	СНА	PTER			PAGE			
	Title Page							
	Approval of the Viva-Voce BoardCertificateAcknowledgementsDeclarationList of SymbolsContentsAbstractIntroduction							
	Ackn							
	Decla							
	List of Symbols							
	·							
1	Intro	duction			1			
2	Revie	Review of Literature						
	2.1	Neural	l Networks		5			
	2.2	Higher	-Order Ne	eural Networks (HONNs)	11			
	2.3	Self-O	rganizing	Maps (SOMs) based Neural Network	12			
	2.4	Bootst	rap based	Neural Networks (BNNs)	13			
	2.5	Wavel	et based N	eural Networks (WNNs)	14			
	2.6							
•	Study Area and Data Used							
	3.1							
	3.2 Data Used							
L	Theo	Theoretical Considerations						
	4.1	Neural	Neural Networks					
		4.1.1	Neural u	inits	28			
			4.1.1.1	Neural units with linear synaptic operation (NU-LSO)	29			
			4.1.1.2	Neural units with higher order (Nth order) synaptic operation (NU-HSO)	30			
		4.1.2 Learning algorithms						
			4.1.2.1	Conjugate-gradient or Powell-Beale restarts conjugate gradient (CGB)	35			
			4.1.2.2	Bayesian-regularisation algorithm	36			
			4.1.2.3	Levenberg-Marquardt algorithm	36			
		4.1.3		g of neural networks	37			
			4.1.3.1	Early stopping criteria (STC)	40			
	4.2	Bootet			41			
	4.2	Bootstrapped Neural Networks Wavelet Analysis						
	4.3 4.4	Self-Organizing Maps (SOMs)						
	4.4 4.5							

## CONTENTS

	4.6	Multiple Linear Regression (MLR)				
5	Metł	hodology	51			
•	5.1	Selection of Optimal NN Model Structure	51			
		5.1.1 Selection of input vectors	51			
		5.1.2 Selection of hidden neurons	55			
	5.2	Development of NN Models				
	5.3	Development of BNN Models				
	5.4	•				
	5.5 Development of WBNN Models					
	5.6	65				
	5.7	66				
	5.8	5.8 Model Evaluation Measures				
	5.9	Development of User Friendly Software	70			
6	Resu	lts and Discussion	71			
U	6.1	Daily Discharge Forecasting	71			
	0.1	6.1.1 Selection of optimal length of training datasets and	71			
		appropriate training algorithm	/1			
		6.1.2 Daily discharge forecasting using NN models	76			
		6.1.2.1 Comparative performance of NNs with linear	80			
		and higher-order synaptic operations				
		6.1.3 Ensemble daily discharge forecasting using BNN	84			
		models	-			
		6.1.3.1 Comparative performance of BNN and NN	88			
		models				
		6.1.3.2 Effect of length of training datasets	88			
		6.1.3.3 Effect of split sample validation	90			
		6.1.4 Daily discharge forecasting using WNN models	91			
		6.1.5 Ensemble daily discharge forecasting using WBNN	94			
		models				
		6.1.6 Comparative performance of NN, BNN, WNN and	96			
		WBNN models				
		6.1.6.1 Performance comparison of NN models with	103			
		simpler models				
		6.1.7 Improving the performance of the developed models	105			
	with cluster analysis					
	6.2	Uncertainty Assessment in Daily Discharge Forecasts using				
	BNN and WBNN Models					
	6.3	Hourly Water Level Forecasting	122			
		6.3.1 Hourly water level forecasting using NN models	122			
	6.3.2 Ensemble hourly water level forecasting using BNN					
		models	100			
		6.3.2.1 Comparative performance of BNN and NN models	129			
		6.3.2.2 Effect of length of training datasets	130			

		6.3.2.3	Effect of split sample validation	134		
	6.3.3	Hourly v	vater level forecasting using WNN models	136		
<ul> <li>6.3.4 Ensemble hourly water level forecasting using WBN models</li> <li>6.3.5 Comparative performance of NN, BNN, WNN and WBNN models</li> </ul>				137		
				138		
		6.3.5.1	Performance comparison of NN models with simpler models	144		
6.4						
6.5	5 Development of User Friendly Software					
	6.5.1	Descript	ion of software for river flow forecasting	159		
7 Summary and Conclusions						
References Brief Curriculum Vitae						