



**AIN SHAMS UNIVERSITY**  
**FACULTY OF ENGINEERING**

Irrigation and Hydraulics Department

**Effect of Storm Kinematics on Runoff Hydrograph in Arid Regions Using a  
2-D Model**

A Thesis Submitted in Partial Fulfillment for the Requirements  
Of the Degree of Master of Science in Civil Engineering  
(Irrigation and Hydraulics)

By

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## Effect of Storm Kinematics on Runoff Hydrograph in Arid Regions Using a 2-D Model

By  
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A thesis Submitted for the partial fulfillment of the  
Master Degree

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## STATEMENT

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This thesis is submitted to the Irrigation and Hydraulics Department, Faculty of Engineering, Ain Shams University in the partial fulfillment of the requirements for the Degree of Master in Civil Engineering.

The work in this thesis was carried out in the Irrigation and Hydraulics Department, Faculty of Engineering, Ain Shams University from 2013 to 2019.

No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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## ACKNOWLEDGMENTS

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At the beginning and end, thanks to Allah for everything

I would like with honor to thank my supervisors of the thesis, **Prof. Dr. Nahla M. Abdel Hamid AboulAtta** and **Prof. Dr. Ayman Georges Awadallah** for their continuous guidance, support and mentoring. I have learned a lot from them whether technical or managerial. They believed in me from the first day and helped me to overcome all the problems and obstacles which faced me through the preparation of this thesis.

I am very thankful also to examiners committee members **Prof. Dr. Alaa El-Din M. El-Zawahry** and **Prof. Dr. Ashraf Mohamed El Moustafa** who examined this thesis and enriched the content of this thesis by their constructive discussion with me. Their notes added values to the thesis and their compliments on the thesis were very appreciated. They gave hand in pushing the progress of this thesis forward.

**Dr. Refaat El-Gendy**, my dad who have always been and will always be my idol who guided me how to work hard for adding values to myself, community and even the whole world. His continuous motivation encouraged me to face all types of challenges I have ever met whether through the thesis preparation or through my whole life.

**My mother**, you are a great gift from Allah. Thanks for taking care of me on the way that no one have ever done. You always give for no favor, for no reason, just to see me happy. I hope that I can make you always happy and proud of me. Watching your tears which fall when you see my success is a precious moment that I hope it could last forever.

**Noha, Dr. Ahmed, Eng Mostafa, Mahmoud, Dr. Alhassan**, my brothers and sister, only Allah knows how thankful I am for your kind feelings and supportive speeches through the hardest moments of my life. Your existence made it easier for me to face different types of obstacles and gave me the support which I always needed.

**Eng. Radwa Ahmed**, my fiancé and my beloved one who always supports me, you have lightened my whole life. Your existence in my life converted impossible matters

to possible, possible matters to real and made every difficult goal come true. You made me believe that beside every great man there is a great woman. I hope that we can make progress together and that your existence in my life last forever and after life.

I would like also to thank all of my relatives and friends who supported me in different spiritual and technical ways and celebrate with me those memorial moments.

Many thanks to my colleagues who helped me with solving many technical problems which faced me throughout the preparation of the thesis i.e. **Ahmed Madany, Abdullah El Mofty, Ahmed Hany, Mostafa Shebl, Mohamed Shams, Omar Zohny, Ahmed Teleb**, and many others who gave the support for no favor.

It is worth mentioning the appreciative role of the Department of Irrigation and Hydraulics, Ain Shams University staff and Water Resources and Environmental Engineering department staff in Dar Al-Handasah company in giving the continuous support and assistance.

## **Abstract of thesis**

### **Effect of Storm Kinematics on Runoff Hydrograph in Arid Regions Using a 2-D Model**

The right estimation of catchment peak flow due to a specific storm is very important. Based on the estimated peak flow, drainage and flood protection systems are proposed and designed. Meteorological data such as storm characteristics and storm return period are main factors that affect runoff hydrograph and peak flow discharging from a catchment.

The main objective of this research is to study the effect of storm kinematics i.e. storm speed and direction on the modelled runoff hydrograph using a 2D model. The computations have been carried out using InfoWorks Integrated Catchment Modeling (ICM) software.

The runoff hydrograph of the study catchment is estimated under different scenarios such as:

- The catchment is subjected to a commonly used stationary rainfall Storm (Without spatial Distribution).
- The catchment is subjected to a moving rainfall storm
  - In the direction of flow (downstream)
  - Opposite to the direction of flow with the same speed (upstream)
  - In the direction of flow with higher speed (change in speed)
- The catchment is subjected to a stationary rainfall storm (with spatial distribution) in order to evaluate the effect of simulating rainstorm spatial distribution separately.

Storm characteristics (such as rainfall total depth) are kept the same for all scenarios. As-Sulai catchment, located in Riyadh, Kingdom of Saudi Arabia KSA, is used as a case study.

# Table of Contents

|                                                                                |    |
|--------------------------------------------------------------------------------|----|
| Abstract of thesis .....                                                       | I  |
| <b><u>CHAPTER ONE</u></b> .....                                                | 1  |
| 1 INTRODUCTION .....                                                           | 1  |
| 1.1 General.....                                                               | 1  |
| 1.2 Objective of the Research .....                                            | 1  |
| 1.3 Organization of Work .....                                                 | 2  |
| <b><u>CHAPTER TWO</u></b> .....                                                | 4  |
| 2 LITERATURE REVIEW .....                                                      | 4  |
| 2.1 <u>General</u> .....                                                       | 4  |
| 2.1.1 Rainfall in Arid Regions .....                                           | 5  |
| 2.1.2 Moving Rainstorms.....                                                   | 9  |
| 2.1.3 Review of Previously Used Methods .....                                  | 14 |
| 2.2 Hydrodynamic Model: .....                                                  | 18 |
| 2.2.1 General.....                                                             | 18 |
| 2.2.2 Classification of Model Types .....                                      | 18 |
| 2.2.3 Software Selection .....                                                 | 18 |
| 2.2.4 Software Description and Capabilities .....                              | 20 |
| <b><u>CHAPTER THREE</u></b> .....                                              | 22 |
| 3 METHODOLOGY .....                                                            | 22 |
| 3.1 General.....                                                               | 22 |
| 3.2 Research Approach .....                                                    | 22 |
| 3.2.1 Research Assumptions: .....                                              | 23 |
| 3.2.2 Simulation of Moving Storm: .....                                        | 23 |
| 3.2.3 Rainfall Runoff Transformation.....                                      | 34 |
| 3.2.4 Hydrodynamic Model Software.....                                         | 36 |
| 3.2.5 Governing Equations .....                                                | 36 |
| 3.2.6 Common hydrodynamic approximations .....                                 | 37 |
| <b><u>CHAPTER FOUR</u></b> .....                                               | 40 |
| 4 CASE STUDY .....                                                             | 40 |
| 4.1 Wadi As-Sulai Location:.....                                               | 40 |
| 4.2 General Topographic and Climatic Features of Wadi As-Sulai and Riyadh..... | 43 |
| 4.3 Data Collection .....                                                      | 43 |
| 4.3.1 Topographic Maps .....                                                   | 44 |
| 4.3.2 Imagery; .....                                                           | 44 |
| 4.3.3 LIDAR Data.....                                                          | 44 |
| 4.3.4 Digital Terrain Model (DTM).....                                         | 44 |
| 4.3.5 Landuse and Land Cover Data .....                                        | 46 |
| 4.3.6 Meteorological data: .....                                               | 49 |
| 4.3.7 Radar rainfall data:.....                                                | 50 |
| 4.4 Data Preparation .....                                                     | 52 |

|                                  |                                                                                                                       |     |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------|-----|
| 4.4.1                            | Working on Terrain Data (Preparation of DEM) .....                                                                    | 52  |
| 4.4.2                            | Preparation of Hyetographs .....                                                                                      | 59  |
| 4.5                              | 2D Model Parameters .....                                                                                             | 65  |
| 4.5.1                            | 2D Domain.....                                                                                                        | 65  |
| 4.5.2                            | Initial Conditions .....                                                                                              | 65  |
| 4.5.3                            | Boundary Conditions .....                                                                                             | 66  |
| 4.5.4                            | Mesh Zone .....                                                                                                       | 66  |
| 4.5.5                            | Roughness Zones .....                                                                                                 | 68  |
| 4.5.6                            | Time Step.....                                                                                                        | 68  |
| 4.5.7                            | Simulation Duration.....                                                                                              | 69  |
| 4.5.8                            | Outputs.....                                                                                                          | 69  |
| <b><u>CHAPTER FIVE</u></b> ..... |                                                                                                                       | 70  |
| 5                                | RESULTS AND DISCUSSION .....                                                                                          | 70  |
| 5.1                              | General.....                                                                                                          | 70  |
| 5.2                              | Analysis and Simulated Scenarios .....                                                                                | 70  |
| 5.2.1                            | Case 1 Scenarios –Using DEM with Sinks Filled (Eliminating Ponding Effect).....                                       | 71  |
| 5.2.2                            | Comparison between Results of Case 1 Simulated Scenarios.....                                                         | 88  |
| 5.2.3                            | Case 2 Scenarios – Using DEM without Sinks Filled (Considering Ponding Effect).....                                   | 93  |
| 5.2.4                            | Comparison between Results of Case 2 Simulated Scenarios .....                                                        | 102 |
| 5.2.5                            | Summary of Comparison between Results of Cases 1& 2.....                                                              | 107 |
| 5.3                              | Outcomes of Analysis: .....                                                                                           | 108 |
| 5.3.1                            | Outcomes of Case 1 Scenarios – Using DEM with Sinks Filled (Eliminating Ponding Effect) .....                         | 108 |
| 5.3.2                            | Outcomes of Case 2 Scenarios – Using DEM without Sinks Filled (Considering Ponding Effect) .....                      | 109 |
| <b><u>CHAPTER SIX</u></b> .....  |                                                                                                                       | 111 |
| 6                                | CONCLUSIONS AND RECOMMENDATIONS .....                                                                                 | 111 |
| 6.1                              | General.....                                                                                                          | 111 |
| 6.2                              | Conclusions.....                                                                                                      | 112 |
| 6.3                              | Recommendations:.....                                                                                                 | 113 |
| 7                                | Appendix A.....                                                                                                       | 117 |
| 7.1                              | Scenario (2): Moving Storm in the Direction of Flow (Storm Speed = 15 km/hr Moving South East).....                   | 117 |
| 7.1.1                            | Extract Average DBZ over Each Subdivisions: .....                                                                     | 117 |
| 7.1.2                            | Developing rainfall intensity hyetographs: .....                                                                      | 150 |
| 7.2                              | Scenario (4): Moving Storm in the Direction of Flow with Higher Speed (Storm Speed = 15 km/hr Moving South East)..... | 183 |
| 7.2.1                            | Extract Average DBZ over Each Subdivisions: .....                                                                     | 183 |
| 7.2.2                            | Developing Rainfall Intensity Hyetographs:.....                                                                       | 200 |
| 7.2.3                            | Developing Rainfall Hyetographs Equivalent to the Stationary Storm:.....                                              | 211 |
| 7.3                              | Scenario (5): Stationary Storm with Spatial Distribution Rainfall.....                                                | 234 |
| 7.3.1                            | Extract Average DBZ over Each Subdivision.....                                                                        | 234 |
| 7.3.2                            | Developing Rainfall Hyetographs Equivalent to the Stationary Storm:.....                                              | 235 |

## List of Tables

|                                                                                                     |     |
|-----------------------------------------------------------------------------------------------------|-----|
| Table 2-1: UNESCO (1979) Aridity Classification.....                                                | 6   |
| Table 2-2: Summary of Benchmark Tests.....                                                          | 19  |
| Table 3-1: Conversion from DBZ Units to Intensity Rate Units (mm/h).....                            | 25  |
| Table 3-2: Case Study Catchment Area Subdivisions.....                                              | 26  |
| Table 3-3: Average DBZ over Subdivisions at T=8 hr.....                                             | 27  |
| Table 3-4: Rainfall Intensity for Each Subdivision at Time T=8hr.....                               | 32  |
| Table 3-5: Average Rainfall Intensity Hyetograph for Subdivision No.13.....                         | 33  |
| Table 4-1: Maximum daily rainfall depths for different return periods in Riyadh City.....           | 49  |
| Table 4-2: Maximum Daily Rainfall Depths for Different Return Periods in Riyadh City .....          | 59  |
| Table 4-3: 24-hr Rainfall Depths for Different Return Periods in Riyadh City .....                  | 59  |
| Table 4-4: Mesh Zone Parameter Setup .....                                                          | 66  |
| Table 5-1: Excess Rainfall Hyetograph for Each Subdivision for Scenario (2) Simulation (mm/hr)..... | 76  |
| Table 5-2: Excess Rainfall Hyetograph for Each Subdivision for Scenario (3) Simulation (mm/hr)..... | 79  |
| Table 5-3: Excess Rainfall Hyetograph for Each Subdivision for Scenario (4) Simulation (mm/hr)..... | 82  |
| Table 5-4: Excess Rainfall Hyetograph for Each Subdivision for Scenario (5) Simulation (mm/hr)..... | 86  |
| Table 5-5: Comparison between Peak Flow Values for Scenarios of Case 1 & Case 2 .....               | 107 |
| Table 5-6: Comparison between Time to Peak for Scenarios of Case 1 & Case 2 .....                   | 108 |
| Table 7-1: Case Study Catchment Area Subdivisions.....                                              | 117 |
| Table 7-2: Average DBZ over Subdivisions at T=1hr.....                                              | 142 |
| Table 7-3: Average DBZ over Subdivisions at T=2 hr.....                                             | 142 |
| Table 7-4: Average DBZ over Subdivisions at T=3 hr.....                                             | 142 |
| Table 7-5: Average DBZ over Subdivisions at T=4 hr.....                                             | 142 |
| Table 7-6: Average DBZ over Subdivisions at T=5 hr.....                                             | 142 |
| Table 7-7: Average DBZ over Subdivisions at T=6 hr.....                                             | 143 |
| Table 7-8: Average DBZ over Subdivisions at T=7 hr.....                                             | 144 |
| Table 7-9: Average DBZ over Subdivisions at T=8 hr.....                                             | 144 |
| Table 7-10: Average DBZ over Subdivisions at T=9 hr.....                                            | 144 |
| Table 7-11: Average DBZ over Subdivisions at T=10 hr.....                                           | 145 |
| Table 7-12: Average DBZ over Subdivisions at T=11hr.....                                            | 145 |
| Table 7-13: Average DBZ over Subdivisions at T=12hr.....                                            | 146 |
| Table 7-14: Average DBZ over Subdivisions at T=13hr.....                                            | 146 |
| Table 7-15: Average DBZ over Subdivisions at T=14hr.....                                            | 147 |
| Table 7-16: Average DBZ over Subdivisions at T=15hr.....                                            | 147 |
| Table 7-17: Average DBZ over Subdivisions at T=16hr.....                                            | 148 |
| Table 7-18: Average DBZ over Subdivisions at T=17hr.....                                            | 148 |
| Table 7-19: Average DBZ over Subdivisions at T=18hr.....                                            | 149 |
| Table 7-20: Average DBZ over Subdivisions at T=19hr.....                                            | 149 |
| Table 7-21: Average DBZ over Subdivisions at T=20hr.....                                            | 150 |
| Table 7-22: Average DBZ over Subdivisions at T=21hr.....                                            | 150 |
| Table 7-23: Average DBZ over Subdivisions at T=23hr.....                                            | 150 |
| Table 7-24: Rainfall Intensity Hyetograph for Subdivision No.1 .....                                | 150 |
| Table 7-25: Rainfall Intensity Hyetograph for Subdivision No.2 .....                                | 151 |
| Table 7-26: Rainfall Intensity Hyetograph for Subdivision No.3 .....                                | 151 |
| Table 7-27: Rainfall Intensity Hyetograph for Subdivision No.4 .....                                | 152 |
| Table 7-28: Rainfall Intensity Hyetograph for Subdivision No.5 .....                                | 152 |
| Table 7-29: Rainfall Intensity Hyetograph for Subdivision No.6 .....                                | 153 |
| Table 7-30: Rainfall Intensity Hyetograph for Subdivision No.7 .....                                | 153 |
| Table 7-31: Rainfall Intensity Hyetograph for Subdivision No.8 .....                                | 154 |
| Table 7-32: Rainfall Intensity Hyetograph for Subdivision No.9 .....                                | 154 |
| Table 7-33: Rainfall Intensity Hyetograph for Subdivision No.10 .....                               | 155 |
| Table 7-34: Rainfall Intensity Hyetograph for Subdivision No.11 .....                               | 155 |
| Table 7-35: Rainfall Intensity Hyetograph for Subdivision No.12 .....                               | 156 |
| Table 7-36: Rainfall Intensity Hyetograph for Subdivision No.13 .....                               | 156 |
| Table 7-37: Rainfall Intensity Hyetograph for Subdivision No.14 .....                               | 157 |
| Table 7-38: Rainfall Intensity Hyetograph for Subdivision No.15 .....                               | 157 |
| Table 7-39: Rainfall Intensity Hyetograph for Subdivision No.16 .....                               | 158 |
| Table 7-40: Rainfall Intensity Hyetograph for Subdivision No.17 .....                               | 159 |
| Table 7-41: Rainfall Intensity Hyetograph for Subdivision No.18 .....                               | 159 |

|                                                                                                            |     |
|------------------------------------------------------------------------------------------------------------|-----|
| Table 7-42: Rainfall Intensity Hyetograph for Subdivision No.19 .....                                      | 160 |
| Table 7-43: Rainfall Intensity Hyetograph for Subdivision No.20 .....                                      | 160 |
| Table 7-44: Rainfall Intensity Hyetograph for Subdivision No.21 .....                                      | 161 |
| Table 7-45: Calculation of Factor for Estimating Rainfall Hyetographs Equivalent to Stationary Storm ..... | 161 |
| Table 7-46: Excess Rainfall Intensity Hyetograph for Subdivision No.1 .....                                | 162 |
| Table 7-47: Excess Rainfall Intensity Hyetograph for Subdivision No.2 .....                                | 164 |
| Table 7-48: Excess Rainfall Intensity Hyetograph for Subdivision No.3 .....                                | 165 |
| Table 7-49: Excess Rainfall Intensity Hyetograph for Subdivision No.4 .....                                | 166 |
| Table 7-50: Excess Rainfall Intensity Hyetograph for Subdivision No.5 .....                                | 167 |
| Table 7-51: Excess Rainfall Intensity Hyetograph for Subdivision No.6 .....                                | 168 |
| Table 7-52: Excess Rainfall Intensity Hyetograph for Subdivision No.7 .....                                | 169 |
| Table 7-53: Excess Rainfall Intensity Hyetograph for Subdivision No.8 .....                                | 170 |
| Table 7-54: Excess Rainfall Intensity Hyetograph for Subdivision No.9 .....                                | 171 |
| Table 7-55: Excess Rainfall Intensity Hyetograph for Subdivision No.10 .....                               | 172 |
| Table 7-56: Excess Rainfall Intensity Hyetograph for Subdivision No.11 .....                               | 173 |
| Table 7-57: Excess Rainfall Intensity Hyetograph for Subdivision No.12 .....                               | 174 |
| Table 7-58: Excess Rainfall Intensity Hyetograph for Subdivision No.13 .....                               | 175 |
| Table 7-59: Excess Rainfall Intensity Hyetograph for Subdivision No.14 .....                               | 176 |
| Table 7-60: Excess Rainfall Intensity Hyetograph for Subdivision No.15 .....                               | 177 |
| Table 7-61: Excess Rainfall Intensity Hyetograph for Subdivision No.16 .....                               | 178 |
| Table 7-62: Excess Rainfall Intensity Hyetograph for Subdivision No.17 .....                               | 179 |
| Table 7-63: Excess Rainfall Intensity Hyetograph for Subdivision No.18 .....                               | 179 |
| Table 7-64: Excess Rainfall Intensity Hyetograph for Subdivision No.19 .....                               | 181 |
| Table 7-65: Excess Rainfall Intensity Hyetograph for Subdivision No.20 .....                               | 182 |
| Table 7-66: Excess Rainfall Intensity Hyetograph for Subdivision No.21 .....                               | 183 |
| Table 7-67: Average DBZ over Subdivisions at T=1 hr .....                                                  | 196 |
| Table 7-68: Average DBZ over Subdivisions at T=2 hr .....                                                  | 196 |
| Table 7-69: Average DBZ over Subdivisions at T=3 hr .....                                                  | 196 |
| Table 7-70: Average DBZ over Subdivisions at T=4 hr .....                                                  | 197 |
| Table 7-71: Average DBZ over Subdivisions at T=5 hr .....                                                  | 197 |
| Table 7-72: Average DBZ over Subdivisions at T=6 hr .....                                                  | 198 |
| Table 7-73: Average DBZ over Subdivisions at T=7 hr .....                                                  | 198 |
| Table 7-74: Average DBZ over Subdivisions at T=8 hr .....                                                  | 199 |
| Table 7-75: Average DBZ over Subdivisions at T=9 hr .....                                                  | 199 |
| Table 7-76: Average DBZ over Subdivisions at T=10 hr .....                                                 | 200 |
| Table 7-77: Rainfall Intensity Hyetograph for Subdivision No.1 .....                                       | 200 |
| Table 7-78: Rainfall Intensity Hyetograph for Subdivision No.2 .....                                       | 200 |
| Table 7-79: Rainfall Intensity Hyetograph for Subdivision No.3 .....                                       | 201 |
| Table 7-80: Rainfall Intensity Hyetograph for Subdivision No.4 .....                                       | 201 |
| Table 7-81: Rainfall Intensity Hyetograph for Subdivision No.5 .....                                       | 202 |
| Table 7-82: Rainfall Intensity Hyetograph for Subdivision No.6 .....                                       | 202 |
| Table 7-83: Rainfall Intensity Hyetograph for Subdivision No.7 .....                                       | 203 |
| Table 7-84: Rainfall Intensity Hyetograph for Subdivision No.8 .....                                       | 204 |
| Table 7-85: Rainfall Intensity Hyetograph for Subdivision No.9 .....                                       | 204 |
| Table 7-86: Rainfall Intensity Hyetograph for Subdivision No.10 .....                                      | 205 |
| Table 7-87: Rainfall Intensity Hyetograph for Subdivision No.11 .....                                      | 205 |
| Table 7-88: Rainfall Intensity Hyetograph for Subdivision No.12 .....                                      | 206 |
| Table 7-89: Rainfall Intensity Hyetograph for Subdivision No.13 .....                                      | 206 |
| Table 7-90: Rainfall Intensity Hyetograph for Subdivision No.14 .....                                      | 207 |
| Table 7-91: Rainfall Intensity Hyetograph for Subdivision No.15 .....                                      | 207 |
| Table 7-92: Rainfall Intensity Hyetograph for Subdivision No.16 .....                                      | 208 |
| Table 7-93: Rainfall Intensity Hyetograph for Subdivision No.17 .....                                      | 208 |
| Table 7-94: Rainfall Intensity Hyetograph for Subdivision No.18 .....                                      | 209 |
| Table 7-95: Rainfall Intensity Hyetograph for Subdivision No.19 .....                                      | 209 |
| Table 7-96: Rainfall Intensity Hyetograph for Subdivision No.20 .....                                      | 210 |
| Table 7-97: Rainfall Intensity Hyetograph for Subdivision No.21 .....                                      | 210 |
| Table 7-98: Calculation of Factor for Estimating Rainfall Hyetographs Equivalent to Stationary Storm ..... | 211 |
| Table 7-99: Excess Rainfall Intensity Hyetograph for Subdivision No.1 .....                                | 212 |
| Table 7-100: Excess Rainfall Intensity Hyetograph for Subdivision No.2 .....                               | 214 |
| Table 7-101: Excess Rainfall Intensity Hyetograph for Subdivision No.3 .....                               | 215 |

|                                                                                                                                   |     |
|-----------------------------------------------------------------------------------------------------------------------------------|-----|
| <i>Table 7-102: Excess Rainfall Intensity Hyetograph for Subdivision No.4</i> .....                                               | 216 |
| <i>Table 7-103: Excess Rainfall Intensity Hyetograph for Subdivision No.5</i> .....                                               | 217 |
| <i>Table 7-104: Excess Rainfall Intensity Hyetograph for Subdivision No.6</i> .....                                               | 218 |
| <i>Table 7-105: Excess Rainfall Intensity Hyetograph for Subdivision No.7</i> .....                                               | 219 |
| <i>Table 7-106: Excess Rainfall Intensity Hyetograph for Subdivision No.8</i> .....                                               | 220 |
| <i>Table 7-107: Excess Rainfall Intensity Hyetograph for Subdivision No.9</i> .....                                               | 221 |
| <i>Table 7-108: Excess Rainfall Intensity Hyetograph for Subdivision No.10</i> .....                                              | 222 |
| <i>Table 7-109: Excess Rainfall Intensity Hyetograph for Subdivision No.11</i> .....                                              | 223 |
| <i>Table 7-110: Excess Rainfall Intensity Hyetograph for Subdivision No.12</i> .....                                              | 224 |
| <i>Table 7-111: Excess Rainfall Intensity Hyetograph for Subdivision No.13</i> .....                                              | 225 |
| <i>Table 7-112: Excess Rainfall Intensity Hyetograph for Subdivision No.14</i> .....                                              | 226 |
| <i>Table 7-113: Excess Rainfall Intensity Hyetograph for Subdivision No.15</i> .....                                              | 227 |
| <i>Table 7-114: Excess Rainfall Intensity Hyetograph for Subdivision No.16</i> .....                                              | 228 |
| <i>Table 7-115: Excess Rainfall Intensity Hyetograph for Subdivision No.17</i> .....                                              | 229 |
| <i>Table 7-116: Excess Rainfall Intensity Hyetograph for Subdivision No.18</i> .....                                              | 230 |
| <i>Table 7-117: Excess Rainfall Intensity Hyetograph for Subdivision No.19</i> .....                                              | 231 |
| <i>Table 7-118: Excess Rainfall Intensity Hyetograph for Subdivision No.20</i> .....                                              | 232 |
| <i>Table 7-119: Excess Rainfall Intensity Hyetograph for Subdivision No.21</i> .....                                              | 233 |
| <i>Table 7-120: Average DBZ over Subdivisions for Stationary Storm with Spatial Distribution Scenario (during 24 hours)</i> ..... | 235 |
| <i>Table 7-121: Calculation of Factor for Estimating Rainfall Hyetographs Equivalent to Stationary Storm</i> .....                | 236 |
| <i>Table 7-122: Excess Rainfall Intensity Hyetograph for Subdivision No.1</i> .....                                               | 237 |
| <i>Table 7-123: Excess Rainfall Intensity Hyetograph for Subdivision No.2</i> .....                                               | 238 |
| <i>Table 7-124: Excess Rainfall Intensity Hyetograph for Subdivision No.3</i> .....                                               | 239 |
| <i>Table 7-125: Excess Rainfall Intensity Hyetograph for Subdivision No.4</i> .....                                               | 240 |
| <i>Table 7-126: Excess Rainfall Intensity Hyetograph for Subdivision No.5</i> .....                                               | 241 |
| <i>Table 7-127: Excess Rainfall Intensity Hyetograph for Subdivision No.6</i> .....                                               | 242 |
| <i>Table 7-128: Excess Rainfall Intensity Hyetograph for Subdivision No.7</i> .....                                               | 243 |
| <i>Table 7-129: Excess Rainfall Intensity Hyetograph for Subdivision No.8</i> .....                                               | 244 |
| <i>Table 7-130: Excess Rainfall Intensity Hyetograph for Subdivision No.9</i> .....                                               | 245 |
| <i>Table 7-131: Excess Rainfall Intensity Hyetograph for Subdivision No.10</i> .....                                              | 246 |
| <i>Table 7-132: Excess Rainfall Intensity Hyetograph for Subdivision No.11</i> .....                                              | 247 |
| <i>Table 7-133: Excess Rainfall Intensity Hyetograph for Subdivision No.12</i> .....                                              | 248 |
| <i>Table 7-134: Excess Rainfall Intensity Hyetograph for Subdivision No.13</i> .....                                              | 249 |
| <i>Table 7-135: Excess Rainfall Intensity Hyetograph for Subdivision No.14</i> .....                                              | 250 |
| <i>Table 7-136: Excess Rainfall Intensity Hyetograph for Subdivision No.15</i> .....                                              | 251 |
| <i>Table 7-137: Excess Rainfall Intensity Hyetograph for Subdivision No.16</i> .....                                              | 252 |
| <i>Table 7-138: Excess Rainfall Intensity Hyetograph for Subdivision No.17</i> .....                                              | 253 |
| <i>Table 7-139: Excess Rainfall Intensity Hyetograph for Subdivision No.18</i> .....                                              | 254 |
| <i>Table 7-140: Excess Rainfall Intensity Hyetograph for Subdivision No.19</i> .....                                              | 255 |
| <i>Table 7-141: Excess Rainfall Intensity Hyetograph for Subdivision No.20</i> .....                                              | 256 |
| <i>Table 7-142: Excess Rainfall Intensity Hyetograph for Subdivision No.21</i> .....                                              | 257 |

## List of Figures

|                                                                                                             |     |
|-------------------------------------------------------------------------------------------------------------|-----|
| <i>Figure 2-1: Rainfall Frequency Distribution</i> .....                                                    | 9   |
| <i>Figure 3-1 Case Study Catchment Area Subdivisions</i> .....                                              | 28  |
| <i>Figure 3-2 DBZ Values for Each Location at Start of Simulation (T=0 hr)</i> .....                        | 29  |
| <i>Figure 3-3 DBZ Values for Each Location at Time T=8 hr</i> .....                                         | 30  |
| <i>Figure 3-4 DBZ Values for Each Location at End of Simulation (T=24 hr)</i> .....                         | 31  |
| <i>Figure 3-5 Rainfall Intensity Hyetograph for Subdivision No.13</i> .....                                 | 33  |
| <i>Figure 4-1 Location of Wadi As-Sulai</i> .....                                                           | 41  |
| <i>Figure 4-2 As-Sulai Catchment Location</i> .....                                                         | 42  |
| <i>Figure 4-3 Satellite Imagery Covering As-Sulai Catchment</i> .....                                       | 45  |
| <i>Figure 4-4 Expected Land Use Map for Riyadh City at 2021</i> .....                                       | 48  |
| <i>Figure 4-5 Radar Image for March 2015 Storm</i> .....                                                    | 51  |
| <i>Figure 4-6 Lidar Data Covering Most of As-Sulai Catchment</i> .....                                      | 53  |
| <i>Figure 4-7 Combined SRTM Data and LIDAR Data</i> .....                                                   | 54  |
| <i>Figure 4-8 Introducing Crossing Structures</i> .....                                                     | 55  |
| <i>Figure 4-9 Introducing As-Sulai Channel</i> .....                                                        | 57  |
| <i>Figure 4-10 Modified DEM after Introducing Wadi As-Sulai Channel and Crossing Structures</i> .....       | 58  |
| <i>Figure 4-11: SCS Type II Dimensionless Rainfall Curve (24 hrs)</i> .....                                 | 61  |
| <i>Figure 4-12: Area Reduction Factor Curve in Riyadh City</i> .....                                        | 61  |
| <i>Figure 4-14 Digital Soil Map of the Study Area (FAO Source)</i> .....                                    | 63  |
| <i>Figure 4-15 Curve Number map Spatial Distribution in the vicinity of Wadi As-Sulai</i> .....             | 64  |
| <i>Figure 4-16 Storm Excess Rainfall Hyetograph</i> .....                                                   | 65  |
| <i>Figure 4-17 2D Domain of the 2D Model</i> .....                                                          | 66  |
| <i>Figure 4-18 Model Mesh Zones</i> .....                                                                   | 67  |
| <i>Figure 5-1: Excess Rainfall Intensity Hyetograph</i> .....                                               | 72  |
| <i>Figure 5-2: Maximum Floodplain Resulting from Scenario (1) Simulation</i> .....                          | 73  |
| <i>Figure 5-3: Flow Hydrograph at Catchment Outlet Resulting from Case1 - Scenario (1) Simulation</i> ..... | 74  |
| <i>Figure 5-4: Maximum Floodplain Resulting from Scenario (2) Simulation</i> .....                          | 77  |
| <i>Figure 5-5: Flow Hydrograph at Catchment Outlet Resulting from Scenario (2) Simulation</i> .....         | 78  |
| <i>Figure 5-6: Maximum Floodplain Resulting from Scenario (3) Simulation</i> .....                          | 80  |
| <i>Figure 5-7: Flow Hydrograph at Catchment Outlet Resulting from Scenario (3) Simulation</i> .....         | 81  |
| <i>Figure 5-8: Maximum Floodplain Resulting from Scenario (4) Simulation</i> .....                          | 83  |
| <i>Figure 5-9: Flow Hydrograph at Catchment Outlet Resulting from Scenario (4) Simulation</i> .....         | 84  |
| <i>Figure 5-10: Storm Location for Scenario (5) Simulation</i> .....                                        | 85  |
| <i>Figure 5-11: Maximum Floodplain Resulting from Scenario (5) Simulation</i> .....                         | 87  |
| <i>Figure 5-12: Flow Hydrograph at Catchment Outlet Resulting from Scenario (5) Simulation</i> .....        | 88  |
| <i>Figure 5-13: Comparison between Flow Hydrographs Resulting from Scenario (1) &amp; (2)</i> .....         | 89  |
| <i>Figure 5-14: Comparison between Flow Hydrographs Resulting from Scenarios (1), (2) &amp; (3)</i> .....   | 90  |
| <i>Figure 5-15: Comparison between Flow Hydrographs Resulting from Scenarios (1), (2) &amp; (4)</i> .....   | 91  |
| <i>Figure 5-16: Comparison between Flow Hydrographs Resulting from Scenarios (1) &amp; (5)</i> .....        | 92  |
| <i>Figure 5-17: Comparison between Flow Hydrograph Resulting from the 5 Scenarios</i> .....                 | 93  |
| <i>Figure 5-18: Flow Hydrograph at Catchment Outlet Resulting from Scenario (1) Simulation</i> .....        | 94  |
| <i>Figure 5-19: Maximum Floodplain Resulting from Scenario (1) Simulation</i> .....                         | 95  |
| <i>Figure 5-20: Maximum Floodplain Resulting from Scenario (2) Simulation</i> .....                         | 96  |
| <i>Figure 5-21: Flow Hydrograph at Catchment Outlet Resulting from Scenario (2) Simulation</i> .....        | 97  |
| <i>Figure 5-22: Flow Hydrograph at Catchment Outlet Resulting from Scenario (3) Simulation</i> .....        | 97  |
| <i>Figure 5-23: Maximum Floodplain Resulting from Scenario (3) Simulation</i> .....                         | 98  |
| <i>Figure 5-24: Maximum Floodplain Resulting from Scenario (4) Simulation</i> .....                         | 99  |
| <i>Figure 5-25: Flow Hydrograph at Catchment Outlet Resulting from Scenario (4) Simulation</i> .....        | 100 |
| <i>Figure 5-26: Flow Hydrograph at Catchment Outlet Resulting from Scenario (5) Simulation</i> .....        | 100 |
| <i>Figure 5-27: Maximum Floodplain Resulting from Scenario (5) Simulation</i> .....                         | 101 |
| <i>Figure 5-28: Comparison between Flow Hydrographs Resulting from Scenario (1) &amp; (2)</i> .....         | 102 |
| <i>Figure 5-29: Comparison between Flow Hydrographs Resulting from Scenarios (1), (2) &amp; (3)</i> .....   | 104 |
| <i>Figure 5-30: Comparison between Flow Hydrograph Resulting from Scenarios (1), (2) &amp; (4)</i> .....    | 105 |
| <i>Figure 5-31: Comparison between Flow Hydrograph Resulting from Scenarios (1) &amp; (5)</i> .....         | 106 |
| <i>Figure 5-32: Comparison between Flow Hydrograph Resulting from the 5 Scenarios</i> .....                 | 107 |
| <i>Figure 7-1: Storm Location at (T=1 hr)</i> .....                                                         | 118 |
| <i>Figure 7-2: Storm Location at (T=2 hr)</i> .....                                                         | 119 |
| <i>Figure 7-3: Storm Location at (T=3 hr)</i> .....                                                         | 120 |

|                                                                                      |     |
|--------------------------------------------------------------------------------------|-----|
| <i>Figure 7-4: Storm Location at (T=4 hr)</i> .....                                  | 121 |
| <i>Figure 7-5: Storm Location at (T=5 hr)</i> .....                                  | 122 |
| <i>Figure 7-6: Storm Location at (T=6 hr)</i> .....                                  | 123 |
| <i>Figure 7-7: Storm Location at (T=7 hr)</i> .....                                  | 124 |
| <i>Figure 7-8: Storm Location at (T=8 hr)</i> .....                                  | 125 |
| <i>Figure 7-9: Storm Location at (T=9 hr)</i> .....                                  | 126 |
| <i>Figure 7-10: Storm Location at (T=10 hr)</i> .....                                | 127 |
| <i>Figure 7-11: Storm Location at (T=11 hr)</i> .....                                | 128 |
| <i>Figure 7-12: Storm Location at (T=12 hr)</i> .....                                | 129 |
| <i>Figure 7-13: Storm Location at (T=13 hr)</i> .....                                | 130 |
| <i>Figure 7-14: Storm Location at (T=14 hr)</i> .....                                | 131 |
| <i>Figure 7-15: Storm Location at (T=15 hr)</i> .....                                | 132 |
| <i>Figure 7-16: Storm Location at (T=16 hr)</i> .....                                | 133 |
| <i>Figure 7-17: Storm Location at (T=17 hr)</i> .....                                | 134 |
| <i>Figure 7-18: Storm Location at (T=18 hr)</i> .....                                | 135 |
| <i>Figure 7-19: Storm Location at (T=19 hr)</i> .....                                | 136 |
| <i>Figure 7-20: Storm Location at (T=20 hr)</i> .....                                | 137 |
| <i>Figure 7-21: Storm Location at (T=21 hr)</i> .....                                | 138 |
| <i>Figure 7-22: Storm Location at (T=22 hr)</i> .....                                | 139 |
| <i>Figure 7-23: Storm Location at (T=23 hr)</i> .....                                | 140 |
| <i>Figure 7-24: Storm Location at (T=24 hr)</i> .....                                | 141 |
| <i>Figure 7-25: Storm Location at (T=1 hr)</i> .....                                 | 184 |
| <i>Figure 7-26: Storm Location at (T=2 hr)</i> .....                                 | 185 |
| <i>Figure 7-27: Storm Location at (T=3 hr)</i> .....                                 | 186 |
| <i>Figure 7-28: Storm Location at (T=4 hr)</i> .....                                 | 187 |
| <i>Figure 7-29: Storm Location at (T=5 hr)</i> .....                                 | 188 |
| <i>Figure 7-30: Storm Location at (T=6 hr)</i> .....                                 | 189 |
| <i>Figure 7-31: Storm Location at (T=7 hr)</i> .....                                 | 190 |
| <i>Figure 7-32: Storm Location at (T=8 hr)</i> .....                                 | 191 |
| <i>Figure 7-33: Storm Location at (T=9 hr)</i> .....                                 | 192 |
| <i>Figure 7-34: Storm Location at (T=10 hr)</i> .....                                | 193 |
| <i>Figure 7-35: Storm Location at (T=11 hr)</i> .....                                | 194 |
| <i>Figure 7-36: Storm Location at (T=12 hr)</i> .....                                | 195 |
| <i>Figure 7-37 Stationary Storm Location for Spatial Distribution Scenario</i> ..... | 234 |

## List of Symbols

The following symbols are used in this thesis. Usually each symbol has one meaning, but if there is more than one meaning for any symbol, then the meaning will be given in the context in which this symbol is used. Other symbols not listed here are defined in the main text.

|          |   |                                                                          |
|----------|---|--------------------------------------------------------------------------|
| AI       | : | Aridity Index                                                            |
| CN       | : | Curve Number                                                             |
| DBZ      | : | Decibel relative to Z                                                    |
| ETP      | : | Evapotranspiration                                                       |
| g        | : | Acceleration due to gravity                                              |
| h        | : | Water depth                                                              |
| P        | : | Rainfall Depth                                                           |
| Q        | : | Accumulated depth of runoff                                              |
| q        | : | Source flow or sink per unit area                                        |
| S        | : | Potential maximum soil storage depth                                     |
| $S_{0x}$ | : | Bed slope variations in x direction                                      |
| $S_{0y}$ | : | Bed slope variations in y direction                                      |
| $S_{fx}$ | : | Friction slope due to boundary turbulent shear stress in the x-direction |
| $S_{fy}$ | : | Friction slope due to boundary turbulent shear stress in the y-direction |
| t        | : | Time                                                                     |
| $t_c$    | : | Time of concentration                                                    |
| u & v    | : | Depth average velocities in x- & y- directions respectively              |
| x & y    | : | Two space dimensions                                                     |