

ICAR Sponsored Winter School on Machine Learning for Soil Resource Management using Open-Source Data & Tools

Date: 19 January - 08 February 2027



Organized by

Division of Remote Sensing Applications

ICAR-National Bureau of Soil Survey and Land Use Planning

Amravati Road, Nagpur-440 033

About the Training Program

Soil resources exhibit considerable spatial and temporal variability, and their effective management requires reliable, spatially explicit and quantitative soil information. Recent advances in Remote Sensing, Geographic Information Systems (GIS), Digital Soil Mapping (DSM), open-source geospatial technologies, environmental covariates and Machine Learning (ML) have created new opportunities for rapid and high-resolution assessment and mapping of soil resources. The 21-day ICAR Winter School on “Machine Learning for Soil Resource Management using Open-Source Data & Tools” is designed to provide participants with comprehensive theoretical knowledge and extensive hands-on training in modern approaches for soil resource assessment, digital soil mapping and soil resource management. The programme will emphasize the use of open-source data, software and analytical tools, enabling participants to develop practical skills without dependence on proprietary software. The training will cover the complete workflow from soil sampling and field observations to data preparation, environmental covariate generation, machine learning modelling, spatial prediction, model validation and preparation of soil resource information products.

ICAR–NBSS&LUP, Nagpur has extensive experience in soil survey, digital soil mapping and development of soil information systems. The Institute has undertaken national and regional initiatives including digital mapping of soil depth, soil pH and soil texture, development of the National Soil Grid, National Soil Spectral Library, Indian Soil Archive and Bhoomi Geoportal, as well as high-resolution digital soil mapping projects. The Winter School will combine lectures, demonstrations, hands-on practical sessions, problem-solving exercises, field visits and a participant-oriented mini-project, providing an integrated learning experience. The approved programme specifically envisages hands-on sessions accompanying the theoretical topics and mini-project work during the final days.

Objectives

- To introduce participants to the principles and practical workflows of Soil Resource Mapping (SRM) and Digital Soil Mapping (DSM) using geospatial technologies.
- To provide theoretical knowledge and hands-on skills in open-source GIS, image processing, and machine learning tools for spatial data analytics.
- To equip participants with advanced statistical, geostatistical, machine learning, and hyperspectral spectroscopic modeling techniques for soil property prediction and validation.
- To demonstrate the practical application of digital soil information products in precision agriculture, land use planning, soil management zone delineation, and spatial decision support systems.

Themes

Module 1: Foundations of Soil Resource Mapping

- Introduction to soil resource mapping, soil genesis, and soil-forming factors
- Soil variability and landform–soil relationships
- Soil survey techniques and methodologies for large-scale mapping
- Land resource inventory, soil profile studies, and basic physico-chemical analysis

Module 2: Geospatial Technologies for Soil Resource Management

- Principles and applications of remote sensing and GIS in soil resource management
- Overview of open-source software (QGIS, SAGA GIS) for spatial analysis
- Digital image processing techniques for soil resource assessment
- Digital terrain analysis and generation of elevation-derived environmental variables

Module 3: Open-Source Data for Soil Mapping

- Sources and availability of open-access satellite and terrain datasets
- Cloud-based spatial analytics using Google Earth Engine (GEE)
- Preparation, processing, and generation of raster-based environmental covariates
- Workflows for integrating multi-source open data into digital soil mapping pipelines

Module 4: R Programming and Soil Data Analytics

- Fundamentals of R programming, basic statistical analysis, and spatial data visualization
- Specialized R packages for digital soil mapping and spatial data analytics
- Data preparation, transformation, and exploratory spatial data analysis (ESDA)
- Spatial vector and raster data processing workflows in R

Module 5: Digital Soil Mapping

- Core concepts, principles, and soil–landscape relationship modeling
- Spatial sampling strategies for digital soil mapping and resource inventory
- Point-to-raster prediction methods and spatial soil property modeling
- Structure and development of raster-based soil information systems

Module 6: Machine Learning for Soil Resource Mapping

- Supervised machine learning algorithms (Random Forest, tree ensembles) for regression and classification
- Feature selection techniques and evaluation of predictor importance
- Model hyperparameter tuning and optimization strategies
- Spatial prediction of soil properties and interpretation of machine learning outputs

Module 7: Model Assessment and Validation

- Partitioning methods for training and testing dataset preparation
- Model performance evaluation using accuracy and error metrics
- Spatial cross-validation and uncertainty mapping of spatial predictions
- Comparative assessment of machine learning algorithms and output visualization

Module 8: Geostatistics and Spatial Modelling

- Fundamental principles of geostatistics and spatial soil variability
- Semivariogram modeling and quantification of spatial dependence
- Spatial prediction using geostatistical interpolation techniques (e.g., Kriging)
- Integration of geostatistical modeling with machine learning approaches

Module 9: Hyperspectral Remote Sensing and Soil Spectroscopy

- Principles of soil spectroscopy and hyperspectral remote sensing
- Spectral pre-processing techniques and feature extraction from soil spectra
- Machine learning modeling for soil property estimation from spectral data
- Spatial mapping of soil attributes using imaging spectroscopy

Module 10: Applications of Digital Soil Information

- Application of digital soil maps in land use planning and multi-criteria decision analysis
- Delineation of site-specific soil management zones for precision agriculture
- Soil and water conservation planning using spatial decision support systems
- Utilization of soil geoportals, regional information systems, and mobile applications

About ICAR-NBSS&LUP

ICAR-National Bureau of Soil Survey and Land Use Planning (ICAR-NBSS&LUP) was established in the year 1976. It undertakes research, training, soil correlation, classification, mapping and interpretation.

Mission:

To conduct and promote research in the National Agriculture Research System in the areas of Soil Survey, Pedology, Geomorphology, Remote Sensing, Geographic Information System, Cartography, Land Evaluation and Land Use Planning.

Mandate

- To conduct soil survey and mapping of the soils of the country to promote scientific and optimal land use programmes in collaboration with relevant institutions and agencies.
- To conduct and promote research in the National Agricultural Research System in the areas of pedology, soil survey, remote sensing applications, land degradation, land evaluation and land use planning.
- To impart training and education to create awareness on soil and land resources and their state of health.

Eligibility

The applicant should be working in a position not below the rank of Scientist/Assistant Professor/Subject Matter Specialists or Equivalent with specialization of Agriculture, Horticulture, Agricultural Engineering, Animal/Fisheries Sciences and allied disciplines (ICAR, SAUs, KVK, Universities/Institutes, etc). A maximum of 25 participants will be selected for this course based on their qualification, experience, area of work and as per ICAR guidelines.

Travelling Allowance, Boarding and Lodging

All the participants will be reimbursed to and fro travel fare for the journey to ICAR-NBSS&LUP, Nagpur by the shortest route. The payment will be restricted to maximum of AC-II tier train fare/ bus fare (on producing proof of travel). Tickets must be booked from IRCTC or Balmer & Lawrie or Ashoka Travels for reimbursement. Boarding and lodging will be provided free of cost to the outside participants at the institute's guest house on sharing basis and local participants will be provided lunch, inter session tea and course materials only free of cost. Participants are requested not to bring family members with them, as the Institute has limited guest house facilities. No DA will be paid to the participants.

How to Apply

There is no course fee. However, registration fee of Rs 50/- should be paid using the following QR code:



Interested candidate may send the scanned copies of their applications along with a brief CV duly signed by the candidates and their higher authority to through the link <https://forms.gle/bXwo3Vbb7CzbsjTX9>. **Participants are suggested to bring their personal laptop for practical.** For any query write mail to the Course Director.

Important Dates

- Receipt of applications: December 15, 2026
- Intimation to selected candidates: December 20, 2026
- Confirmation by selected candidates: December 25, 2026

Location, Weather Conditions and How to Reach

Nagpur has a pleasant weather and is well connected by road, rail, and air. The ICAR-NBSS&LUP is located at Amravati Road, Nagpur - 440 033 and is 15.9 km from Nagpur Airport, 7 km away from Nagpur railway station. The temperature during the training period will be around 25-30°C (day) and 14-17°C (night). Buses and pre-paid taxi can be availed from railway station and Airport to reach to the guest house/Institute.

Contact

Chief Patron

Dr. N. G. Patil, Director

ICAR-National Bureau of Soil Survey and Land Use Planning
Amravati Road, Nagpur-440 033

Patron

Dr. G.P. Obi Reddy, Principal Scientist & Head, Division of RSA

ICAR-National Bureau of Soil Survey and Land Use Planning
Amravati Road, Nagpur-440 033

Course Director

Dr. Nirmal Kumar, Senior Scientist (Agricultural Physics)

Division of Remote Sensing Applications

ICAR-National Bureau of Soil Survey & Land Use Planning

Amravati Road, Nagpur – 440033, Maharashtra, India

Mobile: 8830531997

Course Co-Directors

Dr. Bappa Das, Senior Scientist (Agricultural Physics)

Division of Remote Sensing Applications

ICAR-National Bureau of Soil Survey & Land Use Planning

Amravati Road, Nagpur – 440033, Maharashtra, India

Mobile: 9013563887

Dr. Partha Pratim Adhikary, Pr. Scientist (Soil Physics and Soil & Water Conservation)

Division of Remote Sensing Applications

ICAR-National Bureau of Soil Survey & Land Use Planning

Amravati Road, Nagpur – 440033, Maharashtra, India

Mobile: 7008504355

Course Co-ordinator

Dr. Benukantha Dash (Land & Water Management Engineering)

Division of Remote Sensing Applications

ICAR-National Bureau of Soil Survey & Land Use Planning

Amravati Road, Nagpur – 440033, Maharashtra, India

Mobile: 7219575145



APPLICATION FORM

Affix recent
colour passport
size photograph

1. Full name (in block letters) :

2. Designation :

3. Present employer and address :

4. Address for communication :

5. Mobile no. with WhatsApp facility :

Email ID :

6. Permanent address :

7. Date of birth :

8. Gender (Male / Female / Other) :

9. Marital status (Married/Unmarried) :

10. Experience in relevant field :

11. Academic qualification :

Signature of Applicant

Date:

Place:

Recommendation of the higher authority:

Signature of the higher authority with designation and seal