

**INVESTIGATION OF HEC-HMS MODEL PARAMETER  
TRANSFERABILITY FOR DAILY RAINFALL RUNOFF  
SIMULATION IN MAHA OYA BASIN**

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Sri Lanka

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July 2020

**DECLARATION**

I declare that this is my own work and this thesis does not incorporate without acknowledgment any material previously submitted for a Degree or Diploma in any other University or Institute of higher learning and to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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Date

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# **Investigation of HEC-HMS Model Parameter Transferability for Daily Rainfall Runoff Simulation in Maha Oya basin**

## **Abstract**

Water is an essential finite natural resource for the developing world, however water is under growing stress due to, increased water consumption resulting from rapid population growth, development activities and industrialization for economic prosperity. Therefore, considerable attention for water resource management and development activities are required. The main challenge in this context is the unavailability of observed flow data. To address the prevailing condition, it is necessary to understand the catchment behavior from the hydrological point of view. Therefore, water quantification with the aid of hydrological modeling is an essential requirement, to facilitate the water resource development in ungauged watersheds.

The objective of this work is to investigate the level of applicability of hydrological parameter transferability by using the HEC-HMS model for Badalgama and Giriulla catchments in the Maha Oya basin, for sustainable development and management of water Resources.

The HEC-HMS model has been developed for Giriulla and Badalgama watersheds in the Maha Oya basin with the use of hydro-meteorological data, climatic data, and topographical data. Then model development, parameter estimation and simulation of the model have been performed systematically. Thereafter model calibration and validation were carried out based on identified objective function as RMSE and model performance evaluation criteria as MRAE. Optimized parameters were transferred by deploying different approaches, including temporal, spatial, and spatiotemporal methods. Model performance evaluation was carried out by observing total flow hydrograph, annual and seasonal water balance, behavior of low, medium and high flow regimes in the flow duration curve.

Developed HEC-HMS models of Giriulla and Badalgama catchments were calibrated with 0.24 and 0.25 of MRAE values, while validated with 0.18 and 0.19 of MRAE value respectively. In addition to that, flow hydrographs and flow duration curves matched well with the observed data. According to the transferability results, it was revealed that best approach for reproducing streamflow in both catchments are temporal transferability, which showed approximately 80% accuracy level. The spatial and spatiotemporal transferability approaches were not capable enough to capture the streamflow in satisfactory accuracy level, as it was approximately less than 50% for both catchments. Further, based on model results, it shows good performance for high and medium flows when compared with low flows in both catchments. Accordingly, at Giriulla watershed high and medium flow prediction accuracy for temporal transferability are 76% and 85%, while same for Badalgama watershed are 89% and 84%. However low flow prediction accuracy maintained approximately less than 60%. Further, annual average water balance error at Giriulla is overestimated 20%, while indicating seasonal water balance errors are overestimated 23% (Maha) and 17% (Yala). Similarly, at Badalgama average water balance error is underestimated 11%, and seasonal water balance errors are underestimated 8% and 20% for Maha and Yala seasons respectively.

In the light of these findings, calibrated and validated HEC-HMS model can be utilized for water resources development activities in daily timescale with approximately 75% accuracy for both catchments. Further, low flow estimation with this model must be carried out with caution due to selection of one layer precipitation loss model. The temporal transferability could be done for the selected catchments with good level of confidence (80% for both catchments), while spatial transferability and spatiotemporal transferability cannot be done with acceptable accuracy, though both catchments are in the same river basin.

## **Key Words:**

HEC-HMS, Hydrological Model, parameter transferability, Calibration, and Validation, Maha Oya Basin

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**TABLE OF CONTENTS**

DECLARATION .....	i
ACKNOWLEDGMENT .....	ii
Abstract .....	iii
ABBREVIATIONS .....	xvii
1 INTRODUCTION .....	1
1.1 General .....	1
1.2 Sustainable Water Resources Developments and associated challenges .....	1
1.3 Hydrological Modeling and Importance .....	2
1.4 Temporal and Spatial resolution of Rainfall-Runoff Modeling .....	3
1.5 Transferability of Streamflow .....	4
1.6 Hydrological Modeling in Maha Oya basin .....	4
1.7 Problem Statement .....	5
1.8 Objectives .....	6
1.8.1 Overall objective .....	6
1.8.2 Specific objectives .....	6
1.9 Study Area .....	6
2 LITERATURE REVIEW .....	8
2.1 General .....	8
2.2 Hydrological Models .....	8
2.2.1 Empirical Models .....	9
2.2.2 Conceptual Models .....	9
2.2.3 Physically-based Models .....	9
2.2.4 Other types of classifications .....	10
2.3 Hydrological Modeling in Sri Lanka .....	11
2.4 Parameter Transferability .....	12
2.5 Model Selection .....	14

2.6	HEC HMS Model Structure .....	16
2.6.1	Canopy Method.....	17
2.6.2	Surface Method .....	18
2.6.3	Selecting a Loss Model .....	18
2.6.4	Selecting a Transform method .....	20
2.6.5	Selecting a Baseflow Method .....	21
2.6.6	Routing model.....	21
2.7	Objective function.....	21
2.8	Model Warm-up.....	24
2.9	Model Calibration and Validation .....	24
2.10	Data requirement and quality assessment .....	25
2.10.1	Data and data durations.....	25
2.10.2	Data Quality Assessment .....	26
2.10.3	Fill missing data.....	27
2.10.4	Data Limitations and Associated Uncertainties .....	27
2.11	Flow Classification .....	28
3	METHODOLOGY .....	30
4	DATA AND DATA VALIDATION .....	32
4.1	Introduction.....	32
4.2	Hydro-Meteorological data.....	33
4.2.1	Missing data .....	33
4.3	Data Gap filling.....	34
4.3.1	Giriulla watershed.....	34
4.3.2	Badalgama Watershed.....	34
4.4	Data checking.....	36
4.4.1	Annual Water Balance .....	36
4.4.2	Annual rainfall and variation in streamflow .....	41
4.4.3	Visual Data Checking after gap-filling of missing data.....	42
4.4.4	Monthly and Annual rainfall.....	48
4.4.5	Monthly streamflow variation over Thiessen Rainfall .....	50
4.4.6	Double Mass Curve.....	50
5	RESULTS AND ANALYSIS .....	53
5.1	Catchment Selection .....	53

5.2	Model Selection .....	53
5.3	Development of HEC-HMS Model .....	53
5.3.1	Basin Model Development .....	53
5.3.2	Meteorological Model.....	58
5.3.3	Control specifications .....	58
5.4	Schematic Diagram of HEC-HMS model.....	58
5.5	Initial model parameters.....	59
5.6	Model Simulation.....	59
5.7	Model Warm-up.....	59
5.8	Parameter optimization .....	60
5.9	Classification of Flow Regime.....	60
5.10	Calibration of HEC-HMS model .....	62
5.10.1	Model calibration for Giriulla watershed.....	62
5.10.2	Model calibration for Badalgama Watershed .....	66
5.11	Validation of HEC-HMS Model .....	70
5.11.1	Model validation for Giriulla watershed.....	70
5.11.2	Model Validation at Badalgama watershed .....	73
5.12	Optimized HEC-HMS Model Parameters.....	77
5.13	Automatic Parameter Optimization .....	78
5.14	Model parameter Transferability .....	81
5.14.1	Temporal Transferability at Giriulla watershed.....	81
5.14.2	Temporal Transferability at Badalgama watershed .....	85
5.14.3	Spatial Transferability at Giriulla Watershed .....	89
5.14.4	Spatial Transferability at Badalgama Watershed.....	93
5.14.5	Spatiotemporal Transferability at Giriulla Watershed.....	98
5.14.6	Spatiotemporal Transferability at Badalgama Watershed .....	101
5.14.7	Transferability of Parameters from main catchment to Sub-catchment 105	
5.14.8	Transferability of parameter from sub-catchment to main catchment	110
6	DISCUSSION.....	117
6.1	Selections of stations and Data .....	117
6.1.1	Gauging Stations and Data Period Selection .....	117
6.1.2	Selection of spatial averaging method .....	118



6.1.3	Existence of Data Errors .....	118
6.2	Selection of Model and Objective function .....	119
6.2.1	Model Selection .....	119
6.2.2	Objective Function Selection .....	120
6.3	Model Development.....	121
6.3.1	Selection of model components and parameters.....	121
6.3.2	Model simulation and optimization .....	121
6.4	Model performance Evaluation.....	122
6.4.1	Model calibration and validation .....	123
6.5	Parameter Transferability.....	130
6.5.1	Selection of Parameter Transferability Approach.....	131
6.5.2	Temporal Transferability .....	131
6.5.3	Spatial Transferability.....	132
6.5.4	Spatiotemporal Transferability .....	134
6.5.5	Transferability of model parameters for the entire period .....	136
7	CONCLUSION AND RECOMMENDATION .....	139
7.1	Conclusion .....	139
7.2	Recommendation .....	140
	REFERENCES .....	141
	APPENDIX A – DATA AND DATA CHECKING AT GIRIULLA .....	150
	APPENDIX B – DATA CHECKING AT BADALGAMA .....	165
	APPENDIX C – OBSERVED STREAMFLOW COMPARISON .....	180
	APPENDIX D – CALIBRATION AND VALIDATION RESULTS IN NORMAL PLOT.....	185
	APPENDIX E: ANNUAL TRANSFERABILITY PERFORMANCE .....	194

## LIST OF FIGURES

Figure 1-1: Study Area Map .....	7
Figure 3-1: Methodology Flow Chart .....	31
Figure 4-1: Thiessen Polygon Giriulla Watershed.....	35
Figure 4-2: Thiessen Polygon Badalgama Watershed .....	35
Figure 4-3: Comparison of Annual rainfall, Stream Flow, Evaporation and runoff coefficient Giriulla watershed.....	38
Figure 4-4: Comparison of Annual rainfall, Stream Flow, Evaporation and runoff coefficient in Badalama watershed .....	40
Figure 4-5: Variation of Annual Rainfall and Streamflow at Giriulla.....	41
Figure 4-6: Variation of Annual Rainfall and Streamflow at Badalgama .....	42
Figure 4-7: Thiessen Rainfall and stream flow responses at Giriulla watershed.....	45
Figure 4-8: Rainfall and stream flow responses in Badalgama Watershed .....	48
Figure 4-9: Variation of monthly rainfall at Badalgama watershed .....	49
Figure 4-10: Annual rainfall variation in selected rainfall stations .....	50
Figure 4-11: Monthly Stream flow and Thiessen rainfall in Giriulla (Top) and Badalgama (Bottom) watersheds .....	51
Figure 4-12: Double mass curve at selected rainfall stations.....	52
Figure 5-1: Land use map of Giriulla watershed .....	55
Figure 5-2: Land use map of Badalgama Watershed.....	56
Figure 5-3: Schematic Diagram of HEC-HMS model used in the Study .....	58
Figure 5-4: High, Intermediate and Low flow classification at Giriulla.....	61
Figure 5-5: High, Intermediate and Low flow classification at Badalgama .....	61
Figure 5-6: Observed and Simulated flow hydrograph in Giriulla - calibration.....	63
Figure 5-7: Annual Water Balance in Giriulla - calibration .....	64
Figure 5-8: Seasonal (Maha) water balance in Giriulla - calibration.....	64
Figure 5-9: Seasonal (Yala) water balance in Giriulla - calibration .....	65
Figure 5-10: Flow duration curve (sorted) in Giriulla - Calibration .....	65
Figure 5-11: Flow duration curve (unsorted) for Giriulla - Calibration .....	66
Figure 5-12: Observed and Simulated flow hydrograph in Badalgama - calibration	67
Figure 5-13: Annual water balance in Badalgama – calibration.....	68
Figure 5-14: Seasonal (Maha) water balance in Badalgama – Calibration.....	68
Figure 5-15: Seasonal (Yala) water balance in Badalgama – Calibration .....	69

Figure 5-16: Sorted flow duration curve for Badalgama Sub-watershed – calibration .....	69
Figure 5-17: Unsorted flow duration curve for Badalgama Watershed – calibration	69
Figure 5-18: Observed vs simulated Streamflow hydrograph for Giriulla – Validation .....	71
Figure 5-19: Annual water balance for Giriulla – validation.....	72
Figure 5-20: Seasonal (Maha) water balance in Giriulla – validation .....	72
Figure 5-21: Seasonal (Yala) water balance in Giriulla – validation.....	72
Figure 5-22: Sorted flow duration curve for Giriulla – validation.....	73
Figure 5-23: Unsorted flow duration curve for Giriulla – validation .....	73
Figure 5-24: Observed and Estimated Flow Hydrograph for Badalgama – Validation .....	75
Figure 5-25: Annual water balance for Badalgama Watershed – validation .....	76
Figure 5-26: Seasonal (Maha) water balance for Badalgama watershed – validation	76
Figure 5-27: Seasonal (Yala) water balance for Badalgama watershed – validation	76
Figure 5-28: Sorted flow duration curve for Badalgama watershed – validation.....	77
Figure 5-29: Unsorted Flow duration curve for Badalgama watershed – validation.	77
Figure 5-30: Sorted FDC for automatic calibration – Giriulla .....	80
Figure 5-31: Sorted FDC for automatic calibration – Badalgama.....	80
Figure 5-32: Sorted FDC for temporal transferability – Giriulla.....	82
Figure 5-33: Unsorted FDC for temporal transferability – Giriulla.....	82
Figure 5-34: Comparison of simulated and observed flow hydrograph - Giriulla.....	83
Figure 5-35: Annual water Balance error for temporal transferability – Giriulla.....	84
Figure 5-36: Seasonal (Maha) water balance error for temporal transferability – Giriulla .....	85
Figure 5-37: Seasonal (Yala) water balance error for temporal transferability – Giriulla .....	85
Figure 5-38: Sorted flow duration curve for temporal transferability – Badalgma ...	86
Figure 5-39: Unsorted flow duration curve for temporal transferability – Badalgma	86
Figure 5-40: Comparison of flow hydrograph of temporal transferability - Badalgama .....	87
Figure 5-41: Annual water balance error for temporal transferability at Badalgama	88
Figure 5-42: Seasonal (Maha) water balance error for temporal transferability at Badalgama.....	89

Figure 5-43: Seasonal (Yala) water balance error for temporal transferability at Badalgama.....	89
Figure 5-44: Sorted FDC curve for spatial transferability - Giriulla .....	90
Figure 5-45: Unsorted FDC curve for Spatial Transferability – Giriulla .....	90
<i>Figure 5-46: Comparison between observed and simulated for spatial transferability – Giriulla.....</i>	<i>91</i>
Figure 5-47: Annual Water Balance for spatial Transferability – Giriulla.....	92
Figure 5-48: Seasonal (Maha) water balance error for spatial transferability - Giriulla .....	93
Figure 5-49: Seasonal (Yala) water balance error for spatial transferability - Giriulla .....	93
Figure 5-50: Sorted FDC for spatial transferability - Badalgama.....	94
Figure 5-51: Unsorted FDC for spatial transferability – Badalgama.....	95
Figure 5-52: Comparison between observed and simulated streamflow for spatial transferability – Badalgama .....	96
Figure 5-53: Annual water Balance for the spatial transferability – Badalgama.....	97
Figure 5-54: Seasonal (Maha) Water Balance for the spatial transferability – Badalgama.....	97
Figure 5-55: Seasonal (Yala) water Balance for the Spatial Transferability – Badalgama.....	97
Figure 5-56: Sorted FDC curve for spatiotemporal transferability - Giriulla.....	98
Figure 5-57: Un-sorted FDC curve for spatiotemporal transferability – Giriulla.....	99
Figure 5-58: Comparison between observed and simulated streamflow for spatiotemporal transferability – Giriulla.....	100
Figure 5-59: Annual water balance error for spatiotemporal transferability - Giriulla .....	100
Figure 5-60: Seasonal (Maha) water balance error for spatiotemporal transferability – Giriulla .....	101
Figure 5-61: Seasonal (Yala) water balance error for spatiotemporal transferability - Giriulla .....	101
Figure 5-62: Sorted FDC curve for the spatiotemporal transferability – Badalgama .....	102
Figure 5-63: Unsorted FDC curve for the spatiotemporal transferability – Badalgama .....	103
Figure 5-64: Comparison between observed and simulated streamflow for spatiotemporal transferability – Badalgama .....	104

Figure 5-65: Annual water Balance error for spatiotemporal transferability – Badalgama.....	104
Figure 5-66: Seasonal (Maha) water Balance error for spatiotemporal transferability – Badalgama.....	105
Figure 5-67: Seasonal (Yala) water Balance error for spatiotemporal transferability – Badalgama.....	105
Figure 5-68: Flow Hydrograph for Giriulla with transferred parameters from 2000/2001 to 2005/2006 .....	107
Figure 5-69: Flow Hydrograph for Giriulla with transferred parameters from 2006/2007 to 2008/2009 .....	107
Figure 5-70: Annual Water Balance error for the entire period with transferability – Giriulla .....	108
Figure 5-71: Seasonal (Maha) Water Balance error for the entire period with transferability – Giriulla.....	109
Figure 5-72: Seasonal (Yala) Water Balance error for the entire period with transferability – Giriulla.....	109
Figure 5-73: Sorted FDC for the entire period with transferred parameters - Giriulla catchment .....	110
Figure 5-74: Unsorted FDC for the entire period with transferred parameters – Giriulla catchment .....	110
Figure 5-75: comparison of observed and simulated Flow Hydrographs for Badalgama with transferred parameters.....	113
Figure 5-76: Annual water Balance for Badalgama with Parameter Transferability .....	114
Figure 5-77: Seasonal (Maha) water balance for Badalgama with Parameter Transferability.....	115
Figure 5-78: Seasonal (Yala) water balance for Badalgama with Parameter Transferability.....	115
Figure 5-79: Sorted FDC for Badalgama catchment with transferred parameters from Giriulla catchment.....	116
Figure 5-80: Unsorted FDC for Badalgama catchment with transferred parameters from Giriulla catchment .....	116
Figure 6-1: Comparison of flow duration curve in both Badalgama and Giriulla watersheds.....	119
Figure 6-2: Unsorted (Left) and sorted (Right) performance indicators – Giriulla .	128
Figure 6-3: Unsorted (Left) and sorted (Right) Performance Indicators – Badalgama .....	129
Figure 6-4: Observed streamflow vs, simulated streamflow for calibration period - Giriulla (Left) and Badalgama (Right).....	129

Figure 6-5: Observed streamflow vs, simulated streamflow for the validation period - Giriulla (Left) and Badalgama (Right).....	130
Figure 6-6: Performance Indicators for parameter Transferability - Giriulla .....	135
Figure 6-7: Performance indicators for parameter transferability - Badalgama .....	136
Figure 6-8: Scatter plot of observed vs simulated streamflow with transferred parameters - Giriulla (Left) and Badalgama (Right).....	137
Figure A-1: Rainfall responses from each station in year 2005/2006.....	151
Figure A-2: Rainfall responses from each station in year 2006/2007.....	152
Figure A-3: Rainfall responses from each station in year 2007/2008.....	153
Figure A-4: Rainfall responses from each station in year 2008/2009.....	154
Figure A-5: Rainfall responses from each station in year 2009/2010.....	155
Figure A-6: Rainfall responses from each station in year 2010/2011.....	156
Figure A-7: Rainfall responses from each station in year 2011/2012.....	157
Figure A-8: Rainfall responses from each station in year 2012/2013.....	158
Figure A-9: Rainfall responses from each station in year 2013/2014.....	159
Figure A-10: Rainfall responses from each station in year 2014/2015.....	160
Figure A-11: Rainfall responses from each station in year 2015/2016.....	161
Figure A-12: Rainfall responses from each station in year 2016/2017.....	162
Figure A-13: Rainfall responses from each station in year 2017/2018.....	163
Figure A-14: Rainfall responses from each station in year 2018/2019.....	164
Figure B-1: Rainfall responses from each station in year 2005/2006.....	166
Figure B-2: Rainfall responses from each station in year 2006/200.....	167
Figure B-3: Rainfall responses from each station in year 2007/2008.....	168
Figure B-4: Rainfall responses from each station in year 2008/2009.....	169
Figure B-5: Rainfall responses from each station in year 2009/2010.....	170
Figure B-6: Rainfall responses from each station in year 2010.....	171
Figure B-7: Rainfall responses from each station in year 2011/2012.....	172
Figure B-8: Rainfall responses from each station in year 2012/2013.....	173
Figure B-9: Rainfall responses from each station in year 2013/2014.....	174
Figure B-10: Rainfall responses from each station in year 2014/2015.....	175
Figure B-11: Rainfall responses from each station in year 2015/2016.....	176
Figure B-12: Rainfall responses from each station in year 2016/2017.....	177
Figure B-13: Rainfall responses from each station in year 2017/2018.....	178
Figure B-14: Rainfall responses from each station in year 2018/2019.....	179

Figure C-1: Comparison of streamflow from 2005/2006 to 2008/2009 .....	181
Figure C- 2: Comparison of streamflow from 2009/2010 to 2012/2013 .....	182
Figure C-3: Comparison of streamflow from 2013/2014 to 2016/2017 .....	183
Figure C-4: Comparison of streamflow from 2017/2018 to 2018/2019 .....	184
Figure D-1: Normal plot of Streamflow hydrographs at Giriulla – calibration .....	186
Figure D-2: Normal plot of Streamflow hydrographs at Badalgama – calibration .	187
Figure D-3: Normal plot of Streamflow hydrographs at Giriulla – Validation .....	188
Figure D-4: Normal plot of Streamflow hydrographs at Badalgama – Validation..	189
Figure D- 5: Normal plot of Streamflow hydrographs at Giriulla – Transferability	190
Figure D-6: Normal plot of stream flow hydrographs at Badalgama – Transferability .....	193
Figure E-1: Flow Duration Curve in Annual Scale for temporal Transferability at Giriulla .....	195
Figure E-2: Flow Duration Curve in Annual Scale for Temporal Transferability at Badalgama.....	196
Figure E-3: Flow Duration Curve in Annual Scale for Spatial Transferability at Giriulla .....	197
Figure E-4: Flow Duration Curve in Annual Scale for Spatial Transferability at Badalgama.....	198
Figure E-5: Flow Duration Curve in Annual Scale for Spatiotemporal transferability at Giriulla .....	199
Figure E-6: Flow Duration Curve in Annual Scale for Spatiotemporal transferability at Badalgama.....	200

## LIST OF TABLES

Table 2-1: Characteristics of different models.....	10
Table 2-2: classification of Hydrological model parameter transferring methods ....	14
Table 2-3: Model selection criteria .....	15
Table 2-4: Model Selection prioritization.....	16
Table 2-5: Surface Depression Storage.....	18
Table 2-6: Summary of Loss models .....	18
Table 2-7: Objective function commonly in practice .....	23
Table 4-1: Summary of data collection and responsible Authorities.....	32
Table 4-2: Hydrometric Station Summary.....	33
Table 4-3: Summary of data missing Periods .....	33
Table 4-4: Station Density and Thiessen weights of Giriulla watershed.....	36
Table 4-5: Station Density and Thiessen weights of Badalgama watershed .....	36
Table 4-6: Annual Water Balance Giriulla Watershed .....	37
Table 4-7: Missing percentages of observed streamflow measurements at Giriulla Gauging Station .....	39
Table 4-8: Annual Water Balance Badalgama Watershed.....	40
Table 4-9: Missing percentages of observed streamflow measurements at Badalgama Gauging Station .....	41
Table 4-10: Monthly Average Rainfall at selected stations.....	48
Table 4-11: Annual rainfall at selected rainfall stations .....	49
Table 5-1: Weighted Average CN of Giriulla Watershed.....	55
Table 5-2: Weighted Average CN of Badalgama Watershed .....	56
Table 5-3: Derived Initial Parameters of selected watersheds.....	59
Table 5-4: Statistical performance of the model for Calibration – Giriulla.....	62
Table 5-5: Annual Water Balance for Giriulla - Calibration .....	64
Table 5-6: Measure of goodness of fit of the model for Badalgama – Calibration ...	66
Table 5-7: Annual Water Balance for calibration at Badalgama.....	68
Table 5-8: Measures of goodness of fit of the model for Giriulla – validation .....	70
Table 5-9: Annual Water Balance for Giriulla - Validation .....	71
Table 5-10: Measure of goodness of fit of the model for Badalgama – Validation ..	74
Table 5-11: Annual Water Balance for Badalgama sub-watershed - Validation.....	75
Table 5-12: Optimized Model Parameters for both catchments .....	78
Table 5-13: Optimised Parameters from Automatic Calibration - Giriulla .....	78



Table 5-14: Optimised Parameters from Automatic Calibration - Badalgama.....	79
Table 5-15: Performance Indicators of Automatic Calibration - Giriulla.....	80
Table 5-16: Performance Indicators of Automatic Calibration - Badalgama .....	81
Table 5-17: Statistical Performance of Temporal Transferability - Giriulla .....	82
Table 5-18: Annual water balance error for temporal transferability at Giriulla.....	84
Table 5-19: Statistical Performance of Temporal Transferability - Badalgama.....	86
Table 5-20: Annual water balance error for temporal transferability at Badalgama .	88
Table 5-21: Statistical Performance of Spatial Transferability - Giriulla.....	90
Table 5-22: Annual Water Balance error for Spatial Transferability - Giriulla.....	92
Table 5-23: Statistical Performance of spatial transferability - Badalgama .....	94
Table 5-24: Annual water Balance for the spatial transferability - Badalgama.....	96
Table 5-25: Statistical model performance for Spatiotemporal transferability - Giriulla .....	98
Table 5-26: Annual water Balance for the Spatiotemporal transferability - Giriulla .....	100
Table 5-27: Statistical performance of spatiotemporal transferability - Badalgama	102
Table 5-28 Annual water Balance for spatiotemporal transferability - Badalgama	104
Table 5-29: Measure of goodness of fit of the model for Giriulla with transferred parameters .....	106
Table 5-30: Annual water Balance error for the entire period with transferability – Giriulla .....	108
Table 5-31: Measure of goodness of fit of the model for Badalgama with transferred parameters .....	111
Table 5-32: Annual water Balance for Badalgama with Parameter Transferability	113
Table 6-1: Comparison of annual MRAE and RMSE variation - Giriulla .....	125
Table 6-2: Comparison of annual MRAE and RMSE variation - Badalgama.....	125
Table 6-3: Comparison of annual MRAE and RMSE variation in the validation period - Giriulla.....	127
Table 6-4: Comparison of annual MRAE and RMSE variation in the validation period - Badalgama .....	128
Table 6-5: Annual model performance for Spatial Transferability - Giriulla.....	133
Table 6-6: Annual model performance for Spatial Transferability - Badalgama ....	133
Table 6-7: Annual model performance for spatiotemporal transferability - Giriulla .....	135
Table 6-8: Annual model performance for spatiotemporal transferability – Badalgama .....	135

Table 6-9: Comparison of annual MRAE and RMSE values with transferred parameters at Giriulla catchment .....	137
Table 6-10: Comparison of annual MRAE and RMSE values with transferred parameters at Badalgama catchment.....	138

## ABBREVIATIONS

2-P	- Two Parameter
4-P	- Four Parameter
AMC	- Antecedent Moisture Condition
AMSL	- At Mean Sea Level
ANN	- Artificial Neural Network
CN	- Curve Number
ET	- Evapotranspiration
FDC	- Flow Duration Curve
GIS	- Geographic Information System
GW	- Ground Water
HEC-HMS	- Hydrological Engineering Center-Hydrological Modeling System
IDW	- Inverse Distance Weighted
ID	- Irrigation Department
L	- Stream Length
MRAE	- Mean Ratio of Absolute Error
MSL	- Mean Sea Level
MSE	- Mean Square Error
NASH	- Nash Sutcliffe
PoR	- Period of Record
RF	- Rainfall
RMSE	- Root Mean Square Error
RR	- Rainfall-Runoff
SCS	- Soil Conservation Service
SD	- Survey Department
SF	- Stream Flow
SMA	- Soil Moisture Accounting
SWAT	- Soil Water Allocation Model
WMO	- World Meteorological Organization