



GROUNDWATER VULNERABILITY ASSESSMENT AND MAPPING USING DRASTIC MODEL

Prashant Kumar, Praveen K. Thakur and
Sanjit K. Debnath



CRC Press
Taylor & Francis Group

Groundwater Vulnerability Assessment and Mapping Using DRASTIC Model



Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

Groundwater Vulnerability Assessment and Mapping Using DRASTIC Model

Prashant Kumar
Praveen K. Thakur
Sanjit K. Debnath



CRC Press

Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

© 2020 by Taylor & Francis Group, LLC
CRC Press is an imprint of Taylor & Francis Group, an Informa business

No claim to original U.S. Government works

Printed on acid-free paper

International Standard Book Number-13: 978-0-367-25446-9 (Hardback)

This book contains information obtained from authentic and highly regarded sources. Reasonable efforts have been made to publish reliable data and information, but the author and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors and publishers have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, please access www.copyright.com (<http://www.copyright.com/>) or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and registration for a variety of users. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

Visit the Taylor & Francis Web site at
<http://www.taylorandfrancis.com>

and the CRC Press Web site at
<http://www.crcpress.com>

To my wonderful family

To my wonderful parents Raghaw Choubey and Pushpa Choubey; my wife Pinki Choubey—my best friend and constant companion; and Shaurya—my loving son!

Prashant Kumar

To my wonderful family

To my late grandfather, my respected parents Krishan Singh and Saraswati Thakur, my loving wife Jyoti Thakur, and my children Dhruv and Darsh who make my world!

Praveen K. Thakur

To my wonderful family

To my parents

Sanjit K. Debnath



Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

Contents

Preface.....	xi
Authors	xiii
1. Introduction	1
Index-Based Vulnerability Mapping Models.....	3
Parametric Models	3
Pragmatic.....	3
Classical	11
Non-parametric Models	14
Indicator Kriging.....	14
Hybrid Models.....	15
ISIS.....	15
Comparative Study and Discussion.....	15
Conclusion and Further Recommendations	20
References	21
2. Assessment of Effectiveness of DRASTIC Model.....	29
Methodology	30
GIS for Hydrological Investigations	31
Study Area	31
DRASTIC Model.....	33
Estimation of Hydrogeological Parameters	33
Depth of Water Table	33
Net Recharge.....	35
Aquifer Type	37
Soil Type	37
Topography	37
Lithological Structures and Vadose Zone Assessment.....	38
Hydraulic Conductivity.....	41
Implementation of DRASTIC Model and Analysis	41
Vulnerability Map	41
Validation	43
Conclusion and Further Recommendations	45
References	45

3. Multi-criteria Evaluation of Hydrogeological and Anthropogenic Parameters49

Materials and Methods50

 Hydrogeological Settings.....51

 Data Used52

 Groundwater Vulnerability Assessment52

 DRASTIC Model.....53

 Modified DRASTIC Model (DRASTICL) with Anthropogenic Factors53

 Estimation of Hydrogeological Parameters for Modified DRASTIC53

 Multi-criteria Evaluation Technique60

 Comparison Matrix and Consistency Ratio62

Implementation of Modified DRASTIC Model and AHP-DRASTICL Model72

 Estimation of Vulnerability Index for Modified and AHP-DRASTICL Model72

 Comparative Analysis of Vulnerability73

 Validation74

 Accuracy and Uncertainty Assessment.....77

Conclusion78

References79

4. Groundwater Governance83

Exploratory Survey of the Study Area.....84

 Small Land Holding85

 Limited Power Supply85

 Hand Pump versus Submersible Pumps.....85

 Routine Cultivation.....86

 Geopolitical Reasons86

Water Resources86

 Surface Water86

 Groundwater.....87

Groundwater Fluctuation87

Groundwater Quality and Contamination87

 Geogenic Causes88

 Anthropogenic Causes88

Groundwater Governance and Management.....89

 Groundwater Contamination.....89

 Assessment of Contamination/Vulnerability to Contamination90

 Empirical Methods.....90

 Chemical Methods90

 Remedial Measures.....91

Ex-Situ Techniques91

In-Situ Techniques.....91

Groundwater Level Decline 91

Groundwater Conservation 92

Groundwater Governance..... 92

Groundwater Governance Framework..... 93

Conclusion and Future Prospects..... 94

References 95

Index 101



Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

Preface

There are several books on groundwater vulnerability assessment. So, why this book? It all started during our research related to groundwater vulnerability assessment when we struggled to find a simple, yet robust book full of case studies in the field of groundwater vulnerability assessment. We had to read several research papers to develop the contents for this book to be written in a lucid manner. Several theses are written every year worldwide, but few are read and that forms the so called “Library to Library Research.” In this, you choose a research gap from the available literature in the library and solve it and submit the thesis to the library. We are an advocate of “Library to General Mass” research, wherein you solve a problem and bring it to the general people including research scholars, academicians, policymakers, etc., in the form a book. So, this is a book for anyone who wants to work in the field of development of rapid regional assessment tool for the estimation of vulnerability of groundwater to contamination. This book takes Fatehgarh Sahib region (Punjab, India) as a pilot study area and describes how to assess the vulnerability of groundwater to contamination in a very simple manner by stitching the several hydro-geological and human-made factors and highlighting the inherent research problems.

The authors would like to thank all the people who helped make this book a reality. The authors are grateful to Dr. Gagandeep Singh, senior editor and his team members for their tireless efforts and timely feedbacks to make this book in the current state.



Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>