
Contents

1	Introduction.....	1
1.1	Background and State-of-the-Art	3
1.2	Motivation and Structure.....	5
2	Field Site Description	9
2.1	Geology	11
2.2	Experimental Setup	14
3	Theory of Electrical Resistivity Tomography (ERT).....	19
3.1	Measurement Principle.....	21
3.2	Modeling	24
3.2.1	Physical Fundamentals	24
3.2.2	Modeling Concepts	25
3.2.3	The Forward Problem.....	26
3.2.4	The Inverse Problem.....	26
3.2.5	Error Model	28
3.2.6	Robust Inversion	29
3.2.7	Accumulated Sensitivity	30
3.2.8	Temperature Correction	30
4	Characterization of Data Noise and its Implementation in Electrical Resistivity Tomography for Imaging Bulk Electrical Conductivity in the Vadose Zone	33
4.1	Abstract	35
4.2	Introduction	36
4.3	Materials and Methods.....	38
4.3.1	Forward Simulation	38
4.3.2	Generating Noisy Data.....	39
4.3.3	Error Model Dependent on Resistance	44
4.3.4	Error Model Dependent on Electrode Configuration	44
4.3.5	Inversion	45
4.4	Results and Discussion	46
4.4.1	Reproduction of the Earth Model	46

4.4.2	Uncertainty in Resistivity	50
4.4.3	Comparison Between wet and dry Conditions.....	52
4.5	Conclusions	57
5	Determination of Seasonal Water Content Dynamics in a Forest Soil	
	Using Electrical Resistivity Tomography	59
5.1	Abstract	61
5.2	Introduction	62
5.3	Materials and Methods.....	65
5.3.1	ERT Data Processing.....	65
5.3.2	Calibration of Field-Scale Petrophysical Relationship.....	67
5.3.3	Application of Field-Scale Petrophysical Relationship.....	68
5.4	Results and Discussion	76
5.4.1	ERT Data Processing.....	76
5.4.2	Calibration of Field-Scale Petrophysical Relationship.....	81
5.4.3	Application of Field-Scale Petrophysical Relationship.....	86
5.5	Conclusions	101
6	Investigating Preferential Flow Processes in a Forest Soil Using Time	
	Domain Reflectometry and Electrical Resistivity Tomography	105
6.1	Abstract	107
6.2	Introduction	108
6.3	Materials and Methods.....	111
6.3.1	Experimental Setup	111
6.3.2	Data Analysis	113
6.4	Results and Discussion	117
6.5	Conclusions	133
7	Summary and Conclusions	137
8	Bibliography	143