

Contents

Preface	xv
Acknowledgements	xvii
Contributors	xix
Chapter 1. Introduction to Soil Erosion and Landscape Evolution Modeling	
1. Soil Erosion Management and Model Development	1
2. Soil Erosion Processes	3
3. Models and Modeling Approaches	7
4. Linking Reality and Modeling	12
Acknowledgements	13
References	13
Chapter 2. Erosion Problems on U.S. Army Training Lands	
1. Introduction	15
2. Regulatory Controls	19
3. Plant Material Development and Use on Military Lands	21
4. Physical Erosion and Sediment Controls	23
5. Applying Science in Erosion and Sediment Control	27
References	28
Chapter 3. Effects of Freeze-Thaw Cycling on Soil Erosion	
1. Introduction	29
1.1. Landscape Evolution and Soil Erosion	29
1.2. Effects of Military Maneuvers on Soil-Erosion Mechanics	30

2. Effects of Soil Freeze–Thaw Cycling	33
2.1. Soil Freeze–Thaw Regimes and Associated Soil-Water Redistribution	34
2.2. Soil Erodibility	38
2.2.1. Soil Density	39
2.2.2. Soil Strength	40
2.3. Infiltration and Runoff	43
2.4. Soil-Surface Geometry	46
2.4.1. Soil Fluffing and Frost Heave	46
2.4.2. Rut and Rill Cross-Sectional Shape	47
3. Summary and Conclusions	50
4. Future Research Needs	51
Acknowledgements	52
References	52
Chapter 4. Determination of Slope Displacement Mechanisms and Causes	
1. Introduction	57
2. Bluff Geometry and Stratigraphy	59
3. Ground Water Conditions	62
4. Soil Characteristics	62
5. Slope Displacement Monitoring Methods	67
6. Displacement Models	71
7. Causes of Displacement	75
7.1. Waves and Lake Levels	76
7.2. Precipitation	78
7.3. Air Temperatures and Ground Water Levels	80
8. Processes of Bluff Failure	81
9. Limit Equilibrium Analyses	82
10. Conclusions	84
Acknowledgements	85
References	85
Chapter 5. Using Cosmogenic Nuclide Measurements in Sediments to Understand Background Rates of Erosion and Sediment Transport	
1. Introduction	89
2. Methods	92
3. Cosmogenic Nuclide Systematics and Interpretative Models	93
4. Case Studies	95
4.1. Drift Creek, Coast Range, Oregon	95
4.2. Trephina Creek, Northern Territory, Australia	100
4.3. Sandy Creek, Llano Uplift, Central Texas	101
4.4. Yuma Proving Ground, Southwestern Arizona	103
4.5. Nahal Yael, Southern Negev Desert, Israel	107

4.6. Camp Iron Mountain, Mojave Desert, California	108
5. Implications Of Sediment Cosmogenic Nuclide Measurements	111
Acknowledgements	113
References	113
Chapter 6. Erosion Modeling	
1. Introduction	117
2. Empirical Models	119
2.1. <i>USLE</i> and Related Models	119
2.2. Alternatives to the <i>USLE</i>	120
3. Process-Based Models	122
3.1. Examples of Available Models	122
3.2. Steady State Versus Dynamic Simulations	123
3.3. Erosion Process Simulations	124
3.4. Grid Versus Polygon Models	126
4. Model Testing	127
4.1. Sensitivity Analysis	127
4.2. Rationality	129
5. Model Validation	130
5.1. Uncertainty in Model Output	130
5.2. Importance of Topographic Position	133
5.3. Is Validation Feasible?	135
6. Model Application	136
6.1. Policy Evaluation	136
6.2. Evaluating Global Change	137
6.3. Slope Evolution	138
7. Conclusions	138
References	139
Chapter 7. The Water Erosion Prediction Project (<i>WEPP</i>) Model	
1. Introduction	145
2. <i>WEPP</i> Model Development History	146
2.1. User Requirements	148
2.2. <i>WEPP</i> Experimental Research Program	149
3. <i>WEPP</i> Hillslope Model Component	151
3.1. Introduction	151
3.2. Weather Generation	152
3.3. Irrigation	153
3.4. Hydrology	154
3.4.1. Infiltration and Runoff	154
3.4.2. Water Balance	155
3.5. Soil Component	156
3.5.1. Effective Hydraulic Conductivity	157
3.5.2. Soil Erodibility	158
3.6. Plant Growth	160

3.7. Residue Decomposition and Management	161
3.8. Overland Flow Hydraulics	162
3.9. Soil Erosion	163
4. <i>WEPP</i> Model Watershed Component	166
4.1. Introduction	166
4.2. Watershed Component Development	167
4.2.1. Conceptual Framework	167
4.2.2. Watershed Processes	169
4.2.3. Range of Application	170
4.3. Channel Hydrology Processes	171
4.3.1. Runoff Volume	171
4.3.2. Channel Water Balance	173
4.3.3. Channel Peak Runoff Rate	173
4.3.3.1. Modified Rational Equation	174
4.3.3.2. The <i>CREAMS</i> Equation	175
4.3.4. Effective Runoff Duration	176
4.4. Channel Erosion Processes	176
4.4.1. Effective Channel Length	177
4.4.2. Sediment Load	179
4.4.3. Sediment Detachment/Transport/Deposition	179
4.5. Watershed Component Summary	181
5. Model Validation Study Results	182
6. Data and Model Uncertainty: Impacts on Model Evaluation and Application	187
7. <i>WEPP</i> Model Status and Current Activities	191
References	193
Chapter 8. A Simulation Model for Erosion and Sediment Yield at the Hillslope Scale	
1. Introduction	201
1.1. Background	201
1.2. Purpose, Scope, and Limitations	202
2. Review of Erosion and Sediment Yield Modeling at the Hillslope Scale	202
2.1. Historical Perspective	202
2.2. Water Erosion Modeling on Non-Croplands	204
2.3. Examples of Rangeland, Hillslope Scale Water Erosion Models	205
2.4. Hillslope Erosion Processes	207
3. Development of the <i>Hillslope Erosion Model</i>	209
3.1. Overland Flow and Erosion Equations	209
3.2. Analytic Solutions and an Integrated Sediment Yield Equation	211
3.3. The <i>Hillslope Erosion Model</i>	211

4. Calibration and Validation of the <i>Hillslope Erosion Model</i>	212
4.1. Specified Parameters and Relationships	212
4.2. Optimizing the Relative (Dimensionless) Erodibility Parameter	214
4.3. Relative Erodibility by Soil Texture Class	219
4.4. Selected Validation Studies Using Data from the Walnut Gulch Experimental Watershed	219
5. Applications of the <i>Hillslope Erosion Model</i> at the Fort Carson Military Reservation and the Pinon Canyon Maneuver Site	223
5.1. Introduction - The Fort Carson Military Reservation and the Pinon Canyon Maneuver Site	223
5.2. The Land Condition-Trend Analysis (LCTA) Program	224
5.3. Description of Hillslope Profile Data Collection	225
5.4. Estimation of Runoff Using the <i>IRS</i> Model	226
5.5. <i>IRS</i> Model Results and Analyses	227
5.6. Estimation of Sediment Yield using the <i>Hillslope Erosion Model</i> - Application at Fort Carson and Pinon Canyon	227
5.7. Model Results and Analyses	228
5.8. Comparisons with Data from Erosion Control Structures	229
5.8.1. Fort Carson	229
5.8.2. Pinon Canyon Maneuver Site	230
6. Discussion and Summary	231
7. Conclusions	233
References	234
Chapter 9. Waterbots	
1. Introduction	239
2. The Waterbot Model	243
3. Hillslope Diffusion	245
4. Bedrock Erosion	246
5. Weathering	248
6. Other Landscape Transport Processes	248
7. Nonlinear Effects	249
8. Contributing Area and Hydrographs	252
9. Example - Setting up the DEM and Raining on the Black Mountains	254
10. Dimensionless Numbers in the Black Mountains	261
11. The Case of Gower Gulch: A Change in Flow Regime	265
12. Summary	272
Acknowledgements	273
References	273
Chapter 10. Two-Dimensional Watershed-Scale Erosion Modeling with <i>CASC2D</i>	
1. Introduction	277