performance of the model has also been studied by integrating the model with input initial and boundary conditions from NCEP's GFS and NCMRWRF's NGFS. In both the cases model configuration remains same and model integrated to generate day-ahead forecast at 24 km spatial resolution. Simulated CG counts have been compared against the NRSC's lightning network data LDSN (Lightning Detection Sensor Network) over the Indian landmass. Model simulations show good agreement with ground based observations in most of the cases, however model simulations with NGFS show better performance over the Northern and Central regions as compared to the simulation with GFS data. It is also observed that the quantitative estimations of model simulated CG counts are better matched with in-situ observations in case of NGFS simulations than the GFS simulation. Model simulations show that in both cases CG flash counts are overestimated over Kerala & some other regions. With this preliminary study it has been understood that the model is capturing CG counts better with NGFS as compared to the GFS, this may be due to the incorporation of more in-situ measurements over Indian regions in the NGFS assimilation system. Performance of the model will be further examined to understand its capability in capturing the lightning strikes that reach the ground. Detailed results with analysis will be presented during the conference.

Keywords: WRF-Elec, Lightning, CG Flash count, LDSN, NGFS

SPATIO-TEMPORAL CHARACTERISTICS OF SCATTEROMETER RADAR CROSS SECTION ON THE SNOW AND ICE SURFACE OF GREENLAND

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Abstract

The Arctic has been an important topic of research in recent years due to the increasing melt of its huge ice sheets because of the impact of climate change happening worldwide. The Greenland ice sheet, representing an extensive freshwater reservoir, has the potential to exert a notable impact on global sea level rise. Hence the study of this region is important for understanding its dynamics, which is crucial for predicting and preparing for coastal inundation, change in ocean's salinity, temperature and circulation. Remote sensing being the most practical solution for this, has been used to monitor the region in near real-time. Due to the advantage of cloud free and day-night monitoring capability of the microwave based sensors, Radar Cross-Section (RCS) data from the Scatterometers have been extensively used for the study of cryosphere. In this study we used SCATSAT1 observed daily RCS for the years 2017-2020 to study the sensitivity of HH and VV polarization components during different seasons. The mean climatological maps although exhibit highly coherent spatial features, but the HH amplitude is more intense than that of the VV RCS over most of the regions except the southern coastal region. The spatial pattern of the climatology can be classified into three distinct domains: central high altitude-plateau (>2500m) with mean RCS between -7 and -12, and insignificant seasonal amplitude (<0.5) considered as the permanent snow/ice cover region; the coastal fringes (with gentle slope and altitude < 500 m) with RCS < -9 and moderately high seasonal amplitude (0.5-2) due to the oceanic influence; the steep sloping region between the two with high RCS > -6 and seasonal amplitude (>1) considered as the most dynamic region. Intense seasonality is seen in the RCS mainly due to the winter snow fall and summer snow melt and has been verified with the snow melt extent/snow cover information available over Greenland from other sources. The probability distribution functions (PDF) of these data over southern and northern segments of each regional domain were analysed for both polarizations. PDFs are highly coherent for both the polarization with unimodal skewed distribution for most of the regions and bimodal for north central and southern intermediate region which signifies the mixing of two or multiple classes. Further, analysis is carried out to delineate and quantify the extent of snow melt and freeze during the study period.

Keywords: Greenland, Scatterometer, RADAR Cross-Section, SCATSAT1, Polarization

INTEGRATION OF TERRESTRIAL LASER SCANNING AND CLOSE RANGE PHOTOGRAMMETRY FOR ESTIMATING HORIZONTAL DEFORMATION OF TALL HERITAGE STRUCTURE

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Abstract

Deformation measurements or of tall structures is one of the most important issues of surveying engineering. To analyze the stability of tall buildings the inclination of axis of the structure is one of the key parameters. The Qutub Minar, named as the world's tallest brick tower, has been leaning to one side for a few years now. According to the Survey of India the Qutub Minar has already tilted 65 cm away from its vertical axis. Hence, it is essential to measure the deformation of the Qutub minar. In this paper, we present a method for the estimation of inclination in Qutub Minar using integration of terrestrial laser scanning (TLS) and close range photogrammetry (CRP) derived point clouds. The range data for Qutub Minar was collected with FARO Focus 350S. Due to the height and multiple angular flanges of the minar, multiple scans were used to cover the entire structure. It was calculated that a point density of ~4mm could be obtained till height of 28.9m. Beyond this height the point density decreased considerable. Thus to to improve the point density of upper part of minar, terrestrial photographs were also integrated. In order to estimate the minar tilt, rings with the width of 25 mm were cut out of point cloud at every floor level. A circle was fitted into every ring with the use of the least squares method and then x, y coordinates of cylinder axes and mean error of adjustment were calculated. By comparing x and y coordinates on higher levels to coordinates on the lowest level, deviations of the minar's axis from vertical were calculated. The shift of plumb line from the central axis towards south-west direction was measured to be 64.30 cm which was 0.8cm less than the reported tilt of 64.5 cm. The measured tilt angle was $0^0 30' 34''$ as compared to $0^0 30' 7''$ as reported by ASI. The study proves that integration of data collected with ground based techniques such a TLS and CRP can be used effectively for monitoring of tilt of tall minars.

Keywords: Terrestrial Laser Scanning, Close Range Photogrammetry, Tilt Estimation, Deformation

RIVER DISCHARGE ESTIMATION USING SWOT SIMULATOR AND POTENTIAL OF SWOT SATELLITE OBSERVATIONS IN RIVER HYDRAULICS

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Abstract

Surface Water Ocean Topography (SWOT) is a unique satellite mission to quantify the fresh water dynamics of the earth surface. It uses Ka band radar interferometry (KaRIN) to generate the water surface profiles over the inland water bodies. To maximize the potential of SWOT observations, SWOT hydrology simulator was developed by CNES, France. Which produce synthetic SWOT observations over inland water bodies. In this study, we have utilized the SWOT hydrology simulator over the Brahmaputra River. Which generated the 2-D time-series elevation profile for the river using reach wise water level values. Water surface time-series was generated for different reaches of the Brahmaputra River for the period of 2020 to 2023. The water surface profiles were used to estimate different river hydraulic parameters such as reach-wise water surface slopes, season flow depth and the Manning's roughness coefficient. To strengthen the development of algorithm for river discharge estimation over the braided reaches of the Brahmaputra River a hydrological model (WRF-Hydro) was setup over the Brahmaputra river basin. The model is capable to simulate peak flood discharge for a hydrologically complex catchment. The simulations were carried out for the period of 2020 to 2023 to capture the river discharge dynamics. It was found that seasonal water surface profile varies from 5-7 meters at different reaches of the Brahmaputra River. The peak flow during the monsoon season also varies from 45,000 to 55,000 m^3/sec at different stations over the Brahmaputra River. Integration of model observations and SWOT hydrology simulator generated water surface profiles strengthen the development of discharge estimation algorithm over the braided reaches of the Brahmaputra River. Initial results of discharge estimation algorithm over complex braided reaches found to be encouraging.

Keywords: SWOT, River Discharge, River Hydraulics, Hydrological Modeling

TRACKING PLATE VELOCITY AND MOTION OF HIMACHAL PRADESH AND UTTARAKHAND USING CORS DATA

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Abstract

In the dynamic realm of geodesy and geophysics, understanding the movements of tectonic plates is of paramount importance. The Indian subcontinent, situated on the northern fringe of the vast Indo-Australian plate, has been witness to significant geological changes over the eons. With an emphasis on Northern India (Himachal Pradesh and Uttarakhand), this research explores precise positioning data to trace the plate velocity migration using Continuous Operating Reference Stations (CORS) data from the Global Navigation Satellite Systems (GNSS) for 2021-23. A total 18 stations CORS data were collected and processed using Trimble business software to convert it into readable format (rinex file) and quality check was performed using the TEQC software that guides about the various constellations and errors in the file. To estimate plate velocity, Bernese 4.2 software was used which is based on the NNR-NUVEL 1A model to process the observation files into important information the 3D velocities of different stations which shows the co-ordinates shift, plate shifting in x, y and z coordinate, latitude, longitude, height of the station, priori value and estimated value of the shifting of the plates. Based on the two and half year's data, it is observed that Indian plate is moving northeasterly. After calculating the velocity of each year, it is noted that the plate is moving 4.9 mm per year in 2021, 5.3 mm per year in 2022 and 5.3 mm in 5 months. It is crucial to understand that plate motion is not constant over the entire plate and that there may be differences in the direction and speed of movement across various plate sections. As the plate is constantly moving the most common kind of hazard faced by the state is earthquake which occurs every month in all the stations. With the reference lineaments present in the study area, earthquake vulnerability maps are prepared for both states which show vulnerability of earthquake with a small magnitude or greater but does not fall beyond 3 magnitudes. In conclusion, it has been possible to learn a great deal about the tectonic dynamics of Northern India by combining the tracking of plate velocity movements using CORS data. By expanding understanding of plate tectonics and geodynamics, ongoing study in this field will help protect vulnerable communities from upcoming geological disasters.

Keywords: Tectonic Plates, Plate Velocity, CORS Data, Vulnerability

SPATIO-TEMPORAL CHANGES IN GROUNDWATER STORAGE AND IDENTIFICATION OF GROUNDWATER STRESS ZONES IN INDIAN GANGA BASIN USING MULTI-TEMPORAL SATELLITE DATASETS

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Abstract

Groundwater is an essential natural resource crucial for human life and a vital component of earth ecosystems, also plays important role in agriculture, industrial purpose and domestic sectors. With rapid population growth, increasing demand on food and consequent enhanced water intensive cultivation groundwater storage has been depleting in many parts of the world and recent research shows that approximately two-third of the global population currently lives in areas that faces groundwater scarcity at least one month in every year. Ganga basin is the India's largest river basin which is characterized by dense population, extensive irrigated lands where approximately 50 % groundwater is being used for irrigation purposes. The basin is the backbone of food supply of our country and a large part of the basin comprises intensive agricultural activity. Gravity Recovery and Climate Experiment (GRACE) provides an unparalleled possibility to science community for measurement of changes in terrestrial water storage change and monitoring groundwater storage change on a large scale and also provide the temporal variation of earth gravitational field. In this study, GRACE derive TWSA and GLDAS water components were used for monitoring groundwater storage changes through MMK test and Sen-Slope analysis. MODIS-NDVI and Land Surface Water Index (LSWI) with 8 days' interval and 500m spatial resolution (2005-2022) were used for cropping intensity mapping. Pre-processing of this data was performed by using Sgolay filtering techniques. We identified vulnerable zone under groundwater stress by using groundwater change rate, changing pattern of cropping intensity and population density during the study period. The study reveals that North western part of the study area is facing the most challenging condition and also, the middle and lower Gangetic plains are in very high alarming stage as a consequence of rapid urbanization and intense cropping system with irrigated water.

Keywords: GRACE, MMK, Cropping Intensity, Population Density, Indian Ganga Basin

SUB THEME-13: DIGITAL AGRO-ECOSYSTEM

A SEMI-PHYSICAL APPROACH USING REMOTE SENSING BASED NET PRIMARY PRODUCTIVITY (NPP), SPATIAL, SPECTRAL & TEMPORAL PADDY YIELD MODEL DEVELOPMENT FOR THE STATE OF ASSAM.

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Abstract

India, renowned as the leading rice exporter and the second-largest rice producer globally, faces the crucial task of ensuring an adequate rice supply to meet the demands of its growing population. Consequently, accurate yield prediction plays a vital role in enabling policymakers and planners to devise effective strategies concerning import-export dynamics to achieve food security objectives. Additionally, such predictions serve as a valuable tool for crop insurance purposes. This research focuses on Assam, a state in India known for its significant cultivation of paddy. In Assam, paddy is cultivated three seasons, namely Ahu (Autumn rice), *Sali* (Winter rice), and Boro (summer rice). The study primarily focuses on the "*Sali*" season, given its prominence as the dominant crop, occupying approximately 77.5% of the rice-growing area(*dmagri.in*) and contributing to nearly 75% of the overall rice production in the state *(dmagr.in*). The selection of the Sali season is further influenced by its vulnerability to flood- related challenges, rendering it an ideal period for investigation. To achieve cost-effective and efficient crop monitoring, remote sensing technology is employed. This study adopts a semi- physical approach for predicting crop yield, utilizing remote sensing data for crop masking in the study area, coupled with essential physiological parameters including temperature stress, water stress, and insolation. The estimation of Net Primary Productivity (NPP) is accomplished through Monteith's model, leveraging variables such as Photosynthetically Active Radiation (PAR), Fraction of Absorbed Photosynthetically Active Radiation (fAPAR), Radiation Use Efficiency (RUE), water stress, and temperature stress. The NPP and Harvest Index (HI) are then utilized to compute rice/paddy yield. The investigation spans a period of five years (2018- 2022) and encompasses the entirety of Assam. Comparisons with existing data from the Directorate of Economics and Statistics (DES) demonstrate slight deviations in yield, primarily attributed to the relatively coarse resolution of the remote sensing data (500m or 1km). Nonetheless, this research model exhibits promising potential for semi-operational utilization in forecasting rice crop yield.

Key Words: Remote Sensing, Monteith equation, NPP, Yield Estimation, INSAT 3D

MODELLING INTERRELATIONSHIPS AMONG PADDY TRANSPLANTING, CROP RESIDUE BURNING AND CROP YIELD USING OPTICAL, MICROWAVE AND THERMAL REMOTE SENSING

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Abstract

The problems of crop residue burning is associated with all the farmers that grow paddy crops during the Kharif (summer) season and wheat in the Rabi (winter) season in a cycle. Due to delayed sowing of paddy crop, the harvest is delayed, and the farmers have to prepare the wheat crop field within a short period, thereby increasing residue burning incidents. There are few studies in which the relationships among paddy transplanting, crop residue burning, and the following crop yield is evaluated using optical, microwave and thermal remote sensing. Sentinel-1 synthetic aperture radar (SAR) data during May to August of the five years (2017- 2021) was used for paddy identification in the Ludhiana district of Punjab. Paddy harvest during October-November each of the five years (2017-2021) was detected from Sentinel-2 data using Normalised Difference Harvest Index (NDHI). The grids with recurrent burning and non- recurrent burning of 1 x 1 km were selected based on the daily Visible Infrared Imaging Radiometer Suite (spatial resolution of 375 meters) from 1 October to 30 November over the five years. The semi-physical approach was used to estimate the wheat yield of the grids with recurrent burning and non-recurrent burning. Results showed that paddy was mainly sown/transplanted in the Ludhiana district between 1 June and 16 August, however highest paddy sowing/transplanting (approximately 63%) took place from the second week of June to first week of July during all the five years. Paddy was mainly harvested in the Ludhiana district between 1 October and 30 November, however highest paddy harvesting (approximately 63%) took place between 30 October and 12 November during all the five years. The number of paddy residue burning in recurrent burning grids of 1 km x 1 km were in the order: 2021 > 2020 >2017> 2018 >2019. Paddy sowing was significantly positively correlated with harvesting (r= 0.68), and burning (r=0.63). NDHI was also significantly positively correlated with fire count (r=0.96). The simulated grain yield of wheat was higher form recurrent non-burning sites than adjacent burning sites. However, the analysis of simulated wheat grain yield of all the recurrent burning and non-burning sites across the Ludhiana district showed higher yield from recurrent burning sites than recurrent non-burning sites due to differences in soil texture. These results provide a practical assessment of the existing mitigation policy, which would help the government for a successful policy implementation for sustainable management of crop residues.

Keywords: Crop Yield, Paddy, Residue Burning, Sentinel-1 &2, Wheat

MAPPING *Pinus roxburghii* USING AN INNOVATIVE TRAINING APPROACH OF FUZZY MODELS IN WESTERN HIMALAYAN FORESTS

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Abstract

Application of semi-hypertemporal (SH) remote sensing for the mapping of plant species can contribute significantly to their sustainable management while handling spectral overlap between classes. *Pinus roxburghii* (PR), commonly known as *Chir Pine*, is a plant of immense ecological and economic significance in the Himalayan region. It is often found in association with *Quercus leucotricophora* (QL) and *Rhododendron arboreum* (RA) in the surroundings of the Dudhatoli range, Uttarakhand. Although found in pure patches, PR shows heterogeneity in an image probably due to changes in slope, aspect and availability of resources. This study aims to map PR using an innovative individual sample as mean (ISM) training approach within the framework of the possibilistic *c*-means (PCM) and noise clustering (NC) fuzzy models while handling heterogeneity within the class. The study uses SH-Modified Soil Vegetation Index 2 (MSAVI2) derived from the SH dataset comprising 17 images captured by the 8-band PlanetScope (PS) data. The accuracy assessment of the mapped PR was conducted using mean membership difference (MMD) and F-score. This study represents significant progress towards effectively using SH remote sensing and advanced ISM-based PCM and NC models to precisely identify and map PR while handling the challenges posed by heterogeneity within the class.

Keywords: Fuzzy Classification, Possibilistic *c*-Means, Noise Clustering, *Pinus roxburghii*, MSAVI2ISG

ASSESSING THE PERFORMANCE OF SIF DATASETS IN TRACKING THE PHOTOSYNTHETIC ACTIVITY OF AN INDIAN FOREST

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Abstract

Solar-induced chlorophyll fluorescence (SIF) refers to the energy emitted by plants during photosynthesis, resulting from the excitation of electrons to higher energy levels after absorbing the photosynthetically active radiation (PAR) and their subsequent radiative decay. SIF, being emitted in a narrow band, can be detected by a handful of satellites. Gross primary productivity (GPP) quantifies the photosynthetic carbon assimilation by plants and can be best estimated using the ground-based eddy covariance (EC) technique. The photosynthetic carbon uptake is a major means of climate mitigation; hence, it is imperative to monitor the same in the context of climate change, which has significant implications for terrestrial ecosystems. The potential of SIF for this purpose can be assessed by exploring its linkage with GPP. In this work, we have utilised the space-based measurements of SIF at 740 nm by Global Ozone Monitoring Experiment-2 (GOME-2) and at 757 nm and 771 nm by Orbiting Carbon Observatory-2 (OCO-2) and Greenhouse Gases Observing Satellite (GOSAT) in conjunction with the tower-based EC GPP measurements at a broadleaf deciduous forest in the Kaziranga National Park (KNP) in Assam. We find linear relationships exist between the SIF and GPP of this forest, which improves with temporal downscaling; at finer temporal resolutions, the microclimatic variations introduce nonlinearity in the underlying SIF-GPP relationships. Additionally, we also look into the absorbed photosynthetically active radiation (APAR), which refers to the portion of sunlight captured and used by plants for photosynthesis and compute the SIF use efficiency of this ecosystem. Despite significant discord among the various space-based SIF datasets, the promising replication of the photosynthesis pattern by different sensors points to the high possibility of using these for tracking photosynthesis. However, the environmental drivers are found to modulate the functional relationships governing this.

Keywords: Solar-Induced Chlorophyll Fluorescence (SIF), Eddy Covariance (EC), Carbon Cycle, Forest Ecosystems, Climate Change

DEVELOPMENT OF A SMART PHONE BASED SOIL QUALITY PARAMETERS ESTIMATION APPLICATION (SSQ-APP) AT FARMER'S FIELD LEVEL BASED ON QUANTITATIVE COLOUR MEASUREMENT

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Abstract

Soil quality which indicates the ability of a soil to effectively perform its various designated functions is known to be highly influenced by various inherent as well as anthropogenic factors. Due to the complex nature of soil quality, its measurement mainly relies on use of various indicators, which are primarily the different quantifiable soil properties. Among the various indicators, soil organic carbon, nitrogen as well as clay content are known to influence numerous soil physical, chemical as well as biological processes thus playing a prominent role in determining soil quality. Soil colour is an important soil physical property which is influenced by different soil quality parameters through their spectral response in the visible range of the electromagnetic spectrum. Hence, soil colour has long been used as a tool for identification of soil as well as determining various soil characteristics in qualitative manner. However, no such attempts have been made in India to predict different soil quality parameters using soil colour measurements. The present study was carried out for development of prediction models for soil quality parameters (Soil C, N, Clay) based on quantified colour measurement and development of a mobile based application for real time monitoring of soil nutrients at farmer's field level particularly for the Himalayan region of Uttarakhand. Nearly 2500 surface soil samples from different land use types and belonging to different textural classes, were pre-processed and subdivided into two parts. One part was used for estimation of various soil quality parameters including soil organic carbon (SOC), nitrogen (N), clay content (%) as well as different nutrients using standard laboratory analytical procedures and other part used for quantitative measurement of soil colour using mobile based NixProTM colour sensor. The colour sensor measured colour of each soil sample in eight different quantitative color space models of which five color spaces (namely LAB, LCH, XYZ, RGB, CMYK) were further selected and used for model development. The soil property and corresponding colour databases thus generated were further used for the development of prediction models. The soil Database was then segregated based on broad textural groups – fine, medium and coarse and development of colour based soil quality prediction models for each of the textural groups was attempted. Multiple linear regression modelling approach was adopted for identification of soil quality sensitive color spaces as well as development of prediction models. Among the 05 different color spaces compared, *LAB* color space was found to be the most suitable for prediction of soil properties. Using the identified color spaces, predictive models were developed. Prediction of soil organic carbon and total Nitrogen in medium and fine textured soils could be done with considerable accuracies as revealed by the results. The developed models predicted organic carbon, nitrogen and clay content with adj R2values of 0.73, 0.67, and 0.58 respectively, in medium texture group while lower adj R2 values of 0.40 (SOC) and

0.58 (nitrogen) were observed in case of fine texture group. The prediction ability of models developed for coarse textured soils were found to be very low. Further attempts to predict available phosphorus and potassium content yielded no significant relationship with any of the colour spaces.

The soil quality parameter predictions models were further used for development of mobile based application which could be adopted by the farming community at field level to monitor soil quality based on the soil color. The mobile app operates based on the photograph of soil samples by converting the *RGB* values into *LAB* colour space and further employing the developed prediction equations depending on the broad textural group to which the soil belongs. A prototype of the application has been developed and is in further improvement phase to enhance its efficiency for accurate prediction of SOC as well as Nitrogen content in the soils. The application could be a very helpful tool for the farming community by enabling them with a less expensive tool for estimating quality parameters of their soils with considerable accuracies.

Keywords: Soil Organic Carbon (SOC), Nitrogen Content, Clay Percentage, Soil Color Measurement, Prediction Models

WHEAT LODGING ASSESSMENT FROM SENTINEL-2 DATA USING MACHINE LEARNING ALGORITHMS

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Abstract

Wheat lodging is a recurrent phenomenon that significantly reduces grain yield and impedes harvesting efficiency. Therefore, the precise and rapid assessment of wheat lodging is crucial for estimating the yield loss. Recently few studies related to machine learning based wheat lodging have been reported; however, the literature is still silent on assessing machine learning algorithms for wheat lodging on the Indian agricultural fields. This study presented a systematic approach for detecting the wheat lodging occurred during the end of March /April 2023 in the Ludhiana district of Punjab (India) from multi-temporal Sentinel-2 data using the machine learning algorithms. The ground control points for healthy and lodged areas were collected during March and April 2023. The temporal characteristics of crop phenology from November 2022 to April 2023 were studied for wheat classification. Normalized difference vegetation index (NDVI) was computed for this period followed by implementation of random forest (RF), decision tree (DT), and support vector machine (SVM) algorithms to evaluate their performance for wheat classification. It was found that RF performed better than the other algorithms in terms of prediction accuracy and wheat area extraction. The mapped wheat area in the Ludhiana district was 2400 km^2 during 2022-23. In order to separate the wheat lodging and non-lodging, nine spectral indices derived from different bands of Sentinel-2 were computed. The Crop Lodging Index (CLI) derived from blue, green, red and near infrared band accurately separated the lodged wheat from non-lodged wheat. The CLI index was fed to RF, DT, and SVM for extracting the wheat lodged areas which occurred in ~40% of the wheat grown area in the Ludhiana district. Among the three algorithms, RF algorithm mapped the wheat lodged area with ~90% accuracy. These results suggest that CLI index derived from Sentinel-2 data coupled with machine learning algorithms is useful for the assessment of crop lodging on spatio-temporal scale which may be helpful for developing the decision support system to assess the crop yield loss in a region.

Keywords: Lodging, Machine learning, Sentinel-2

SENSITIVITY ANALYSIS OF THE RUSLE EROSION MODEL TO SOIL ERODIBILITY FACTOR FOR NORTH- EASTERN PARTS OF PUNJAB USING GEOSPATIAL TECHNOLOGY

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Abstract

Soil erosion assessment and mapping of erosion prone areas serve the knowledge for soil conservation and watershed management. Therefore, the need is not merely the qualifying the erosion rate but such results of erosion assessment can be useful for any decision making and supportive in policy formulation for the land productivity. The dominant model applied worldwide to soil loss prediction is Universal Soil Loss Equation (USLE)/ Revised Universal Soil Loss Equation (RUSLE). Although it is an empirical model, the combined use of remote sensing, geographical information system (GIS) and USLE/RUSLE equations make soil erosion estimation and its spatial distribution feasible with reasonable costs and better accuracy in larger areas. The integrated use of remote sensing and GIS could help to assess quantitative soil loss at various scales and also to identify areas that are at potential risk of soil erosion. Many studies have used the Food and Agriculture Organization (FAO) soil map to derive the soil erodibility (K) factor to estimate the soil loss for a watershed, which may not be useful for developing the field applicable strategies to control the land degradation by soil erosion. Therefore, the sensitivity of the RUSLE erosion model to soil erodibility factor was evaluated using FAO soil map and the field collected soil samples at 1 km x 1 km grid in the 13 micro- watersheds of north-eastern parts of Punjab. Soil samples were analysed for particle size distribution and organic carbon using standard methods. The rainfall erosivity (R) factor was calculated from 0.25 X 0.25-degree data of the India Meteorological Department, soil erodibility (K) factor from FAO data and the field collected gridded soil data, slope characteristics (LS) from ALOS PALSAR digital elevation data, cover management (C) factor from NDVI and conservation practice (P) factor from landuse/landcover data. Each of these factors were derived separately, and the yearly average loss of soil erosion was determined by multiplying the R, K, LS, C and P factors in the GIS software. Results showed that the 'soil erodibility' factor (K) varied from 0.068 to 0.082 t hr MJ^{-1} mm^{-1} using the FAO soil map and from 0 to 0.068 t hr MJ^{-1} mm^{-1} using the measured gridded soil data. Using the RUSLE equation, calculated soil erosion ranged from 0 to 2.24 t ha^{-1} $year^{-1}$ with K factor derived from FAO soil map, and from 0 to 1.79 t ha^{-1} $year^{-1}$ with K factor derived from measured gridded soil data. Spatial distribution of the soil erosion showed that 95% of the total watersheds area (101.9 km^2) is exposed to soil erosion within 0-0.5 t ha^{-1} $year^{-1}$ using measured gridded soil data, but 89% of the total watersheds area is exposed to soil erosion range using FAO soil data. The estimated soil loss in the 0.5-1 t ha^{-1} $year^{-1}$ range accounted for 4.80 % and 9.53% of the total area based on measured gridded soil data and FAO data, respectively. Furthermore, only a small portion, 0.12% and 0.87% of the total area, exhibited soil loss exceeding 1 t ha^{-1} $year^{-1}$ in the measured gridded soil data and FAO datasets, respectively. These results have implications on accurate assessment of possible soil erosion in an area followed by planning and implementing erosion control measures in the impacted areas.

Keywords: Erodibility, K Factor, Sensitivity, Soil Erosion

GIS- BASED SITE SUITABILITY STUDY FOR EXPANSION OF PINEAPPLE IN RI BHOI DISTRICT OF MEGHALAYA, INDIA

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Abstract

Meghalaya is agrarian State rich in biodiversity favorable for variety of sub-tropical and temperate fruits including citrus species, pineapple, banana, papaya, guava and jack-fruit. Pineapple is one of the most important fruit crops in the State, besides mandarin orange and banana, with a positive average growth rate in production. The most prominent pineapple variety grown in the State is Giant Kew, followed by the Queen variety. Ribhoi district being one of the largest producer in the state contributes about 1,38,701 MT. Total area occupied by pineapple in the state is around 12,202 ha out of which 4063 ha area is represented by Ri Bhoi district. An attempt was made to identify potential sites for expansion of pineapple in Ri Bhoi district using geospatial technology. Suitable areas for growing pineapple were assessed using multi-criteria decision making (MCDM) and weighted overlay analysis (WOA). The parameters taken into consideration were climatic (rainfall & temperature), physiographic (elevation & slope) and soil (depth, drainage, texture, pH, organic carbon, K_2O & P_2O_5). Culturable wastelands *viz.* current jhum, abandoned jhum, open scrub & agricultural plantations were identified using Sentinel-2 satellite imagery and considered for site suitability study. All the parameters were categorized into four class *viz.* high, moderate, marginal and not suitable following standard criteria. The suitable sites were obtained by WOA after assigning appropriate weight to each layer and rank to each class. The total area of Ribhoi district is 2,35,972 ha out of which 4199.68 ha was found to be suitable for expansion of pineapple cultivation. An area of about 135.07 ha, 3478.88 ha and 585.74 ha were found to be highly suitable, moderately suitable and marginally suitable, respectively.

Key words: Culturable Wastelands, Geospatial Technology, Pineapple, Site Suitability, Weighted Overlay

ESTIMATION OF GROSS PRIMARY PRODUCTION IN RICE-WHEAT SYSTEM USING SATELLITE BASED VPM MODEL

Akarsh S. G., Shweta Pokhariyal, N. R. Patel and R. S. Rana

Indian Institute of Remote Sensing – ISRO, Dehradun

Abstract

In India, rice and wheat are pivotal field crops, and understanding their impact on climate change necessitates a comprehensive assessment of their Gross Primary Production (GPP) through source and sink relationships. In this study, we employed the Vegetation Photosynthesis Model (VPM) to calculate GPP of Rice-Wheat system in the Kangra, Palampur, and Dharmashala regions of Himachal Pradesh from 2020 to 2023. Our data selection was guided by crop-specific phenology, and crop masks using TIMESAT and Google Earth Engine's (GEE) Random Forest classification respectively. To fine-tune our analysis, we calibrated Photosynthetically Active Radiation (PAR) data from INSAT-3D using eddy covariance (EC) data from the Palampur Flux Station (PFS). The Fraction of Absorbed Photosynthetically Active Radiation (*f*APAR) was computed using a derived Leaf Area Index (LAI) map, applying Beer Lambert's Law. Additionally, we determined two-stage Maximum Light Use Efficiency (LUE_{max}) during the vegetative and reproductive phases based on EC data. Temperature and water stress indicators were derived from ERA-5 air temperature and Sentinel-2 Land Surface Water Index (LSWI). Our findings revealed that rice exhibited a higher biomass production rate compared to wheat. For rice, the cumulative average seasonal GPP was 997.89 g C m^{-2}, with the highest fortnightly mean daily GPP occuring duringsecond fortnight of August. Conversely, wheat had a cumulative average seasonal GPP of 822.17 g C m^{-2}, with the highest fortnightly mean daily GPP observed during second fortnight of March. We validated our modeled GPP (GPP_{VPM}) against EC GPP (GPP_{EC}) at fortnightly intervals, achieving reasonable agreement index of 0.995, with a RMSE of 0.95 g C m^{-2} day^{-1} and a MAPE of 16.88%.

Keywords: VPM, Light Use Efficiency Model, Lue_{max}, GPP, Rice, Wheat, GEE, Eddy Covariance

YIELD MODELLING OF CITRONELLA (*Cymbopogon winterianus Jowitt*.) CROP BASED ON HYPERSPECTRAL SENSING

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Abstract

Farmers and growers generally use approaches based on the crop environment and local meteorological data, many of which are labor-intensive, to predict crop yield. Though, these approaches have wide acceptability, but they lack real time feedback which may be useful for crop management purposes. This is true for the Citronella crop, which is a major essential oil crop cultivated by farmers for its remunerative value. Early detection of stunted crop growth can help in devising a strategy to prevent the occurrence or spread of the disease in the crop, thus ultimately affecting the crop growth yield. Citronella crop is grown by the group of farmers in clusters, which generally cover a wide area, so the use of advanced technologies like remote sensing can be a very important tool to minimize the cost of monitoring, and also eliminate the wasting of natural resources. Nowadays, various crop growth models based on remote sensing data and machine learning models are being widely used for crop yield estimation. In this study, we aim to investigate the relationships between citronella crop yield and plant spectral and biophysical information, collected using a hyperspectral camera (400-1000 nm). The experiment focused on 30 experimental plots of 10 treatments during 2020 and 2021. We used applicable accuracy and precision metrics from partial least squares regression and cross- validation methods to evaluate the predictive ability of harvest stages against our yield indicator (crop biomass). Spectral data sets were investigated to study that whether application of Artificial Neural Network (ANN) could accurately and precisely model observed variability in yield, in terms of the coefficient of determination (R^2) and root-mean-square error (RMSE). Our results suggested that the model performing at a low RMSE (0.323 tons/ha) and a high coefficient of determination (R^2 = 0.68).

Keywords: Remote Sensing, Hyperspectral, Crop Health, Citronella, Precision Agriculture.

VIRTUAL WATER ACCOUNTING OF AGRICULTURE IN PUNE DISTRICT

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Abstract

This study broadens the scope of water resource management by accounting virtual water content (VWC) in Pune district of Maharashtra by using remote sensing techniques. The quantification of virtual water content blue (VWCb) and green (VWCg) is conducted using MODIS Evapotranspiration and CHIRPS rainfall data. The data processing is carried out by Google Earth Engine (GEE). The core objective of this research is to account the VWC and analyse the variations in the water utilization in Kharif and Rabi seasons of agriculture in Pune district. In the Kharif season, agriculture predominantly depends on rainwater (green water), with an average VWCg of 1500 m^3 per ton to 2500 m^3 per ton in heavy and moderate rainfall years. In contrast, during Rabi season the range of VWC_b is 2300 m^3 per ton to 3000 m^3 per ton which is much higher than VWCg. It shows the excessive use of surface water and ground water for the agriculture. The study indicates the significant effects of water availability and varying rainfall patterns on crop production and VWC throughout the season. These results reveal important information for creating agricultural planning strategies and sustainable water resource management plans with the goal of increasing crop production and water efficiency in Pune District.

Keywords: VWCg, VWCb, Remote Sensing

ESTIMATION OF GROSS PRIMARY PRODUCTION IN RICE-WHEAT SYSTEM USING SATELLITE BASED VPM MODEL

Akarsh S. G., Shweta Pokhariyal, N. R. Patel and R. S. Rana

Indian Institute of Remote Sensing – ISRO, Dehradun

Abstract

In India, rice and wheat are pivotal field crops, and understanding their impact on climate change necessitates a comprehensive assessment of their Gross Primary Production (GPP) through source and sink relationships. In this study, we employed the Vegetation Photosynthesis Model (VPM) to calculate GPP of Rice-Wheat system in the Kangra, Palampur, and Dharmashala regions of Himachal Pradesh from 2020 to 2023. Our data selection was guided by crop-specific phenology, and crop masks using TIMESAT and Google Earth Engine's (GEE) Random Forest classification respectively. To fine-tune our analysis, we calibrated Photosynthetically Active Radiation (PAR) data from INSAT-3D using eddy covariance (EC) data from the Palampur Flux Station (PFS). The Fraction of Absorbed Photosynthetically Active Radiation (*f*APAR) was computed using a derived Leaf Area Index (LAI) map, applying Beer Lambert's Law. Additionally, we determined two-stage Maximum Light Use Efficiency (LUE_{max}) during the vegetative and reproductive phases based on EC data. Temperature and water stress indicators were derived from ERA-5 air temperature and Sentinel-2 Land Surface Water Index (LSWI). Our findings revealed that rice exhibited a higher biomass production rate compared to wheat. For rice, the cumulative average seasonal GPP was 997.89 g C m^{-2}, with the highest fortnightly mean daily GPP occuring duringsecond fortnight of August. Conversely, wheat had a cumulative average seasonal GPP of 822.17 g C m^{-2}, with the highest fortnightly mean daily GPP observed during second fortnight of March. We validated our modeled GPP (GPP_{VPM}) against EC GPP (GPP_{EC}) at fortnightly intervals, achieving reasonable agreement index of 0.995, with a RMSE of 0.95 g C m^{-2} day^{-1} and a MAPE of 16.88%.

Keywords: VPM, Light Use Efficiency Model, LUE_{max}, GPP, Rice, Wheat, GEE, Eddy Covariance

SPECTRAL CHARACTERISATION OF TERMINAL HEAT STRESS IN WHEAT CROP IN INDIA

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Abstract

With increasing risks of high temperatures particularly during the later part of wheat growing period, significant yield loss due to heat stress has been recurring over the major wheat growing regions of India in the recent years. Heat stress resulting from an unprecedented spike in temperatures beginning in the mid-March 2022 has had a marked impact on India's wheat crop, particularly for late planted crop during critical milking/grain filling stage. Remote sensing techniques are proven as potential tool, having a wide range of applications including crop area mapping, crop phenotyping, yield estimation and crop diseases and abiotic stress detection. However, remote sensing techniques for monitoring the effects of extreme weather events like heat stress are still underdeveloped. In this context, the present study evaluates the potential of satellite-based remote sensing to detect the effects of terminal heat stress on wheat crop in India over the 2019–2020 and 2020–2021 and 2021-2022 seasons. The objective of this study is to assess the feasibility of using medium resolution multispectral information to characterize potential heat stress responses in wheat crop at regional scale. In particular, the spectral response of wheat crop to the heat stress is being characterised in terms of vegetation indices over different spectral ranges .The vegetation indices used for characterising the spectral response of wheat crop stress includes NDVI (Normalised Vegetation Index), Chlorophyll Absorption Ratio Index (CARI), Chlorophyll Red-Edge (Chlred-edge) , Enhanced Vegetation Index (EVI), Modified chlorophyll absorption in reflectance (MCARI), Soil-Adjusted Vegetation Index (SAVI) and Transformed Chlorophyll Absorption Ratio (TCARI) etc. In order to evaluate the spectral response, statistical analysis is being carried out by computing Pearson's correlation coefficients between the environmental parameters and spectral bands/VIs. Inter annual comparison of Vegetation Health Index over wheat crop is carried out to study the overall vegetation condition during the milking and grain filling stages. This study demonstrates a technique to characterise heat stress of wheat crop in the near real time as well as mapping of the stressed crop at regional scale. The impact of heat stress on the wheat crop phenology during the recent past years is also being analysed in the major wheat growing regions of India.

Keyword: Terminal Heat Stress, Chlorophyll Absorption Ratio Index (CARI), Chlorophyll Red-Edge (Chlred-Edge), Vegetation Health Index (VHI), Phenology


POSTER PRESENTATIONS

SUB THEME-1: HPC, MACHINE LEARNING AND GEO AL

INTEGRATED USE OF VEGETATION INDICES AND MACHINE LEARNING TECHNIQUES FOR DELINEATION OF BORO RICE IN ASSAM

S. Vishwakarma, P. Jena, B. K. Handique, F. Dutta, C. Goswami, J. Goswami, P.T. Das and S.P. Aggarwal

North Eastern Space Applications Centre, Umiam, Meghalaya, India

Abstract

Cultivation of summer/boro rice after winter/kharif rice is a strategic and economically viable agricultural practice in Assam. It optimizes residual water resources, supports farmers' livelihoods, and contributes consistent rice supply, ensuring sustainability and economic stability in the region. An exercise was carried out to discriminate boro rice from other land uses (wetland, settlements, permanent vegetation, and seasonal agriculture crops) during 2022- 2023 using geospatial technology. Normalized Difference Vegetation Index (NDVI) and Land Surface Water Index (LSWI) derived from time-series Sentinel-2 Multi Spectral Instrument (MSI) data (January – May, 2023), integrated with machine learning algorithms was used for accurate delineation of boro rice in the state. Because of the peculiar characteristics ofpuddling and flooding in rice cultivation, potential rice area was first estimated, where three decision rules were employed viz., $NDVI_{jan\text{-}mar} < LSWI_{jan\text{-}mar}$, $NDVI_{apr} < 0.15$ (wetland and settlements mask) and $NDVI_{jan\text{-}may} > 0.2$ (permanent vegetation mask). Then two machine learning algorithms viz., Random Forest (RF) and Support Vector Machine (SVM) were used to discriminate boro rice from other agricultural crops. It was observed that the RF algorithm achieved an impressive overall accuracy of 90.5%, showcasing its robust classification capabilities. Similarly, the SVM algorithm exhibited notable accuracy of 82.8%. This exercise underscores the potential of vegetation indices and machine learning in precisely mapping boro rice, which is crucial in ensuring food security and sustainability for the state.

Keywords: Boro Rice, Land Surface Water Index, Normalized Difference Vegetation Index, Random Forest, Support Vector Machine

PREDICTION OF SOIL TEXTURE WITH MACHINE LEARNING MODELS BASED ON THE SPECTRAL RESPONSE OF SOIL SAMPLES IN VISIBLE-NEAR INFRARED (VIS-NIR) REGION

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Abstract

This study aimed to enhance soil texture prediction for effective land management by integrating spectral data and advanced machine learning models, circumventing the constraints of traditional lab-based analyses. In this comprehensive study, we applied a range of preprocessing techniques, including Savitzky–Golay filter (SG filter), Multiplicative Scatter Correction (MSC) and Standard Normal Variate (SNV), in conjunction with variousmachine learning models such as Random Forest (RF), Partial Least Square Regression (PLSR), Support Vector Machine (SVM) and Artificial Neural Network (ANN), to predict crucial soil properties, namely sand, silt, and clay content. The results revealed the exceptional predictive capabilities of the RF model when combined with the SG filter preprocessing technique, yielding high R2 values of 0.88, 0.86 and 0.92 for sand, silt and clay, respectively, signifying the precision and accuracy of our approach in estimating soil properties. Furthermore, the low RMSE values of 1.8940, 1.5880 and 2.4192, alongside robust RPIQ values of 3.18, 3.54 and 4.87, and substantial RPD values of 8.33, 7.14 and 12.5 for sand, silt and clay, respectively, underscore their effectiveness in soil property prediction. This study showcases the potential of integrating spectral data with advanced machine learning techniques for efficient soil texture prediction, offering valuable insights for land management practices.

Keywords: VIS-NIR Spectroradiometer, Pre-Processing, Random Forest, Savitzky-Golay, Coefficient Of Determination

SOLAR PANEL DETECTION: A DEEP LEARNING APPROACH FOR URBAN AREAS

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Abstract

The rapid expansion of solar energy production stands as a transformative force within the global energy landscape. India is one of the fastest-growing solar markets in the world, with a cumulative solar power capacity of 61.97 GW as on 30th November, 2022. The Indian government has set a target of achieving 100 GW of solar capacity by 2022 and 500 GW by 2030. A comprehensive location-based inventory of solar panels in a given urban area is essential to assist analysts and policymakers in defining strategies for further harnessing solar energy. Towards this satellite imagery & solar panel detection algorithms can play a significant role in identifying the existing solar panels and suitable sites for panels in order to support the Indian government's solar targets and policies, such as the PM-KUSUM Yojana and the Rooftop Solar Programme. The current study focuses on solar panel detection especially from building rooftops in urban areas using very high resolution satellite imagery and deep learning based architecture. In this paper, we present Convolutional Neural Network (CNN) architecture, finely tuned for solar panel detection with the available datasets showcasing its robust performance in discriminating between solar panels and non-panel locations. Deep learning based architecture relay on large scale training data, hence in this work a database is also prepared with different existing scenarios of solar panels. This will enable development of automatic solarpanel detection and tracking systems and serve as a potential assessment tool for solar city programme and sustainable urban development.

Keywords: Solar Panel Detection, Deep Learning, Convolutional Neural Network (CNN), Renewable Energy, Urban Planning, Photovoltaic Systems.

PHENOLOGICAL TRAIT RECOGNITION OF UNDERSTORY INVASIVE SPECIES USING MACHINE LEARNING ALGORITHMS

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Abstract

Existence of life forms depends on resources from forest products which has been increasingly affected by human influence in past decade. Forest experts and managers are interested to study reason of biological invasion as they pose threat to endemic biodiversity which can harm this valuable resources. To reduce the impact of invasive alien species, early detection, monitoring, and prediction of future spread are therefore necessary. In the field of biological invasion, remote sensing techniques have been widely used for invasive plant species mapping. Invasive species mapping involves discriminating target invasive species from native species and other land cover types. The phenological traits of non-native species differ from the native species, enabling detection of this species beneath the canopy. In this study, phenology-based vegetation indices were calculated which aim at distinguishing two different herb invasive plant species from forest classes by knowing the most effective ML algorithm that can be used for classification purposes. Temporal graphs indicating differences in band frequency corresponding to pixel values for each phenological indices was studied to understand reason for inter and intra species discrimination. Decision tree-based models like Random Forest (RF) and Gradient Tree Boosting (GTB) were incorporated to understand the best effective for pixel- based classification on cloud computing platform GEE. RF and GTB classification results shows an overall accuracy of these classifiers was calculated as 85.67% and 83.37% respectively and the kappa coefficient of these classifiers was calculated as 0.65 and 0.52 respectively. Results obtained so far shows that machine learning algorithms are still effective for pixel-based classification of understory invasive plant species from forestclass. Thus, this study shows a technical procedure to distinguish invasive plant species from forest class which can help forest managers to locate invasion sites to eradicate them and conserve native biodiversity.

Keywords: Invasive Plant Species, Senescence, Green Period, Phenology, ML

SHIP DETECTION FROM SATELLITE IMAGES USING DEEP LEARNING BASED ALGORITHM

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Abstract

Ship detection is of crucial importance to maritime surveillance, & can assist in monitoring & controlling illegal fishing, marine traffic, & similar activities along sea boundary. Remote sensing harnesses the power of high spatial and temporal resolution enabling comprehensive coverage of maritime areas. Detecting and categorizing ships from satellite image poses various challenges for object detection in computer vision. Deep-learning-based detectors have reported many promising results. Deep learning models are particularly adept at detecting diverse ship types, orientations, and environmental conditions, yielding superior accuracy. However, training a ship detector for maritime security is still an open question with several challenges owing to unavailability of suitable and sufficient training datasets. In this study, YOLOv5 is employed and trained on a custom dataset for ship and boat detection, utilizing high-resolution optical satellite dataset sourced from the Kaggle platform which included Planetscope, WorldView-3 and MASATI v-2. Model hyperparameters viz, optimiser, learning rate etc. were tuned to generate an optimum model for ship detection. A customised model specifically tuned to handle data disparities was developed through implementation of YOLOv5 incorporating the Stochastic gradient descent (SGD) optimizer, configured with a learning rate of 0.01 and momentum of 0.937. The results of this customised model resulted in a mean Average Precision at IoU (Intersection over Union) threshold 0.5 (mAP@0.5) of 0.630. This research framework presents a promising avenue for enhancing the performance of object detection algorithms in the realm of maritime surveillance. By leveraging the capabilities of DL models and RS technologies, it offers a transformative approach to ship detection and monitoring, thereby contributing to more effective maritime security and DSS.

Key Words: Deep Learning, Stochastic Gradient Descent, YOLO, Hyperparameters

SUB THEME-2: UAV APPLICATIONS

TOWARDS EFFECTIVE CROP HEALTH MONITORING AND PRESCRIPTIVE ANALYTICS FROM MULTISPECTRAL DRONE IMAGERY

P.S. Singh, Victor Saikhom, Rajkumar Josmee, Dibyajyoti Chutia and S.P. Aggarwal

Abstract

Drones are increasingly becoming integral to agricultural crop monitoring, particularly in the assessment of crop health, disease detection, phenotyping, and crop counting. Multispectral imagery unveils insights about crops that remain hidden from the human eye. This valuable information finds its application in precision agriculture, offering farmers site-specific guidance on crop health. This, in turn, empowers them to efficiently oversee, strategize, and manage their farms for enhanced productivity and yield. The paper focuses on processing of multispectral drone imagery, generate vegetation indices and build a user interface framework for performing prescriptive analytics for immediate advisory to the farmers. The study employs multispectral images of pineapple crops captured by the Micasense RedEdge-MX sensoracross multiple dates to evaluate crop health. A processing pipeline rooted in open- source tools is devised to convert raw RedEdge data into radiance and reflectance maps. These reflectance maps serve as the foundation for deriving various vegetation indices like the Normalized Difference Vegetation Index (NDVI), Normalized Difference RedEdge Index (NDRE), and Optimised Soil Adjusted Vegetation Index (OSAVI). The RedEdge band, positioned between the Red and NIR bands captured by the sensor, holds significance in accurately assessing plant chlorophyll content. The resulting vegetation indices arethen harnessed to create prescription maps, enabling individual farmers totreatments on specific affected zones based on nutrient-deficient crop areas across the field.

Keywords: Multispectral, Precision Agriculture, Analytics, Crop Health Monitoring

EFFECTIVE AFFORESTATION: BY UTILIZING DRONE TECHNOLOGY

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Abstract

Effective afforestation at remote locations such as deep forests and in very large areas in less time by utilisation of Drones, 3D mapping, and special seeding technology. Rapid deforestation and ecosystem degradation have become critical global concerns, emphasising the urgent need for efficient reforestation strategies. Traditional manual seeding methods are often labour-intensive and time-consuming, limiting their scalability. This abstract explores the potential of drone technology as an innovative and effective method for reforestation through aerial seeding. Firstly, we will do a drone-based survey and scanning of deforested areas by using the 3D-LiDAR object scanning to create a 3D map of empty areas of the forest. Almost 90% of seeds are either eaten up by birds or by insects or in some cases they get infected if they are directly spread over the the empty area of forest. As a solution to this problem, we will do camouflage pattern coating on the seeds so that they can not be identified by the birds. To save seeds from insects and infection, seeds will be soaked into pesticides before spreading them. Now the next problem is that if the seed is directly thrown from the drone then it may get damaged during contact with land and it will reside on the surface which decreases the chance of germination of the seed. As a solution to this problem, we will use a small wet wooden case with sharp tip and biodegradable. It will contain all the important nutrients needed by the seed for proper growth and germination. These small cases will be fired in a particular projectile from the drone. To maintain the proper density of the plants, grid map will be used for spreading the seed. We will generally go through this process of seeding twice a year at the start and end of the rainy season which will increase the chance of germination of seed. Real-time monitoring is done once the seeding process is done. Under this project, we will be developing a drone which will be equipped with various sensors which can be used to accomplish tasks like aerial scanning, projectile calculation, and setting the proper speed of firing the seed in a particular projectile.

Keywords: 3D Mapping, Camouflage Pattern Coating, Pesticides, Biodegradable Case, Grid Map, Projectile, Real-Time Monitoring

SUB THEME-3: OPEN GEOINFORMATICS (DATA & TOOLS)

OPEN GEOINFORMATICS: ADVANCEMENTS IN DATA AND TOOLS

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Abstract

Open Geoinformatics has emerged as a pivotal field at the intersection of geospatial data and open-source technologies, driving innovation and accessibility in the realm of geographic information systems (GIS) and spatial analysis. This abstract provides an overview of the key aspects of open Geoinformatics, encompassing both data and tools. Open Geoinformatics leverages open data sources, including government agencies, satellites, and crowdsourced platforms, to facilitate the free and unrestricted access to geographic data. These diverse datasets cover a wide spectrum, from topographic maps and climate records to socio- economic statistics and geospatial imagery. The open data movement promotes transparency, collaboration, and democratization of information, fostering the development of data-driven solutions for environmental monitoring, disaster response, urban planning, and more. On the tools front, open-source geospatial software has witnessed substantial growth and maturation, enabling users to harness the power of Geoinformatics without proprietary restrictions. Notable tools like QGIS, GDAL/OGR, GRASS GIS, and GeoServer offer advanced geospatial processing, analysis, and visualization capabilities. Additionally, web-based mapping libraries such as Leaflet, OpenLayers and Mapbox provide developers with the means to create interactive and custom geospatial applications. For Spatial Analysis R, python, Orfeo Toolbox, Rasterio are used. The synergy between open geospatial data and open-source tools has given rise to collaborative communities and ecosystems, fostering innovation and knowledge sharing. Geospatial analysts, researchers, and developers worldwide are working together to build and improve tools and workflows, ensuring a robust foundation for Geoinformatics. Challenges in open Geoinformatics include data quality, interoperability, and privacy concerns, which continue to be areas of active research and development. Furthermore, efforts are ongoing to bridge the digital divide and ensure equitable access to geospatial resources, particularly in underserved regions. Open Geoinformatics represents a dynamic and evolving field that harnesses the power of open data and open-source tools to address complex spatial challenges across various domains. This abstract provides a glimpse into the current landscape of open Geoinformatics, highlighting its potential to drive innovation, collaboration, and informed decision-making in an increasingly interconnected world.

Keywords: Open Geoinformatics, Open Data Sources, Open-Source Geospatial Software, Spatial Analysis Tools

SUB THEME-4: TIME-SERIES DATA APPLICATIONS

COMPARATIVE ANALYSIS OF RECONSTRUCTING TECHNIQUES FOR NDVI TIMESERIES

Utkarsh

IIRS (ISRO)-ITC (Netherlands) Joint Education Program 2022-23

Abstract

Normalised Difference Vegetation Index (NDVI) have served as a great tool in the study of crop health, phenology and environmental studies over time. Yet, its time series data often suffers attenuations due to factors like cloud cover and atmospheric disturbances. This issue needs to be addressed to extract accurate and optimal information from the timeseries data. We conducted a comprehensive study in the Karnal district of Haryana, known for its two distinct cropping seasons and low crop diversity. Pixel-wise sampling of three data points in Karnal was done to construct NDVI time series curves. We have employed four filtering techniques to smoothen the NDVI timeseries curve namely Savitzky Golay (SG), Moving Average (MA), Long Short-Term Memory (LSTM) and Bidirectional LSTM. SG filtering worked by fitting a user defined degree of polynomial over a sliding window of neighbouring data points whereas the MA filters assigned an average value to the attenuated part within the specified window size. LSTMs, which are the advanced version of Recurrent Neural Network (RNN) with no long-term dependency issues as observed in traditional RNN, use gated cells to effectively capture and process sequential data, preventing vanishing gradient problem. Results have shown that SG filtering was most effective in smoothening attenuations while preserving curve's shape and seasonality. However, SG's fixed polynomial order limits its ability to handle abrupt NDVI drops. LSTM leverage historical data to normalise the abrupt declines in NDVI and hence outperforms SG filter in these areas. The research opens a future scope of using a hybrid approach of SG and LSTM to smoothen the NDVI timeseries. The study conducted offers valuable insight into enhancing the accuracy NDVI timeseries for various purposes using various filtering techniques.

Keywords: NDVI, Time Series Data, Filtering Techniques, Savitzky Golay (SG) Filter, Long Short-Term Memory (LSTM)

COMPREHENSIVE STUDY OF LAND USE LAND COVER CHANGE AND ITS ECOLOGICAL IMPACT ON ANDAMAN AND NICOBAR ISLAND WITH SPECIAL REFERENCE TO CORAL REEF

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Abstract

The Andaman and Nicobar Islands are the largest archipelago system in the Bay of Bengal, A total of 3,80,581 people were living on 14 islands in the North and Middle Andaman, 7 in the South Andaman, and 10 in the Nicobar districts of the archipelago. Land Use and LandCover (LULC) changes play an important role in planning for the sustainable development of an area. The present study examines the spatial distribution of LULC changes in Andaman Island, Little Andaman Island, and Great Nicobar Island, Andaman, and Nicobar, India, using remote sensing and Geographical Information System (GIS) techniques for a period of the past 30 years. Landsat satellite data from 1990, 2000, 2010, and 2020 were used to investigate the changes. LULC classes mapped are forest, built-up, mixed crop with built-up, coral reefs, waterbodies, and swamps. Andaman and Nicobar Islands are vastly covered by forests. The results show that forest area has decreased, whereas built-up and mixed crops with built-ups have gradually increased over the years. The transition in land use prominently depends on the tourism, defence, civil, and fishing sectors which play a salient economic role in the development of the union territory. Port Blair is the capital city that connects through mainland transportation, so the density of population is high around this city. Over the years, the volume of coral reefs has shrunk from 557.88 km^2 in 1990 to 300.02 km^2 in 2020. The decline in the coral reef zone is due to the construction of coastal resorts the water sports activities, which disturbs the virginity of the coral ecosystem. Polluted water coming from upstream causes damage to the pristine coral reefs. The findings of this study are intended to contribute to effective and appropriate decision-making for resource management and in preparing a holistic island development plan.

Keywords: LULC, Coral reef, Geographical Information System, Climate Change

SPATIOTEMPORAL VARIABILITY IN NEAR-SURFACE AIR TEMPERATURE OVER THE INDUS RIVER BASIN

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Abstract

Near-surface air temperature (T2M) is crucial for regional climate assessment, as it accurately reflects intricate energy exchanges at the Earth's surface. It signifies global warming and impacts a multitude of interconnected climate processes, shaping the evolving climate system. Monitoring and comprehending shifts in near-surface temperatures are vital for evaluating and addressing climate change impacts. This study seeks to understand the changes in air temperature and its relationship with elevation over the Indus River basin from 1960 to 2021. Thus, the trend in T2M has been estimated at seasonal and annual scales, based on the monthly averaged T2M data from ERA5 reanalysis data. The analysis indicates an average increasing trend of nearly 0.23 °C/decade (significance at 0.10 level) over the region from 1960 to 2021, with the highest rise being recorded in pre-monsoon season (0.30°C/decade) followed by post- monsoon (0.26°C/decade), winter (0.25°C/decade) and monsoon (0.20°C/decade). Among the sub-basins, the trend in mean T2M is found to be highest in K (0.34°C/decade), followed by UI (0.30°C/decade), P (0.22°C/decade), and LI (0.16°C/decade). Furthermore, Kabul (K) showed the highest positive trend in mean T2M during winter and pre-monsoon, while it is observed to be highest in Upper Indus (UI) for monsoon and post-monsoon seasons. The study also highlights a higher rate of warming at elevations between 1500 and 4500 m above mean sea level across the IRB, clearly indicating elevation-dependent warming. The rising T2M trend would be helpful in understanding the changing dynamics of evapotranspiration, total cloud cover and hence the precipitable water vapor (PWV), the most prevalent greenhouse gas in the atmosphere. The heightened PWV can exacerbate the pace of warming, serving as positive feedback to global warming.

Keywords: Air-Temperature, Elevation-Dependent Warming, Reanalysis Data, Indus River Basin, Climate Change

MODELING OF URBANISATION AND ITS IMPACT ON REGIONAL AND LOCAL SURFACE TEMPERATURE OF COASTAL CITY USING NEURAL NETWORK ARCHITECTURE

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Abstract

Urbanisation are the common emerging trends in developing countries across the globe, which significantly has an impact in its local weather and climate over years particularly in coastal cities. Chennai a predominant urban growth coastal area experience one such trends on the unique trends of temperature within the city due to the varying land use and landcover across the city and suburbs. Urbanisation impact studies are predominant on numerical approaches with limited on machine learning with limited parameters. In this study multiple urban indices were analysed and machine learning techniques were used to correlate the temperature impacts on Land Surface Temperature(LST) and Local and Regional Urban Heat Island Intensity(UHI) across the city in varying patterns of growth over temporal periods using Landsat series and Sentinel-2 images on GEE and colab platform. The temperature variations show a predominant increase in patterns by 5^{o}C to 7 ^{o}C within the city and suburbs during the growth periods of observations (2000 – 2030). A high correlation of 0.954 shows a considerable impact on the increased built up with significant temperature changes of around 3^{o}C to 4 ^{o}C. Further the projection shows increase in trend of built-up area on the peripheral city with respect to temperature increase but the existing city shows a constant temperature with respect to built up and vegetation indices. The conclusive results on outcomes ultimately suggests the need effective planning of urbaisation for a sustainable living.

Keywords: Urbanisation, Coastal City, Machine Learning, LST, UHI

DECADAL VEGETATION COVER CHANGE ASSESSMENT IN AHMEDABAD CITY, INDIA USING LANDSAT-8 NDVI DATASET DURING 2013-2022

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Abstract

Urban vegetation plays a pivotal role in fostering sustainable development in cities worldwide. The significance of green spaces within urban environments cannot be overstated as they improve the air quality and also mitigate the urban heat island effect. With this background the present study of assessing the urban vegetation was planned for Ahmedabad city which is one of the fastest growing cities of India and has a population of more than 8.2 million in 464 sq km. In this study, Landsat-8 dataset for Normalized Difference Vegetation Index (NDVI) was considered for a period of one decade (2013-22). The spatial resolution of the dataset was 30 m × 30 m and accordingly there were 536,683 data points for NDVI in the study area. The annually averaged NDVI was then analysed using Mann-Kendall Trend Test and Sen's Slope for all the data points. The overall estimates of the city reveals that the NDVI has been decreasing at the rate of 0.0041 per year during 2013-22 at 99% confidence level. 77.4% of the city had a decreasing trend in the NDVI while the remaining 22.6% had an increasing trend. The decreasing trend in the NDVI in 4.6%, 15.7%, 18.2% and 4.2% area of the city was significant at confidence level of 99.9%, 99%, 95% and 90% respectively while that in the remaining 34.8% area was not significant whereas the increasing trend in 0.4%, 1.82%, 3.4% and 1.1% area of the city was significant at 99.9%, 99%, 95% and 90% confidence level while that in the remaining 15.9% area was not significant. The findings of the present study in terms of thematic spatial representation would be of great significance to the city's civic body along with various regulatory agencies for strengthening the urban environmental management plan focussing the well being of the residents.

Keywords: Ahmedabad, NDVI, Landsat-8, Urban Greening, Mann-Kendall Trend Test

SPATIAL AND TEMPORAL TRENDS OF AEROSOL LOADING OVER AHMEDABAD CITY, INDIA DURING 2013-2022

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Abstract

Aerosol Optical Depth (AOD) is a measure of the amount of aerosols, such as dust, smoke, and pollutants, in the Earth's atmosphere, and it provides valuable insights into air quality. AOD data from satellites has been analyzed to identify trends, seasonal variations, and anomalies, shedding light on the dynamics of aerosol distribution spatially and temporally. With this background, the present study of assessing the aerosol loading using satellite data was planned for Ahmedabad city which is one of the fastest growing cities of India and has a population of more than 8.2 million in 464 sq km. In this study, MODIS AOD data (MYD04_3K) was considered for a period of one decade (2013-22). The spatial resolution of the dataset was 3 km × 3 km while the temporal resolution was daily. The annually averaged AOD at all grid points of the study area was then analysed for 'trend' and 'rate of change' using Mann-Kendall Trend Test and Sen's Slope. The overall estimates of the city reveals that the AOD has been increasing at the rate of 0.018 per year during 2013-22 at 99% confidence level. The spatial analysis reveals that the increasing trends in 11.6%, 74.6%, 13.6%, and 0.2% area of the city was significant at 99.9%, 99%, 95% and 90% confidence level respectively. The COVID-19 lead lockdown in the year 2020 reduced the aerosol loading of the city by 2.8% with reference to previous year (2019). The findings of the present study in terms of thematic spatial representation would greatly help the environmental regulators and city's civic body for strengthening their Air Action Plan focussing the improvement in the air quality which would ultimately improve the health of the city dwellers.

Keywords: Ahmedabad, Air Quality, Aerosol Optical Depth, MODIS, Human Health

A SPATIO-TEMPORAL VARIATION OF DAY TIME AND NIGHT TIME LAND SURFACE TEMPERATURE USING MODIS AND GEE: A STUDY OF VADODARA URBAN AREA, GUJARAT

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Abstract

Rapid urbanization has significantly modified the landscape, which has important climatic repercussions through all scales due to the simultaneous transformation of natural land cover and introduction of urban materials i.e., anthropogenic impervious surfaces. As a consequence, these changes are impacting the amount of vegetation in an area and presence of vegetation is affecting the local Land Surface Temperature (LST). This mutual relationship between vegetation and temperature is a key aspect of the changing urban environment. A better understanding of the relationship between LST and its influencing factors is important to the livable, healthy, and sustainable development of cities. In order to assess the climatic and environmental changes, daytime and night time LST trend analysis for two-time period 2001 and 2021 (pre and post monsoon) using MODIS and Google Earth Engine (GEE) for the Vadodara Urban Area was performed. Spatial heterogeneity of the LST and LST change was observed. The results suggest that the nighttime LST has also increased. Hence, the study explores daytime and nighttime surface urban heat islands (SUHIs). The study delineates the thermal zones, calculates temperature within these zones, and compares the thermal variation for two-time period. This pattern was confirmed through LULC analysis using LANDSAT data. In addition, LST and NDVI variation were analyzed showing decline in LST along with rise in NDVI. An inverse relation is found between LST and NDVI using the Pearson Correlation Coefficient. In light of rising temperature this work can inform climate change adaptation efforts including urban planning policies, climate dynamics, ecosystem conditions, and land use changes.

Keywords: GEE, MODIS, SUHI, LST, NDVI

SUB THEME-5: RENEWABLE & NON-RENEWABLE ENERGY

SUB THEME-6: EMERGENCY & DISASTER MANAGEMENT

SUB THEME-7: SUPER RESOLUTION IMAGE & MAPPING

SUB THEM-8: BIOSPHERE, CRYOSPHERE & HYDROSPHERE APPLICATIONS

INTERLINKING OF RIVERS OF PALGHAR DISTRICT USING QGIS

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Abstract

The palghar district is having sufficient number of major and minor rivers and they are well connected due to topography of the region. In the present study an attempt has been made to carry out the interlinking of rivers in the palghar district with the help of satellite image and using QGIS software. Existing water resources are mapped like major and minor rivers, dams and lakes. The excess water during the rainy season is flowing through the rivers and finally entering into the Sea. To preserve this natural water, we have proposed the major dams along the coast-line and they are interlinked with artificial canals. Based on the topography and short distance the links are proposed in the rivers. It is observed that the storage capacity is improved by 38.37 % and area under irrigation is also benefited around 13.36%, Hence it is feasible to carry out the interlinking of rivers of palghar district.

Keywords: QGIS, River, Interlinking, Reservoirs

LAND USE LAND COVER DYNAMICS IN CENTRAL INDIA AND ITS HOTSPOT ANALYSIS USING GEOSPATIAL TECHNOLOGY

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Abstract

Land use/ Land cover (LULC) is a dynamic phenomenon due to various anthropogenic activities. LULC maps play an important role in program planning, management and monitoring at the local, regional and national levels. In this study, the LULC dynamics in the central region of India and changes have been studied through SISDP Phase-I & II data. The study area includes three states, namely, Madhya Pradesh, Chhattisgarh, and Maharashtra, and covers a total Indian geographical area of 22.8%. LULC maps under SIS-DP were generated using visual interpretation and digitization at the scale of 1:10,000. The datasets used in SISDP phase I & II include merged products of Resoursat LISS IV (multispectral image 5.8 m spatial resolution) and Cartosat series data (panchromatic image with 2.5 m spatial resolution). Change detection of SISDP data for Phase I & II were used to identify the changes of the LULC classes with significant positive and negative features. The Hotspot analysis has been carried out using Getis-Ord-Gi tools available in Arc-GIS Pro. Getis-Ord GI statistic measures the intensity of clustering of high or low values in a bin relative to its neighboring bins in the data cube. The sum for a bin and its neighbour's is compared proportionally to the sum of all bins. This generated clusters of spatially distributed features in high values (hot spot) and low values (cool spot). From Phase I to Phase II, the built-up area has increased drastically in M.P. and Maharashtra. The main forces behind change in hotspots, particularly in the context of agriculture, were institutional elements that enhanced access to water resources. The other enabling variables that influenced the transformation were those related to technology and the economy. This study demonstrated the capabilities of SISDP data for LULC strategies and planning at grass root level for local administration.

Keyword: SISDP, LULC, LISS IV, Change Detection, Hotspot Analysis

SPATIO-TEMPORAL LAND USE/LAND COVER CHANGES DUE TO COAL MINING IN PARTS OF TALCHER COALFIELD, ODISHA: A STUDY BASED ON REMOTE SENSING & GIS

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Abstract

Land Use/Land Cover (LULC) refers to the classification of human activities and natural elements on the landscape within a specific time frame. This is done using established scientific and statistical methods to analyze appropriate source materials. Opencast (coal) mining activities alter land use patterns, particularly impacting forests and agricultural lands. Present study aims to assess and quatify the land use/land cover changes from 2013 to 2022 in Talcher Coalfied. Talcher Coalfield in Odisha has seen extensive mining activities in the recent past. A window of 327 km2 around active coal mines was selected for LULC mapping and assessing change detection over 2013-2022 period and satellite data from LANDSAT 8 (OLI/TIRS) of 2013 and 2022 have been utilised for LULC mapping. Supervised classification Maximum Likelihood Classifier (MLC) was applied to prepare LULC maps. The visual interpretation technique supplemented was utilized to identify the desired class signatures and this was then applied to the entire scene. This helped to identify 9 categories of land use/land cover, including dense forest, open forest, open scrub, cultivated land, agricultural land, mining area, overburden dumps, wasteland, and settlement. The accuracy of the produced maps was confirmed by conducting ground truth verification in key areas. The analysis of LU/LC statistics indicates that the area underwent significant changes in LU/LC from 2013 to 2022, attributed to the growth in mining activity, industrialization, and urbanization. The areas under dense forest and open forest have decreased significantly during 2013-2022 period, from 18.5% to 7.9% and 30.1% to 20.4%, respectively. However, open scrub and agricultural land have increased from 14.2% to 18.1% and 22.9% to 30.6% respectively. On the other hand, significant increase in area has been observed under mining areas (5.61 km2), overburden dumps (8.52 km2) and settlement/built-up (10.9 km2). There was also a noticeable increase in water bodies (0.5%) and waste land (0.7%). The study found that mining and associated industrial activities negatively impacted LU patterns.

Keywords: LULC, Talcher Coalfield, LANDSAT, Supervised Classification, Visual Interpretation Technique

SUB THEME-9: DIGITAL TWIN/ECOSYSTEM

MIRRORING THE MAGNIFICENT: DIGITAL TWINNING, AI, ML AND IOT APPROACH TO MAPPING THE FISH BIODIVERSITY OF THE ARTIFICIAL CORAL REEFS

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Abstract

Coral reefs are the most dynamic and vulnerable marine ecosystems that are offering various ecosystem services to the humankind. In India, coral reefs are found in Gulf of Kutch, Gulf of Mannar, Palk Bay, Andaman & Nicobar and Lakshadweep islands, parts of Maharashtra, Kerala, Tamil Nadu and Karnataka. The reef ecosystem provides shelter, food for various reef fishes and the influence of pollution, ocean acidification is affecting corals and impacting the reef fishes thus dwindling their stocks. The Department of Fisheries, Government of India is installing artificial reefs as a conservatory and ecosystem approach fisheries management to enhance reef fisheries. A total of 732 artificial reef units were installed in 10 coastal states accounting to worth of Rs.126 crores. Monitoring the fish stocks and health of the artificial coral reefs remains as a challenge due to poor access to the underwater ecosystems. Digital twinning paired with photogrammetry of reef fishes helps in assessing reef fish stocks in the installed artificial reefs. The images of selected reef fish species in different angles covering 3600 were processed to 3D images using Meshroom and Blender softwares. The 3D images developed would serve as authentic and robust virtual source of information for proofing the species diversity by using artificial intelligence through machine learning from the data received through sensor cameras installed in the artificial reefs on a real time basis without any human intervention to the sites of artificial reefs. Integrating the digital twinning, artificial intelligence and IoT with the coral reef management measures emerges as a revolutionary approach in monitoring and conservation of the reef fishes thus resulting in healthy reef fish stocks in our marine ecosystems. The real-time virtual database of reef associated fish biodiversity helps in assessing artificial reefs thus assists in developing policy and implementing the fisheries schemes by the Government of India.

Keywords: Coral Reef, Fish, Marine, Digital Twin, ML, AI, Iot, Fisheries Management

ASSESSMENT OF WHEAT LODGING AREAS USING SENTINEL 2 DATA OF TEHSIL LUDHIANA WEST

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Abstract

The second-most significant food crop in the world is wheat. Wheat plants that swing or topple over as a result of bad weather, disease, or inadequate nutrition during farming are referred to as "wheat lodging" problems. Lodging is the movement of crop stems from their upright posture (stem lodging) or the breakdown of the root-soil anchorage system (root lodging). One promising way to quickly and accurately learn about the condition of agricultural crops is through the use of remote sensing technology. The primary goal of this study is to use Sentinel 2 data from Tehsil Ludhiana West to identify the area affected by wheat lodging. It reveals that susceptibility and lodging are precisely measured by optical satellite data, which is an essential component of operational crop lodging assessment. Rain and strong winds reaching 40 to 50 mph have been experienced in the study area. The results of the study show that, of the 272.5 square kilometres of wheat in the area, there was a wheat lodging of 130.4 square kilometres (47.8%) in March 2023. Based on Enhanced Vegetation Index (EVI), Normalized Difference Vegetation Index(NDVI), and Modified Normalized Difference Water Index (MNDWI), the overall accuracy for wheat lodging is 89%, 81% and 62 % respectively. In addition, prompt evaluation of lodging risk can lower production losses, boost output, and enhance resource efficiency.

Keywords: Sentinel 2, Wheat Lodging, EVI, NDVI, MNDWI, Supervised Classification

SUB THEME-10: GREEN ECONOMY: CROP INSURANCE & DSS

MAPPING CROPPING INTENSITY USING HLS DATASETS AND GOOGLE EARTH ENGINE (GEE) FOR TWO CONTRAST YEARS IN THE WESTERN PART OF WEST BENGAL

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Abstract

Crop intensity directly involves crop production, food security, and land management at local, regional and national scales. Climate change and various extreme weather events significantly impact crop production and cropping intensity. Due to the cloud cover problem, crop identification is a very challenging task, especially during monsoonal agricultural practice. To overcome the problem, Harmonized Landsat and Sentinel 2 (HLS) time series datasets have been used and processed in the Google Earth Engine (GEE) platform. This multispectral data set provides comparatively higher spatial and temporal information with less cloud cover. In this study, a pixel-based phenological algorithm has been adopted to identify the annual cropping intensity. This study also examined cropping area and intensity for a normal and a recent drought year. The different phenological stage of crop growth has been identified using the normalised difference vegetation index (NDVI) and land surface water index (LSWI). Based on the Field data, the annual cropping intensity map has achieved a significant level of accuracy. The phenology-based cropping intensity map also provides information regarding the duration of the crop growth cycle. The study investigates the effects of drought on the crop growth cycle and its spatial variation. This study also revealed the efficiency of HLS data and crop phenology algorithm to identify the crop intensity, which may be used for better sustainable agriculture management.

Keywords: CI, HLS, NDVI, LSWI Crop Phenology

SUB THEME-11: AR & VR: GEO-VIS, 3D & INTERACTIVE MAPPING

VISUALIZATION OF UAV GENERATED 3D MODELS IN AN IMMERSIVE VIRTUAL ENVIRONMENT: METHODS AND APPROACHES

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Abstract

Modern surveying techniques have facilitated the accurate 3D reconstruction of real-world environments for visualization, measurement, and simulation. Over the years, the way of visualizing Geospatial data has evolved from Toposheets in the olden days to Virtual Environments in the modern days. This study will discuss the methods and approaches for integrating 3D models into an Immersive Virtual Environment. Firstly, a UAV mission was executed at a flying height of 65 meters in a semi-residential region on the northern outskirts of Chennai city, covering an area of 1.6 ha. A double-grided mission with a camera angle of 75° and an overlap of 80% generated a total of 163 geotagged images. The images were subjected to 3D reconstruction based on Photogrammetric techniques in three different software: Pix4D Mapper, Meshroom and WebODM Cloud. The 3D models generated from the processing were imported to the Unity Game Engine, which is used for Immersive Visualization. A VR application was built in the Unity Game Engine to move around the reconstructed environment and assess the quality of the generated 3D Mesh. In assessing the quality of the 3D models, all three software performed admirably, while WebODM performed slightly better. However, the 3D model was not scaled and georeferenced to reality when using Meshroom. The VR application developed in this study allows users to navigate and teleport within a virtual space, delivering a profoundly immersive experience.

Keywords: Immersive Virtual Reality, Unity Game Engine, UAV, 3D Reconstruction, Photogrammetry

SUB THEME-12: FORENSIC GIS & LAW ENFORCEMENT

GEOSPATIAL APPROACH FOR URBAN CRIME MAPPING: A CASE STUDY OF ERNAKULAM DISTRICT, KERALA

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Abstract

The global urbanization movement began in the early 19th Century, and official police institutional arrangements began the recording of criminal activity has increased in the modern world. The 16th goal of the Sustainable Development Goals (SDGs) underscores the importance of fostering peaceful and inclusive societies that can sustainably thrive. Creating a comprehensive database to record all crimes is essential, as it can serve as a valuable resource for future needs and purposes. Geographic Information System (GIS) is now vividly used in every sector and extensively used incrime mapping to visualize crime in a particular area using crime data. The primary aim of this study is to examine the spatial distribution of crime within the Ernakulum district over the period spanning from 2015 to 2022. This investigation also includes pinpointing hot spots or regions characterized by elevated levels of criminal activity and conducting a comprehensive analysis of crime patterns. The data utilized for this study consists of crime statistics from 56 distinct police stations, covering both rural and city areas. The result indicated that Ernakulum city, Fort Kochi, Central, and ET North police stations have the most reported crimes, and can say that this area is more dangerous when compared to the other regions, and there should be an increased focus on maintaining law and order through more vigilant police forces and enhanced patrolling. Crime prevention is of utmost importance as it tackles one of society's most pervasive and pressing challenges. Therefore, this study provides a holistic viewpoint, enabling authorities to make data-driven decisions, allocate resources efficiently, and promote community engagement. Ultimately, these efforts contribute to improved safety and security in urban environments.

Keywords: Crime Mapping, GIS, SDGs, Kochi Police, Spatial Modeling

SUB THEME-13: OCEAN, ATMOSPHERE & WEATHER WATCH

IONOSPHERIC TEC RESPONSES FOR VARIATIONS IN GEOMAGNETIC STORMS

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Abstract

Geomagnetic storms can induce considerable changes in ionospheric total electron content (TEC) with electrodynamic effects being more effective around the equatorial ionization anomaly zone. It is most important to study ionospheric disturbances during geomagnetic storms because they affect communication systems in space and on the ground. The present study shows TEC variations during the 2023 geomagnetic storm. We have chosen three intense geomagnetic storms that occurred in 2023 on March 24, and April 24. We used the TEC data from two IGS networks located in Hyderabad (17.417N, 78.551E) and Bengaluru (13.021N, 77.570E). TEC obtained from these stations are compared with the GNSS receiver located at Bangalore University (12.94N, 77.51E). The Dst index, Kp index, neutral wind, storm wind, composition changes, interplanetary magnetic field, and interplanetary electric field are analysed with respect to universal time to understand the low-latitude ionospheric TEC response when a geomagnetic storm occurs over a longer period of time. Intensity for storm measured in Dst was observed to be higher on April 24 (-212 nT) when compared to March 24 (-163 nT). Results shows positive ionospheric TEC responses during April storm time and negative ionospheric TEC responses during March storm time.

Keywords: Geomagnetic Storm, Total Electron Content, Equatorial Ionization Anomaly