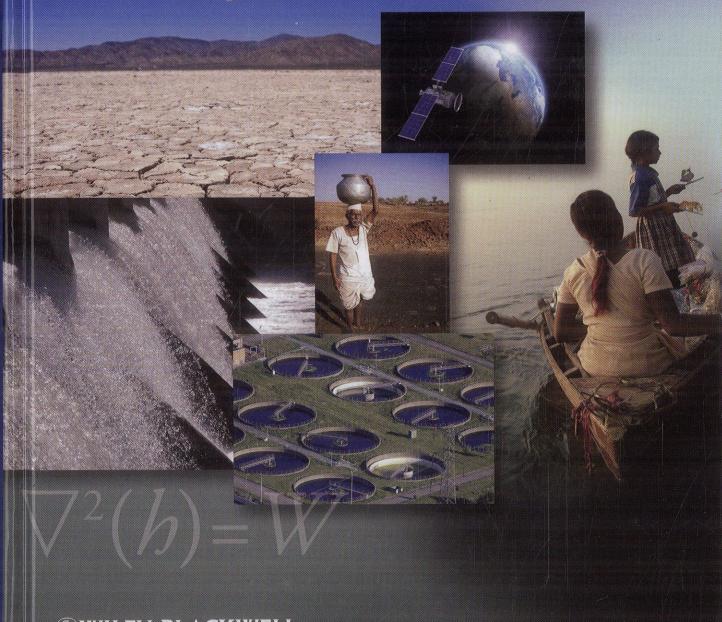
## Modern Hydrology

and Sustainable Water Development

S. K. Gupta



**WILEY-BLACKWELL** 

## **Contents**

Foreword	xi
Preface	xv
Acknowledgements	xvii
A note for students and teachers	xix
1 Fundamentals of hydrology	1
1.1 Properties of water	1
1.2 Common water quality parameters	4
1.3 Hydrologic cycle and global water distribution	10
1.4 Units and dimensions	17
1.5 Significant figures and digits	19
2 Surface water hydrology	20
2.1 Lakes	20
2.2 Glaciers	23
2.3 Streams	25
2.4 Watershed concept	25
2.5 Instrumentation and monitoring	26
2.6 Runoff processes and, flow measurement	38
2.7 Rainfall-runoff analysis and modelling	43
2.8 Stream processes	49
2.9 Stream characteristics	54
2.10 River and reservoir routing	56
2.11 Scales and scaling	<b>5</b> 9
2.12 The invisible resource: groundwater	60
2.13 Tutorial	63
3 Groundwater hydrology	70
3.1 Occurrence of groundwater	70
3.2 Movement of groundwater	74
3.3 Hydraulic head	74
3.4 Dispersion	85
3.5 Specialized flow conditions	86
3.6 Groundwater measurements	87
3.7 Groundwater pollution	89

3.8 Composite nature of surfacewater and groundwater	90
3.9 Conjunctive use of surfacewater and groundwater	91
3.10 Tutorial	93
4 Well hydraulics and test pumping	95
4.1 Steady flow	96
4.2 Superposition in space and time	104
4.3 Boundaries and images in flow modelling	106
4.4 Well flow under special conditions	108
4.5 Well losses	109
4.6 Tutorial	111
5 Surface and groundwater flow modelling	114
5.1 Surface water flow modelling	115
5.2 Groundwater flow modelling	118
5.3 Surface and groundwater interactions and coupled/integrated	110
modelling	133
6 Aqueous chemistry and human impacts on water quality	135
6.1 Principles and processes controlling composition of natural waters	136
6.2 Natural hydrochemical conditions in the subsurface	154
6.3 Presenting inorganic chemical data	155
6.4 Impact of human activities	158
6.5 Geochemical modelling	167
6.6 Chemical tracers	169
6.7 Groundwater - numerical modelling of solute transport	171
6.8 Relation between use and quality of water	174.
6.9 Industrial use	178
6.10 Tutorial	179
7 Hydrologic tracing	101
7.1 Isotopes and radioactivity	181
7.1 Isotopes and fadioactivity 7.2 Hydrologic tracers	182
7.2 Hydrologic tracers 7.3 Tracers and groundwater movement	183
7.4 Stable isotopes of oxygen and hydrogen	188
7.5 Dissolved noble gases	194
7.6 Models for interpretation of groundwater age	199
7.7 Tracers for estimation of groundwater recharge	207
7.7 Tracers for estimation of groundwater recharge 7.8 Tutorial	211
7.8 Tutoriai	214
8 Statistical analyses in hydrology	217
8.1 Descriptive statistics	218
8.2 Probability theory	222
8.3 Hydrologic frequency analysis	241
8.4 Nonparametric density estimation methods	245
8.5 Error analysis	246
8.6 Time series analysis	251
8.7 Tutorial	265

9 Remote sensing and GIS in hydrology	268
9.1 Principle of remote sensing	269
9.2 Approaches to data/image interpretation	279
9.3 Radar and microwave remote sensing	281
9.4 Geographic Information Systems (GIS)	284
9.5 Applications in hydrology	288
10 Urban hydrology	297
10.1 Water balance in urban areas	299
10.2 Disposal of waterborne wastes	302
10.3 New approaches and technologies for sustainable urbanization	317
11 Rainwater harvesting and artificial groundwater recharge	322
11.1 Historical perspective	322
11.2 Rainwater harvesting - some general remarks	323
11.3 Watershed management and water harvesting	335
11.4 Tutorial	337
12 Water resource development: the human dimensions	338
12.1 The global water crisis	338
12.2 Global initiatives	340
12.3 Water and ethics	340
12.4 Global water tele-connections and virtual water	346
13 Some case studies	349
13.1 The Yellow River Basin, China	349
13.2 The Colorado River Basin, United States	362
13.3 The Murray-Darling River Basin, Australia	373
13.4 The North Gujarat-Cambay region, Western India	380
14 Epilogue	389
14.1 Water and its properties, quality considerations, movement, and modelling of	
surface- and groundwater	389
14.2 Distribution of water in space and time	396
14.3 Water resource sustainability	399
Bibliography	403
Index	433

Plate section faces page 172

433