

# INDEX

<b>CHAPTER1. INTRODUCTION .....</b>	<b>1</b>
1.1 MOTIVATION OF THE THESIS .....	3
1.2 GENERAL INTRODUCTION.....	4
1.2.1 Current problems of drainage systems .....	4
1.2.2 Drainage rehabilitation techniques.....	4
1.2.3 The cost of flood damage .....	7
1.2.4 Computational advances applied to the rehabilitation of drainage networks .....	8
1.2.5 Optimization in the rehabilitation of drainage networks .....	9
1.2.7 Search Space Reduction.....	9
1.2.8 Stop criterion.....	10
1.3 OBJECTIVES .....	10
1.3.1 General Objective.....	10
1.3.2. Specific Objectives .....	11
1.4 GENERAL APPROACH.....	11
1.4.1 Background .....	11
1.4.2 Calculation alternatives .....	12
1.4.3 Challenges .....	13
1.4.4 Initial Assumptions and limitations .....	14
1.5 STRUCTURE OF THE THESIS.....	15

<b>CHAPTER 2. INCLUSION OF HYDRAULIC CONTROLS IN REHABILITATION MODELS OF DRAINAGE NETWORKS TO CONTROL FLOODS .....</b>	<b>17</b>
2.1 INTRODUCTION .....	20
2.2. FORMULATION OF THE PROBLEM .....	22
2.2.1. Initial Assumptions .....	22
2.2.2. Hydraulic Control .....	23
2.2.3. Decision Variables .....	25
2.2.4. Objective Function.....	26
2.3. METHODOLOGY .....	27
2.3.1. Optimization Process .....	28
2.4. CASE STUDY .....	30
2.4.1. Description of the Network .....	30
2.4.2. Application of the Methodology .....	33
2.5. RESULTS.....	35
2.6. CONCLUSIONS .....	37
<b>CHAPTER 3. SEARCH SPACE REDUCTION FOR GENETIC ALGORITHMS APPLIED TO DRAINAGE NETWORK OPTIMIZATION PROBLEMS.....</b>	<b>39</b>
3.1. INTRODUCTION .....	42
3.2. MATERIALS AND METHODS .....	44
3.2.1. Problem Statement.....	44
3.2.2. Optimization Model.....	45
3.2.3. Search Space Reduction Process .....	48
3.2.4. Final Optimization .....	52
3.2.5. Application of the Model .....	53
3.3. RESULTS.....	57
3.3.1. E-Chico Network .....	57
3.3.2. Ayurá Network.....	59
3.4. DISCUSSION .....	63
3.5. CONCLUSIONS .....	66

<b>CHAPTER 4. ECONOMIC ANALYSIS OF FLOOD RISK APPLIED TO THE REHABILITATION OF DRAINAGE NETWORKS .....</b>	<b>69</b>
4.1. INTRODUCTION .....	72
4.2. MATERIALS AND METHODS .....	73
4.2.1. Optimization model .....	75
4.2.2. Optimization Process .....	78
4.2.3. Case Studies .....	80
4.3. RESULTS.....	85
4.3.1. Balloon Network.....	85
4.3.2. ES-N Network .....	87
4.4. DISCUSSION .....	91
4.5. CONCLUSIONS .....	92
<b>CHAPTER 5. GENERAL DISCUSSION.....</b>	<b>95</b>
5.1 REHABILITATION METHODOLOGY .....	97
5.1.1 Optimization model .....	97
5.1.2 Use of hydraulic control .....	97
5.1.3. Discretization of decision variables .....	99
5.1.3 Analysis of the cost of floods .....	101
5.2. EFFICIENCY OF THE OPTIMIZATION PROCESS.....	102
5.2.1 Methodologies of search space reduction .....	102
5.2.2 Stopping criteria .....	106
<b>CHAPTER 6. CONCLUSIONS.....</b>	<b>109</b>
6.1 GENERAL CONCLUSIONS .....	111
6.2 MAIN CONTRIBUTIONS OF THE THESIS .....	113
6.2.1 Contributions to flood control through the rehabilitation of drainage networks .....	113
6.2.2 Contributions in the field of optimization .....	114
6.3 FUTURE LINES OF RESEARCH .....	115
6.4 PUBLICATIONS RESULTING FROM THE DOCTORAL THESIS ...	117
<b>CHAPTER 7. REFERENCES .....</b>	<b>119</b>

<b>APPENDIX .....</b>	<b>129</b>
APPENDIX I. NOTATION .....	131
APPENDIX II. ABBREVIATIONS .....	134
APPENDIX III. NETWORKS DATA .....	135
A3.1 Case Study Data of E-Chico network.....	135
A3.2 Case Study Data of Ayurá network.....	139
A3.3 Case Study Data of Balloon network .....	148
A3.4 Case Study Data of ES-N network .....	153