NARAYANARAO BHOGAPURAPU

PhD., Geoinformatics (ongoing)
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PROFILE

My work focuses on the advancements and applicability of Synthetic Aperture Radar (SAR) polarimetric parameters to estimate soil moisture over croplands. In my work, I have devised a novel methodology to estimate soil moisture over croplands solely using dual-pol GRD SAR data. The advantages of this method include continuous monitoring of soil moisture over a larger scale at higher resolutions. Besides, I have also developed a novel methodology to estimate soil moisture using full polarimetric SAR data. On the other hand, monitoring and quantifying vegetation content directly helps in better estimation of soil moisture. In this regard, I have developed different vegetation descriptors for dual-pol GRD SAR data. Besides, these descriptors are also capable of estimating crop biophysical parameters. These techniques are successfully implemented using Amazon Web Services (AWS), Google Earth Engine (GEE) and Google Colaboratory (Google Colab). These novel techniques and strategies might be helpful to develop operational agricultural crop monitoring platforms through the Joint Experiment for Crop Assessment and Monitoring (JECAM) international research network as well as upcoming satellite missions. My career objective is to obtain a researcher position in the field of remote sensing application to agriculture to associate myself with a progressing science and the nation. Besides, I want to put my expertise to the best use for the remote sensing and agricultural community, as well as widening my technical spectrum.

EDUCATION

Ph.D. in Geoinformatics and Natural Resources Engineering 2018 - present
Institute: Indian Institute of Technology Bombay, Mumbai, India.
Thesis title: Soil moisture retrieval over croplands using SAR data
Advisors: Prof. Y.S.Rao & Prof. Avik Bhattacharya
CPI: 9.43/10.0

M.Tech. in Remote sensing and GIS 2016 - 2018
Institute: National Institute of Technology Warangal, India
Thesis title: Subsurface physical parameters sensitivity analysis using GPR modelling and simulations
Advisor: Prof. K. V. Reddy & Mr. D. K. Pandey
CPI: 8.95/10.0

B.E. in Civil Engineering 2012 - 2016
Institute: Andhra University, India
Thesis title: Analysis of multi-storied office building (manual design)
Advisor: Prof. K. Santosh Kumar
CGPA : 8.45/10

Higher secondary (10+2) Science 2005 - 2012
School: Jawahar Navodaya Vidhyalaya, Kiltampalem, India
Marks: 84.8 %

PUBLICATIONS

Google Scholar profile: https://scholar.google.co.in/citations?user=-OryAUsAAAAJ&hl=en
ORCID: https://orcid.org/0000-0002-6496-7283
Citation: 12; h-index: 1; i10-index: 0 (records based on Google scholar 06 September, 2021)

Peer Review Journal:

[**J6**] **Narayanarao Bhogapurapu**, Subhadip Dey, Dipankar Mandal, Avik Bhattacharya, L. Karthikeyan, Heather McNairn and Y. S. Rao 2021 "Soil Moisture Retrieval Over Croplands Using dual-pol L-band GRD SAR Data ", *Remote Sensing of Environment.* (Under review)

[**J5**] Subhadip Dey, **Narayanarao Bhogapurapu**, Saeid Homayouni, Avik Bhattacharya, and Heather McNairn 2021 "Unsupervised Classification of Crop Growth Stages with Scattering Parameters from Dual-Pol Sentinel-1 SAR Data ", *Remote Sensing.* (Under review)

[J4] Subhadip Dey, Ushasi Chaudhuri, **Narayanarao Bhogapurapu**, Juan Lopez-Sanchez, Biplab Banerjee, Avik Bhattacharya, Dipankar Mandal, and Y. S. Rao 2021 "Synergistic Use of TanDEM-X and Landsat-8 Data for Crop-type Classification and Monitoring", *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing.* (In Print)

[J3] **Narayanarao Bhogapurapu**, Subhadip Dey, Avik Bhattacharya, Dipankar Mandal, Juan Lopez-Sanchez, Heather McNairn, Carlos López-Martínez and Y. S. Rao 2021 "Dual-polarimetric descriptors from Sentinel-1 GRD SAR data for crop growth assessment ", *ISPRS Journal of Photogrammetry and Remote Sensing* 178 (2021): 20-35.

[J2] Subhadip Dey, **Narayanarao Bhogapurapu**, Avik Bhattacharya, Dipankar Mandal, Juan Lopez-Sanchez, Heather McNairn, and Alejandro C. Frery 2021 "Rice Phenology Mapping Using Novel Target Characterization Parameters from Polarimetric SAR Data ", *International Journal of Remote Sensing*, 42:14, 5519-5543,

[J1] **Narayanarao Bhogapurapu**, Subhadip Dey, Dipankar Mandal, Avik Bhattacharya and Y. S. Rao 2021 "PolSAR tools: A QGIS plugin for generating SAR descriptors.", *Journal of Open Source Software*, 6(60), 2970.

Conference Proceedings:

[C15] **Narayanarao Bhogapurapu**, S. Dey, A. Verma, A. Bhattacharya, Carlos López-Martínez and P. Pankajakshan 2021 "Crop growth assessment using Sentinel-1 GRD SAR descriptors", *IEEE India Geoscience and Remote Sensing Symposium (InGARSS), IEEE International.* (submitted)

[C14] S. Dey, **Narayanarao Bhogapurapu**, A. Verma, Saeid Homayouni, Carlos López-Martínez, and A. Bhattacharya 2021 "Simultaneous evaluation of the target scattering-type parameter and scattering power components from polarimetric SAR images", *IEEE India Geoscience and Remote Sensing Symposium (InGARSS), IEEE International.* (submitted)

[C13] A. Verma, S. Dey, **Narayanarao Bhogapurapu**, Carlos López-Martínez, and A. Bhattacharya 2021 "Dual polarimetric SAR signature for human-made target characterization", *IEEE India Geoscience and Remote Sensing Symposium (InGARSS), IEEE International.* (submitted)

[C12] **Narayanarao Bhogapurapu**, Subhadip Dey, Avik Bhattacharya, and Y. S. Rao 2021 "Soil Moisture Estimation Using Simulated NISAR Dual Polarimetric GRD Product over Croplands ", *APSAR 2021: The 7th Asia-Pacific Conference on Synthetic Aperture Radar.* (Accepted)

[C11] Subhadip Dey, **Narayanarao Bhogapurapu**, Avik Bhattacharya, Dipankar Mandal, Heather McNairn and Y. S. Rao 2021 "Novel Clustering Technique for Monitoring Crop Phenology ", *APSAR 2021: The 7th Asia-Pacific Conference on Synthetic Aperture Radar.* (Accepted)

[C10] **Narayanarao Bhogapurapu**, Avik Bhattacharya, and Y. S. Rao 2021 "Chandrayaan-2 Dual Frequency Synthetic Aperture Radar (DFSAR) Full and Compact Polarimetric Data Analysis for the Lunar Surface ", *APSAR 2021: The 7th Asia-Pacific Conference on Synthetic Aperture Radar.* (Accepted)

[C9] **Narayanarao Bhogapurapu**, Subhadip Dey, Dipankar Mandal, Avik Bhattacharya and Y. S. Rao 2021 "Monitoring wheat crop growth using a new vegetation index from Sentinel-1 GRD SAR data ", *Geoscience and Remote Sensing Symposium (IGARSS), IEEE International.*

[C8] **Narayanarao Bhogapurapu**, Subhadip Dey, Avik Bhattacharya, and Y. S. Rao 2021 "Soil moisture estimation over canola crop using Simulated NISAR Dual Polarimetric GRD Product", *PolInSAR 2021: The 10th International Workshop on Science and Applications of SAR Polarimetry and Polarimetric Interferometry.*

[C7] Subhadip Dey, **Narayanarao Bhogapurapu**, Avik Bhattacharya, Alejandro C. Frery, and Paolo Gamba 2021 "Built-up area mapping using full and dual polarimetric SAR data", *Geoscience and Remote Sensing Symposium (IGARSS), IEEE International.*

[C6] Subhadip Dey, **Narayanarao Bhogapurapu**, Avik Bhattacharya, and Y. S. Rao 2021 "Crop Monitoring Using Sentinel-1 GRD Product in GEE Platform", *PolInSAR 2021: The 10th International Workshop on Science and Applications of SAR Polarimetry and Polarimetric Interferometry.*

[C5] Abhinav Verma, Subhadip Dey, **Narayanarao Bhogapurapu**, Dipankar Mandal, Dipanwita Haldar, Avik Bhattacharya 2021 "Polarimetric SAR Signature for Crop Characterization ", *Geoscience and Remote Sensing Symposium (IGARSS), IEEE International.*

[C4] **Narayanarao Bhogapurapu**, Dipankar Mandal, Y. S. Rao and Avik Bhattacharya 2020 "Soil Moisture retrieval using SAR derived vegetation descriptors in water could model", *Geoscience and Remote Sensing Symposium (IGARSS), IEEE International.*

[C3] **Narayanarao Bhogapurapu**, Dipankar Mandal, Y. S. Rao and Avik Bhattacharya 2020 "Soil moisture estimation for wheat crop using dual-pol L-band SAR data", *IEEE India Geoscience and Remote Sensing Symposium (InGARSS), IEEE International.*

[C2] Dipankar Mandal, **Narayana Rao Bhogapurapu**, Vineet Kumar, Subhadip Dey, Debanshu Ratha, Avik Bhattacharya, Juan M. Lopez-Sanchez, Heather McNairn, Y. S. Rao 2020 "Vegetation monitoring using a new dual-pol radar vegetation index: A preliminary study with simulated NASA-ISRO SAR (NISAR) L-band data", *Geoscience and Remote Sensing Symposium (IGARSS), IEEE International.*

[C1] **Narayana Rao Bhogapurapu**, Pandey, D.K., Reddy, K.V. and Putrevu, D., 2020. "Study of Subsurface Roughness Impact on GPR Performance Using Modelling and Simulation ", *In Applications of Geomatics in Civil Engineering* (pp. 471-477). Springer, Singapore.

PRODUCT DEVELOPMENT AND TECHNOLOGY TRANSFER

PolSAR tools-QGIS Plugin https://plugins.qgis.org/plugins/polsar_tools/ 2021
Soil moisture estimation code for Dual Polarimetric - EO-browser Custom script contest shortlisted 2019

RESEARCH INTERESTS

- Soil moisture estimation over croplands using PolSAR data
- SAR Polarimetry, Quad and dual polarimetry GRD product
- Crop Monitoring and biophysical parameter estimation
- Big data analytics and cloud based platforms for global agriculture monitoring and soil moisture estimation

RESEARCH PROJECTS/ THIRD PARTY FUNDING ACQUIRED

Acquired Funding	Funding Agency	Project Duration	Project Title	Role in the Project	Remarks
€66000	Group on Earth Observations (GEO) and Amazon Web Services (AWS) GEO Global Agricultural Monitoring (GEOGLAM) / Joint Experiment for Crop Assessment and Monitoring (JECAM)	JUN/2019-JUN/2022	AWS4AgriSAR: Crop Inventory Mapping from SAR Data on Cloud Computing Platform Link: http://www.earthobservations.org/article.php?id=362	Team member	This research grant was through the GEO-Amazon Earth Observation Cloud Credits Programme
€0		JUN/2017-JUN/2020	JECAM SAR Inter-Comparison Experiment: Crop Type Identification & Mapping and crop biophysical parameter retrieval Link: http://jecam.org/experiment/sar-intercomparison/ http://jecam.org/studysite/india-vijayawada/	Team member	JECAM network provided numerous Earth Observation datasets free of charge to the partners through agreement with Canadian Space Agency.

TECHNICAL SKILLS

Programming Skill	C | C++ | Python | MATLAB | R | JS
Software and Tools	ArcGIS | QGIS | ERDAS Imagine | ENVI | PolSARPro | SNAP | Git
Drafting and Design Tools	Autocad.
Python packages	GDAL | Rasterio | Geopandas | Spectral | Pandas | PYRAT | Scipy | Numpy
Cloud based platforms	Google Earth Engine | Amazon Web services (AWS) | Google cloud platform Multi-Mission Algorithm and Analysis Platform (NASA MAAP)

FIELD EXPEDITIONS/ CAMAPIGNS

Co-lead the Field Campaign with joint collaboration by MRSLab – IIT Bombay, and APSAC, at JECAM Test site in Andhra Pradesh, India. The aim of this campaign was to collect Crop and Soil parameters in synchronous with Satellite (Radarsat-2, TerraSAR-X, ALOS-2, Sentinel-1A, Sentinel-2) overpasses. Jun 2019 - Dec 2019

TEACHING EXPERIENCE

EXPERIENCE

CropIn Technology Solutions | India July 2021 - present
Designation: **Earth Observation Fellow**

Institute: CSRE, Indian Institute of Technology Bombay, India

Title of course taught	Level: Postgraduate/ Undergraduate	Role: Instructor/ Teaching Assistant (TA)	Year - session
GNR647: Microwave Remote Sensing	Postgraduate	TA	2021 - Spring
GNR617: Image Interpretation Laboratory	Postgraduate	TA	2021 - Spring
GNR647: Microwave Remote Sensing	Postgraduate	TA	2020 - Spring
GNR792: Communications Skills	Postgraduate	TA	2020 - Autumn
GNR617: Image Interpretation Laboratory	Postgraduate	TA	2020 - Autumn
GNR621: Natural Resources: Hydrosphere, Cryosphere and Atmosphere	Postgraduate	TA	2020 - Autumn
GNR401: Remote sensing and Image Processing	Postgraduate	TA	2020 - Autumn

- Soil moisture estimation and crop monitoring using dual polarimetric SAR data
- Large scale soil moisture mapping and crop monitoring using Sentinel-1 GRD SAR data and cloud based platforms

Indian Institute of Technology Bombay | Microwave Remote Sensing Lab, India 2019 - present
Designation: **Research Scholar**

- Soil moisture estimation and crop monitoring using PolSAR data
- Global soil moisture mapping and crop monitoring using GRD SAR data and cloud based platforms

Indian Institute of Technology Bombay | Centre of Studies in Resources Engineering 2019 - present
Designation: **Teaching Assistant**

- Courses involvement:
  GNR647: Microwave Remote Sensing | **GNR805**: Advanced Concepts in Polarimetric SAR Image Analysis | **GNR617**: Image Interpretation Laboratory | **GNR792**: Communications Skills | **GNR621**: Natural Resources: Hydrosphere, Cryosphere and Atmosphere

Masters In-Plant Training July 2017 - May 2018
Designation: **Trainee**
Institute/organization: Space Applications centre (ISRO), Ahmedabad
Description: Subsurface physical parameters sensitivity analysis using Ground Penetrating Radar modelling and simulations

AWARDS AND ACHIEVEMENTS

Name of award	Value	Description	Year
Earth Observation Fellowship	₹ 40000/ mo	This competitive fellowship award is provided by the Cropin Technology Solutions Pvt. Ltd. India	July 2021 - Present
Shortlisted as EO-browser Custom script contest 2019	NA	Sentinel-hub and the Copernicus EU Earth Observation programme and the European Space Agency organized EO-browser custom script contest for globally scripting hackathon	2020
Ph.D. Assistantship	₹ 35000/ mo	This competitive fellowship award is provided by the Ministry of Human Resource Development, Government of India	2019 - Present
M.Tech Assistantship	₹ 12500/ mo	This competitive fellowship award is provided by the Ministry of Human Resource Development, Government of India	2016 - 2018
Post-matric Scholarship	₹ 35000/ Ye	This competitive sponsorship award is provided by the Government of Andhra Pradesh, India	2012 - 2016

SYNERGISTIC ACTIVITY

Peer Recognition:
Verified Publons account: https://publons.com/researcher/4144298/narayanarao-bhogapurapu/

- Session manager in sessions: MO2.R6, TU2.R15, WE1.R1, WE2.R10, THU2.R15, FR2.R5 in IEEE International Geoscience and Remote Sensing Symposium-IGARSS 2020, Hawaii, United States of America.
- Session manager in sessions: WE1.R2, FR2.R1 in IEEE International India Geoscience and Remote Sensing Symposium 2020, Gujrat, India.

Professional Membership:

- IEEE Geoscience and Remote Sensing Society (S'19)
- Indian Society of Remote Sensing (Life Member'21 – L-5619)

Reviewer: Journals/Conferences/Projects

- Journal: Progress In Electromagnetics Research
- Conference: ICETCI 2021 : International Conference on Emerging Techniques in Computational Intelligence