CONTENTS

	CHAPTER					
	Title	i				
	Арр	the Viva-Voce Board	ii iii			
	Cert					
	Decl	iv				
	Ack	ements	\mathbf{v}			
	Con	tents		vi-viii		
	List of Symbols Abbreviations List of Figures					
	List	of Table	S	xvi-xvii		
	Abst	ract		xviii		
1	Intro	oduction		1		
	1.1	Backgr	ound	1		
	1.2	Objecti	ives	5		
2	Review of Literature			6		
	2.1	ANNs	in Hydrology and Water Resources	6		
	2.2	Estima	tion of Pan Evaporation (E_p) using ANNs	7		
	2.3	Estima	tion of Reference Evapotranspiration (ET _o) using ANNs	11		
		2.3.1	ANN Studies for Estimation of ET _o with Sufficient Climatic Data	11		
		2.3.2	ANN Studies for Estimation of ET_c	16		
		2.3.3	ANN Studies for Forecasting of ET _o	17		
		2.3.4	ANN Studies for Estimation of ET _o with Limited Climatic Data	19		
		2.3.5	Generalized ANN Studies for Estimation of ET _o	21		
	2.4	Estima	tion of ET_0 or E_p using WNN Models	22		
		2.4.1	Estimation of ET _o using WNN Models	23		
		2.4.2	Estimation of E _p using WNN Models	24		
	2.5	Estima	tion of ET_0 or E_p using HSN Models	25		
	2.6	Critiqu	e	26		
3	Theoretical Considerations					
	3.1	Conver	ntional ET _o Estimation Methods	27		
	3.2	Artifici	al Neural Networks (ANNs)	29		
		3.2.1	ANN Architecture Types	29		
		3.2.2	Network Training to Minimize Errors	31		
		3.2.3	Network Training to Update the Weights	32		
	3.3		lized Higher Order Synaptic Neural (GHSN) Models	33		
		3.3.1	Neural Unit (NU)	33		
			3.3.1.1 Synaptic Operation	34		
			3.3.1.2 Somatic Operation	34		
		3.3.2	Generalized Linear Synaptic Neural (GLSN) Model	37		
		3.3.3	Generalized Quadratic Synaptic Neural (GQSN) Model	37		
		3.3.4	Generalized Cubic Synaptic Neural (GCSN) Model	38		
		3.3.5	Training of GHSN Networks	38		

	CHAPTER					
	3.4	3.4 Wavelet Analysis (WA)				
		3.4.1	Wavelet Transform (WT)	41		
		3.4.2		42		
	3.5	Multip	le Linear Regression (MLR) Model	43		
4	Mate	miala an	d Mathada	45		
4		laterials and Methods				
	4.1		ption of the Study Area	45		
	4.2		opment of ANN ET _o Models	51		
		4.2.1	Selection of Effective Inputs	54		
		4.2.2	1 2	54		
	4.2	4.2.3		55		
	4.3		opment of HSN ET _o Models	56 56		
	4.4	Development of GHSN ET _o Models				
	4.5	Development of WHSN ET _o Models				
	4.6	Development of WGHSN ET _o Models				
	4.7		ppment E _p Based GHSN Models	63		
	4.8		opment MLR Models	64		
	4.9		tion of Models' Performance	64		
	4.10	Develo	opment of User-friendly Software for Estimating ET _o	66		
5	Resu	ults and Discussion				
	5.1	Perform	mance of Conventional ET _o Methods	67		
		5.1.1	Performance of Conventional ET _o Methods for 15 Locations	68		
		5.1.2	Performance of Conventional ET _o Methods for Four AERs	69		
	5.2	Develo	ppment of HSN Models for Daily ET _o Estimation	70		
		5.2.1	Training of HSN Models for Daily ET _o Estimation	71		
		5.2.2	FAO-56 PM Based HSN Models (HSN1)	77		
		5.2.3	Turc Based HSN Models (HSN2)	84		
		5.2.4	FAO-24 Pan Based HSN Models (HSN3)	88		
		5.2.5	HG Based HSN Models (HSN4)	92		
		5.2.6	Spatial Distribution of Annual Average QSN Estimated ET_{o}	96		
		5.2.7	Comparison of HSN Models with the Conventional ET_0 Methods	98		
		5.2.8	Summary of HSN Models for ET _o Estimation	99		
	5.3	Develo	opment of GHSN Models for Daily ET _o Estimation	99		
		5.3.1	Training of GHSN Models for Daily ET _o Estimation	100		
		5.3.2	Performance of GMLR Models for ET _o Estimation	103		
		5.3.3	Relative Performance of GHSN Models over GLSN Models	104		
		5.3.4	Ranking of GQSN Models for ET_0 Estimation	109		
		5.3.5	Comparison of GQSN Models with the Conventional ET_0 Methods	109		
		5.3.6	Summary of GHSN Models for ET _o Estimation	110		
	5.4	Application of GHSN Models to Test Generalizing Capability				
	5.5	Development of WHSN Models		110 117		
		5.5.1		117		

		CHAPTER					
	5.5.2 Turc Based WLSN Models		Turc Based WLSN Models (WLSN2)	121			
		5.5.3	5.3 FAO-24 Pan Based WLSN Models (WLSN3)				
		5.5.4 HG Based WLSN Models (WLSN4)					
		5.5.5 Comparison of WLSN Models with the Conventional					
		Develo	ET _o Methods				
	5.6	134					
		5.6.1	Development of WGHSN Models for Model Training	134			
			Locations				
		5.6.2	Comparison of WGLSN Models with the Conventional ET _o Methods	137			
		5.6.3	Application of WGHSN Models for Testing	137			
		Generalizing Capability					
	5.7		pment GHSN Models for Estimating E _p	140			
		5.7.1	Performance of E _p Based GHSN Models	140			
		5.7.2	II P	143			
		5.7.3	Development of WGR and WGLSN Based E _p Models	145			
	5.8	Descrip	otion of User-friendly Software for Estimating ET _o	147			
6	Sum	mary an	d Conclusions	149			
	6.1	Summa	ary	149			
	6.2	Conclu	sions	157			
	6.3	Researc	ch Contributions from the Study	159			
	6.4	Limitat	tions and Future Scope	160			
References							
Brief Curriculum Vitae							

6