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Volume 72

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Gaurav Shukla · Hari Shanker Srivastava

Digital Mapping of Soil Landscape Parameters

Geospatial Analyses using Machine Learning and Geomatics

Springer

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ISSN 2197-6503 ISSN 2197-6511 (electronic)
Studies in Big Data
ISBN 978-981-15-3237-5 ISBN 978-981-15-3238-2 (eBook)
https://doi.org/10.1007/978-981-15-3238-2

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

About This Book

This book begins with the fundamental concepts behind the mapping of soil-landscape parameters in geospatial domain. As readers go through the chapters of this book, they will learn how machine learning and geomatics can be applied for more efficient mapping, understanding, and management of 'soil'.

The judicious utilization of the piece of land is the biggest and most important challenging issue. This is especially true in light of the rapid urbanization worldwide, which requires continuous monitoring of resource consumption. This book provides a clear idea of how machine learning can be used to explore a remote sensing data to monitor the key parameters, below the surface, at the surface, and above the surface. Not only will readers gain insight into the approaches, they will also learn challenges and issues associated with the digital mapping of these parameters. This book also provides understanding, into the selection of data set to represent soil–landscape relationships. Readers will also be able to understand the complex and interconnected linkages between soil-landscape parameters under a range of soil and climatic conditions. The readers gain insight into utilization of a network of satellite-based Earth observations to provide a solution towards smart farming and smart land management.

The first two chapters prepare the readers to comprehend the basic concepts, approaches, and issues/challenges associated with digital mapping of soil parameters. All other chapters develop reader's ability to handle the complexity involved in the digital mapping of three key parameters, i.e. below the surface: soil moisture, at the surface: soil class, and above the surface: crop cover.

Our potential readers will be researchers and geo-scientist, exploring digital mapping techniques for resource management, environmental planning, and sustainable development, as well as the college and university students studying geospatial technologies. It is also hoped that book contents will also attract and inspire the individuals now in the industry who requires framework in the field related to smart land planning, crop management, precision agriculture (satellite farming), and sustainable-city development in geospatial domain.

Contents and Coverage

The book comprises 6 chapters. Chapter 1: “Concept of Digital Mapping”—covers fundamental of digital mapping, key soil-landscape parameters, different approaches, and important challenging issue in digital mapping of soil-landscape parameters. Chapter 2: “Different Approaches on Digital Mapping of Soil-Landscape Parameters”—provides an in-depth explanation of various approaches for the mapping of soil classes, crop cover, and soil moisture using different machine learning algorithms. It also covers the selected method, structure, and assessment systems. Chapter 3: “Selection of Suitable Variables and Their Development”—covers the suitable variables and their development related to soil properties and parent material, climate, organisms/vegetation, relief/topography, relative position, soil moisture, and surface characteristics. Satellite data and its pre-processing are also presented for development of suitable variables. Chapter 4: “Digital Soil Mapping: Implementation and Assessment”—is devoted to approach and assessment of digital soil mapping. It discusses the various approaches that have been, or could be, used for fitting relationships between soil properties or classes and soil-forming factors. It also discusses the data layers that have been, or could be, used to describe the soil-forming factors and their importance in digital soil mapping. Chapter 5: “Prediction Models for Crop Mapping”—describes the framework for implementation of models for crop-type prediction using climate variables in association with texture, vegetation, soil moisture, phenology, topography, parent material, and soil, followed by comparative performance analysis of different ensemble models. It also discusses the potential of different variables for crop-type classification. Chapter 6: “Spatial Soil Moisture Prediction Model Over an Agricultural Land”—discusses the framework for surface soil moisture prediction model. It also discusses the model evaluation based on the goodness-of-fit test and probability of non-exceedance on field and SMAP (Soil Moisture Active and Passive) data.

A Bibliography at the end of each chapter is for the benefits of the students.

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About the Authors

Professor Pradeep Kumar Garg is faculty in Civil Engineering Department of Indian Institute of Technology, Roorkee. He has also served as vice chancellor, Uttarakhand Technical University, Dehradun. He completed his B.Tech. in 1980 and his M.Tech. in 1982, both from the University of Roorkee, India (now IIT Roorkee). He did a Ph.D. from University of Bristol, UK, and postdoctoral research work at the University of Reading, UK. He joined the Department of Civil Engineering at IIT Roorkee in 1982. Dr. Garg has published about 93 research papers, guided 7 Ph.D. thesis, 47 M.Tech. thesis, authored one textbook on Remote Sensing, organized 22 training programmes, and prepared two educational films under UGC programme. He has completed 13 research projects and 25 consultancy projects. He is Fellow member of 5 Technical Societies and life member of 15 Technical Societies. His main areas of research interest are remote sensing and GIS applications.

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Abbreviations

ALOS	Advanced Land Observing Satellite
ANN	Airborne Visible/Infrared Imaging Spectrometer
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVHRR	Advanced Very High Resolution Radiometer
CART	Classification and Regression Tree
CDT	CART Decision Trees
CEA	CART Ensembles ARCing
CEB	CART Ensemble Bagger
CKC	Cohen's Kappa coefficient
CTI	Compound Topographic Index
DEM	Digital Elevation Model
DSM	Digital Soil Mapping
DTM	Digital Terrain Model
EM	Electromagnetic
GIS	Geographical Information System
GPS	Global Positioning System
IRS	Indian Remote Sensing
ISLE	Importance Sampled Learning Ensemble
JCC	Jaccard's Coefficient of Community
jNSM	Java Newhall Simulation Model
LISS	Linear Imaging Self Scanning Sensor
LR	Linear Regression
MDA	Mean Decrease in Accuracy
MDG	Mean Decrease in Gini
MLR	Multinomial Logistic Regression
MODIS	Moderate Resolution Imaging Spectroradiometer
NDVI	Normalized Difference Vegetation Index
NPV	Negative Predictive Value
OLI	Operational Land Imager
PPV	Positive Predictive Value

RADAR	Radio Detection and Ranging
RF	Random Forest
RH	Right Circular Transmit and Horizontal Receive
RISAT	Radar Imaging Satellite
RS	Remote Sensing
RV	Right Circular Transmit and Vertical Receive
SAR	Synthetic Aperture Radar
SMAP	Soil Moisture Active and Passive
SMPM	Soil Moisture Prediction Model
SMR	Soil Moisture Regime
SRTM	Shuttle Radar Topography Mission
SVM	Support Vector Machine
TNGBM	TreeNet Gradient Boosting Machine
TNR	True Negative Rate
TPR	True Positive Rate
USGS	United States Geological Survey
UTM	Universal Transverse Mercator projection
VH	Vertical Transmit and Horizontal Receive
VV	Vertical Transmit and Vertical Receive

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