DEVELOPMENT OF FORECASTING MODEL FOR SUNGAI MUDA, KEDAH BY UTILIZING ARTIFICIAL NEURAL NEYWORK (ANN)

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DEVELOPMENT OF FORECASTING MODEL FOR SUNGAI MUDA, KEDAH BY UTILIZING ARTIFICIAL NERURAL NETWORK METHOD (ANN)

NURUL HASNIZA BINTI MOHD SOPI

A report submitted in partial fulfillment of the
requirements for the award of the degree of
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ABSTRACT

This report deals with flood problem which is eventually happened in Malaysia when it coincides with monsoon and gave harm and damages of human life, as it had took many lives each time it happens. A case study of flood is going to be conduct to analyse the pattern of water level and determine other causes that contributes to the flood. The main aim of the study is to minimize the effect of the flood problems. It is also used to develop high accuracy model utilizing Artificial Neural Network (ANN) in predicting flood. Furthermore, it used to forecast flood occasion in the study area of station number of 5606410 of Sungai Muda (Jabatan Syed Omar) which is the main river that supplies water to Kedah and Penang. Besides, it used to investigate whether water level data alone can be used to produce modelling and to determine whether ANN is functioning in the forecasting. In this case study, a computational model will be used to stimulate the input data and generate the result, which is called Artificial Neural Network, ANN, which are modeled on the operating behavior of the brain, are brain, are tolerant of some imprecision and are especially useful for classification and function approximation or mapping problems, to which hard and fast rules cannot be applied easily. The terminology of artificial neural networks has created form an organic biological model of neural system, which it comprises an asset of joined cells, the neurons. The neurons receive impulses or response from either input cells or any other neurons. It will perform some kind of transformation of the input and then, it will transfer the outcome to other neurons or known as output cells. The neural networks are developed from many layers of connected neurons. The results with RMSE value of 38.414 for 1 hour interval time, while input 6+1 had the highest NSC value of 0.999. Besides that, with RMSE value of 78.692 for 5+1 input and had highest NSC value of 0.997 for 3 hour interval time. Lastly, with RMSE value of 205.404 for 6 hour interval, this time interval had highest value of NSC OF 0.997 for 4+1 input. In conclusion, this research contributes toward the development of forecasting using Artificial Neural Network for flood problem.

ABSTRAK

Laporan ini membincangkan masalah banjir yang kerap berlaku di Malaysia kebetulan dengan berlakunya monsun yang meyebabkan kerosakan dalam kehidupan manusia, kerana ia juga mendatangkan bahaya terhadap nyawa setiap kali ia berlaku. Satu kajian kes banjir akan menjalankan untuk menganalisis corak paras air dan menentukan sebab-sebab lain yang menyumbang kepada banjir. Tujuan utama kajian ini adalah untuk mengurangkan kesan masalah banjir. Ia juga digunakan untuk membentuk model ketepatan yang tinggi menggunakan *Artificial Neural Network* (ANN) dalam meramalkan banjir. Tambahan pula, ia digunakan untuk meramal peristiwa banjir di kawasan kajian iaitu di stesen bernombor 5606410 Sungai Muda (Jabatan Syed Omar) yang merupakan sungai utama yang membekalkan air kepada Kedah dan Pulau Pinang. Selain itu, ia digunakan untuk menyiasat sama ada data paras air sahaja boleh digunakan untuk menghasilkan model dan untuk menentukan sama ada ANN berfungsi dalam ramalan tersebut. Dalam kajian kes ini, satu model pengiraan akan digunakan untuk merangsang data input dan menjana hasil, yang dipanggil *Artificial Neural Network* (ANN), yang mencontohi tingkah laku operasi otak, ia adalah toleran terhadap beberapa ketakpersisan dan amat berguna untuk pengkelasan dan fungsi anggaran masalah bahawa peraturan yang cepat dan susah tidak boleh diaplikasikan dengan mudah. Istilah rangkaian neural tiruan telah mencipta bentuk model biologi organik sistem saraf, yang ia terdiri daripada aset sel-sel neuron. Neuron menerima impuls atau respons sama ada daripada sel-sel input atau mana-mana neuron lain. Ia akan melaksanakan beberapa jenis transformasi input dan kemudian, ia akan memindahkan hasilnya kepada neuron lain atau dikenali sebagai sel output. Rangkaian neural dibangunkan daripada banyak lapisan neuron disambungkan. Dengan nilai RMSE dengan nilai 38.414 untuk 1 jam masa selang, input 6+1 mempunyai nilai tertinggi NSC 0.999. Selain itu, dengan nilai RMSE 78.692 dengan 5+1 input dan mempunyai nilai tertinggi NSC sebanyak 0.997 untuk 3 jam masa selang. Akhirnya, dengan nilai RMSE 205.404 selama 6 jam selangn untuk 4+1, jam ini mempunyai nilai tertinggi NSC sebanyak 0.997. Kesimpulannya, kajian ini menyumbang ke arah pembangunan ramalan menggunakan Artificial Neural Network untuk masalah banjir.

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LIST OF ABBREVIATION

ANN	Artificial Neural Network.
MRA	Multiple Regression Analysis.
NEM	North East Monsoon.
NSC	Nash-Sutch Coefficient.
RMSE	Root Mean Square Error.
SWM	South West Malaysia.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Water defines as the main landscape of a region and most important resources to earth eco-system. On earth, about 70% of water covers the earth and continuously moving bottom, above and on the earth surface. From all this movement of water is called water cycle. Plus, about 90% of water on earth and 80% of water evaporations occurs. Water stores in the form of clouds and the process of precipitation occurs where water falls on the land and sea. Water that fall on the land will become surface water such as streams and some water will infiltrate into the ground that become underground water. Other process where surface water change into gases called evaporation processed. On the land, water that moves in either cycle back to the sea or being evaporate to the atmosphere. Although the water on the earth are going through different states of cycle, the water on the earth will always be in the balance level and moves to different locations over time.

Nowadays, high demand on water resources every day and available resources in the form of precipitation are more or less constant. Water management available in hydrological system for the survival of future needs of water. The most complex

hydrological process known as rainfall-runoff where need to comprehend due to tremendous spatial variability of watershed characteristics and rainfall pattern. Rainfall-runoff modeling of the hydrological processes to calibrates and validate the modal certain amount of records available for certain period. (Avianash Agarwal and R.D.Singh, 23 May 2002). Rainfall-runoff model and provide enough evidence as a training model in extracting the behavior of the hydrological system. On the other hands, compare to other training model. A number of researches have proved that the potential of this modeling rainfall-runoff process in their study. (French et al.
1992; Lorrai and Sechi, 1995; Hus et al. 1995; Raman and Sunikumar, 1995; Shamseldin, 1997; Fernando and Jayawardena, 1998; Thirumalasah and Deo, 1998; Tokar and Johnson, 199).

Another important thing that needed to be concern about water resources is flooding. Disaster management for urban and suburban is a growing priority of the development of the city. The functionality of the digital city can be adapted for managing urban flood disasters. Urban flooding should be mitigated using a judicious mix of both structural and non-structural strategies. (R.K.Prince[a*] & Z. Vojinovic[a] 11 Sept 2008; 259-276). Flooding events have been a major crisis over generations due to the loss of lives and damages to the causes of flooding. Flooding events normally occurs when there is heavy rainfall over a short period of time and also if there is an extensive rainfall over a long period of time in plain areas. On the other hand, poor maintenance of drainage networks, deforestation and inappropriate development in the area cause by human factors contributing to the causes of the flooding. Common region that always be the area of flooding events is coastal regions and low level areas which have high tide that can slow or stop the flowing of river water flow from the stream to the sea. Not only urban area, the city also can be one of the common regions of flooding due the human illegal contribution development. Besides that, the changes of global warming can be a big factor to the causes of flooding that have been in a recorded high in the past hundred years.

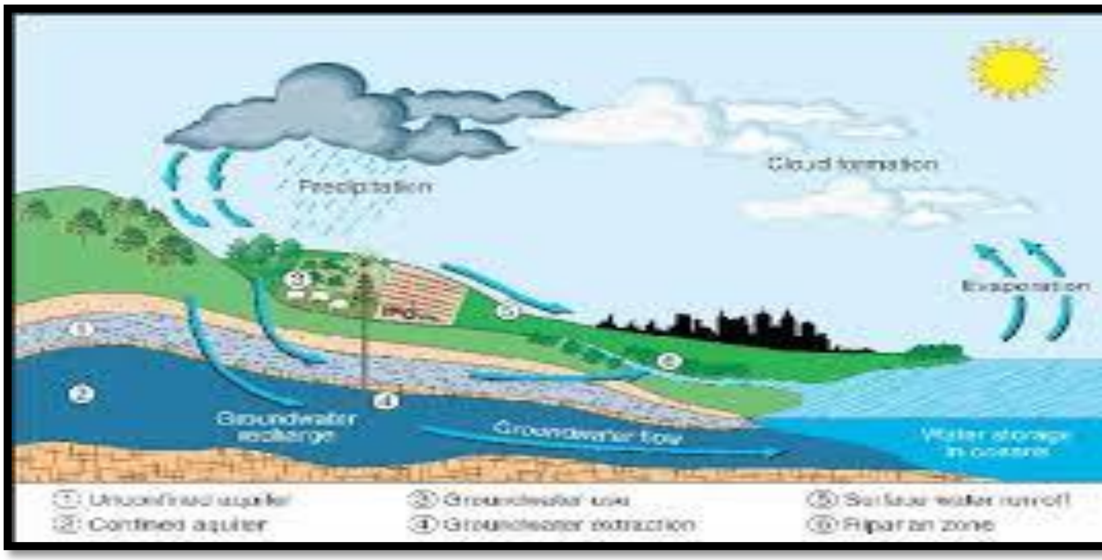


Figure 1.1: Formation of rain

The event of overflow with big quantity of water or well known as flood which is the soil infiltrate more amount of water and also can cause if there is tide period. The effects of combination gravitational forces exerted by the Moon and the Sun and the rotation of earth in orbit which cause rise and fall of sea levels is called tide. The flow rates will exceed the capacity of water flow channel when sea levels start to raise and also cause spillway of rainfall. Besides that, if there are too much of rainfall, the rainfall could not absorb in soil because the soil are fully saturated of water. During the phase, water levels will increase which is possibility to achieve to a maximum point. Flood events often cause losses and damages to living life. On the other hand, for those who are doing business near the river will experience more effect. This is because river also can be another travelling way to access to commerce industry.

Furthermore, news about flood problems in Malaysia, especially Peninsular Malaysia is more often to get. In peninsular Malaysia, there are having a humid tropical climate where is the weather is warm and humid with low temperature within ranging from $20^{o}C$ to $32^{o}C$ and normal water temperature $37^{o}C$ to $38^{o}C$ (Jasim et al., 2013). Climate in Peninsular Malaysia also influences by the monsoons and experiences two rainy seasons throughout the year with South West Monsoon (SWM) that occur between May to August and the North East Monsoon from November to February (Wong et al., 2009).

Case study will be conducted in Sungai Muda located in Kuala Muda, Kedah with catchment area of 4,192 km^2. The population living area of study is almost 456,605 people. Flood study by using Artificial Neural Network (ANN) will conducted might require large number of data of water level from study area to determine the water level that will produce flood and other causes. Daily water level data for 14 years is going to be select based on completeness of data and the length of records. The input of the data will be used in this case study obtained from Drainage and Irrigation Department (DID) for the period of 2000 to 2014.

Figure 1.2: Map state of Kedah

Figure 1.3: Maps of Kuala Muda River

1.2 BACKGROUND

Artificial Neural Network also known as ANN was found in 1943, by a neurophysiologist, Warren McCulloh and mathematician, Walter Pitts founding what was happened during both of researches wrote a paper on how neurons work. Incidentally, to described how neurons in brain might work they have modelled a simple neural network using electrical circuit. From a single biological neuron (Figure 1.4) they have developed an artificial neuron (perceptron)(Figure 1.5). This model are officially approved in 1994, by Donald Hebb, in 1959, by Bernard Widrow and Marcian Hoff of Stanford and new model that similar to network independently of one another were developed by Kohonen and Anderson in 1972.

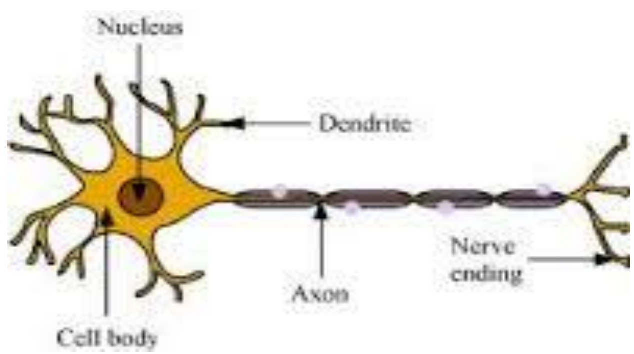


Figure 1.4: A biological neuron

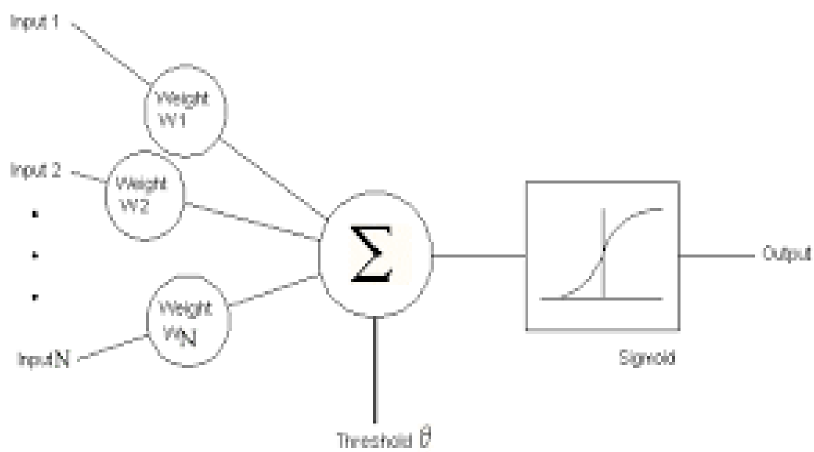


Figure 1.5: An artificial neuron

In this case of study, data obtain will gathered and stimulate by using Artificial Neural Network (ANN). This computational model is based on animal's central system which is more prefer as brain. The functions estimation result is based on a large number of input data. The model presented as interconnected "neurons", means that the model that can compute or generate values from the data obtained as the pattern of data that lead to the final result. For this case of study, rainfall data will be gathered in specific study area, where the flood events tend to occur. In order to generate and stimulate the data, ANN is used to produce result. Besides that, it can help in analyzing the hydrological data in determine the water level that might cause of flood and also in understanding the relationship between water level and flood.

1.3 PROBLEM STATEMENT

Industrial countries which are rapidly developing had to face environmental disaster. Flood event occur due to the excessive rainfall in the river catchment area that can be a major problem that can cause bigger issues to the environment, damage of properties and also losses to human kind. Flood forecasting is a necessity which will help to reduce the effects of flood and planning for flood events. By using statistically method such as Auto Regression Moving Average (ARMA) is used, but this method only can read the rough estimation of the flow. There are few alternative modeling that can be used to computing the data and have been successfully tested in flood forecasting studies known as Artificial Neural Network (ANN). This model can help to obtained accurate forecasting results.

In addition, from previous studied about using mathematical equations known as Multiple Regression Analysis (MRA) that also can be used in prediction of flood but does not produce accurate result due to independent variables are correlated with each other will make complex approach.

1.4 OBJECTIVES

The general aim of this study is to minimize the effect of flood events due to sub-objectives of this study are:

1. Make the prediction of the flood event more accurate using ANN model
2. To validate flood occasion in Sungai Kuala Muda, Kedah Darul Aman.

1.5 SCOPE OF STUDY

2. The study case will conduct in area of Sungai Kuala Muda, Kedah Darul Aman.
3. Gathered data from related department and accessible sources.
4. All data will predict in hourly.
5. Data input for 14 years will be stimulates by utilizing ANN.

CHAPTER 2

LITERATURE RIVIEW

2.1 INTRODUCTION

The discussion in this chapter is regarding the method and material use in past study done by researchers in flood prediction and artificial neural network. It will serve as a guideline in conducting this research.

2.1.1 FLOOD

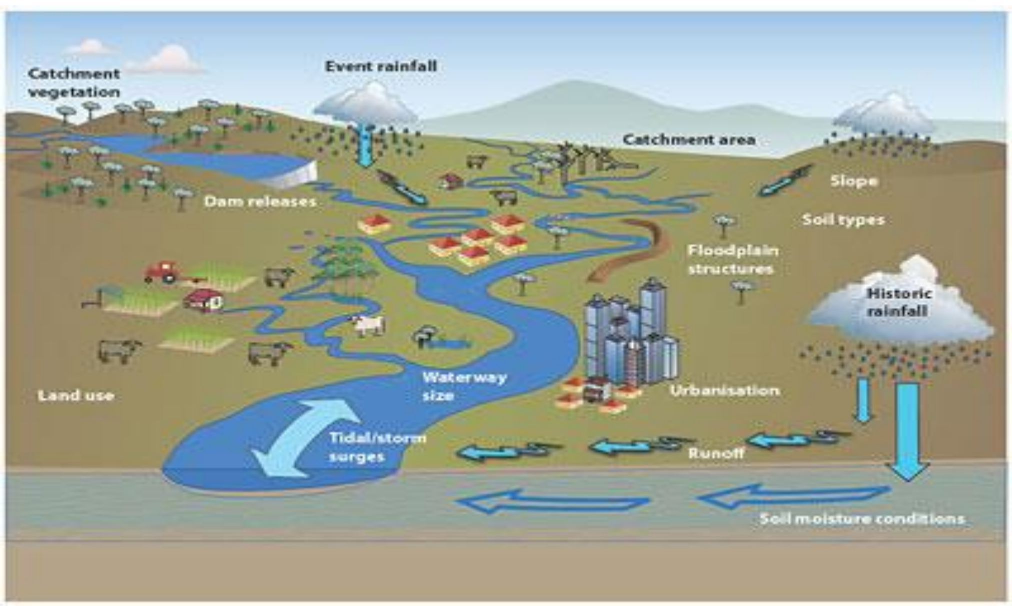
2.1.1.1 Introduction

Flood is one of the common environmental disasters. Some floods take time to elevate, mean while some can happen without any sign of heavy rain such as flash floods. This flood event happened in certain low area that only effecting neighbourhoods and small communities, and also can become worse affecting the whole river basin and multiple states in one time. In Malaysia, flood occurrence is very general among Malaysians.

According to C. and Low, K.S., (1972), “an appraisal of the flood situation in East Malaysia”, paper presented at the Symposium on Biological Resources and National Development, Faculty of Agriculture, University of Malaya, Malaysians are historically a riverine people as early settlements grew on the banks of the major rivers in the country.

2.1.1.2 Factors causing flood

Many contibutor that can be take causing of flood development until causes the losses life and damage of properties due to the changes structure of the soil surface.



Urban and suburban

Most urban area are more likely to experienced flooding events where the increase of the amount of rainfall that could not be support by drainage systems. This flood event will repetitively and impacts the communities systematically. The structures of the natural river present in the city are effect by the urbanization. The development's structure will decreased the area of the river section and pollution will reduced the flow of the water due to impediments.

Insufficient permeable ground surface

Most floods occur on low land areas, where the grounds get saturated quickly during heavy raining. Infiltration phase could not take place as quickly as accumulation of water, thus resulting flood. This is happen when there are not enough permeable surfaces of the soil that hold up the water flow.

Low land area

River more effective in depth compared to width (Vishawas, 2002). When there is too much water flow into the river at the same time will cause the river to over flow and all the water will be spilled out from the river and flow to the low land area. As an example, when rainy season in Kelantan, the tendency for Kuala Krai's area to have flood events because too much water flow through the Kelantan's river and cause all the excess water flow out away from the river and filled up the lower area.

Downstream water levels

The capacity of waterways can also be affected by the water level in the ocean or lake they are flowing into. For example, a king tide or storm surge can hamper the release of water from a river into the ocean. A similar effect can occur near the junction of creeks with rivers, where backwater effects from river flooding can extend a significant distance up the creek.

2.2 FLOOD IMPACTS

Flood event is common occurring natural event in Malaysia which is leaves a massive effect to human, properties, infrastructure and environment.

2.2.1 Impacts on human

Flooding causes physical injury, illness and depth to livelihood. Fast flowing or rapidly rising flood water can be dangerous to people where is more risked. Besides that, floodwater can hide other hazards for pedestrians such as the manhole that covered by floodwater. Diseases is the main impacts to victims during the flood, where floodwater contaminated by sewage of other pollutants which can effect health (OPW, 2009). Immediate causes of death in floods include drowning and trauma or injury. Over an extended time period, there may also be increased mortality due to infectious disease

2.2.2 Impact on property and infrastructure

Most properties and infrastructures get damaged by the floodwater such as transport or utility which impact on local and regional economies. Primary roads and most of the railways can deny access to large area beyond those directly effect by flood. Flooding of water distribution infrastructures such as pumping stations and electricity sub-stations causing loss of water and power supply over large areas (OPW, 2009).

2.2.3 Impacts on environment

Environmental effect by flood event can be include soil erosion, bank erosion, land slide and damage to vegetation as well as the impacts on water quality, and habitats such as by bacteria and other pollutants carried by flood water (OPW, 2009).

CHAPTER 3

METHODOLOGY

3.1 STUDY AREA

Water level forecasting is commonly done in the rainfall catchment area. This scope of study is focused at Sungai Muda, Kuala Muda, Kedah Darul Aman, located in North of peninsular Malaysia. There is a station in Kuala Muda, Kedah with station number is 5606410. The nearest city from the area of study is Sungai Petani. This study will cover the area of Sungai Muda with area coordinate of latitude 5^{o} 12’ 57 N and 100^{o} 27’ 16 E (Figure 3.1). All information is get from Meteorology Department Malaysia. Kuala Muda is one of the low land area and open to the risk of flood every rainy season every year. Flooding usually happened because of exceed water level of nearest river catchment. Many factors are related to the flooding events, such as uncontrolled logging activities and the new residential area could not support the capacity of excessive rainfall cause the water to overflow from the river. The normal reading of water level at Sungai Muda is 8.00m where flood level at the station is 13.10m. Sungai Muda having basin area of 4,192 km^2 and length about 203 km is the main river for districts of Sungai Petani. Kuala Muda has population of about 456,605 people (Department of Statistic Malaysia 2010).

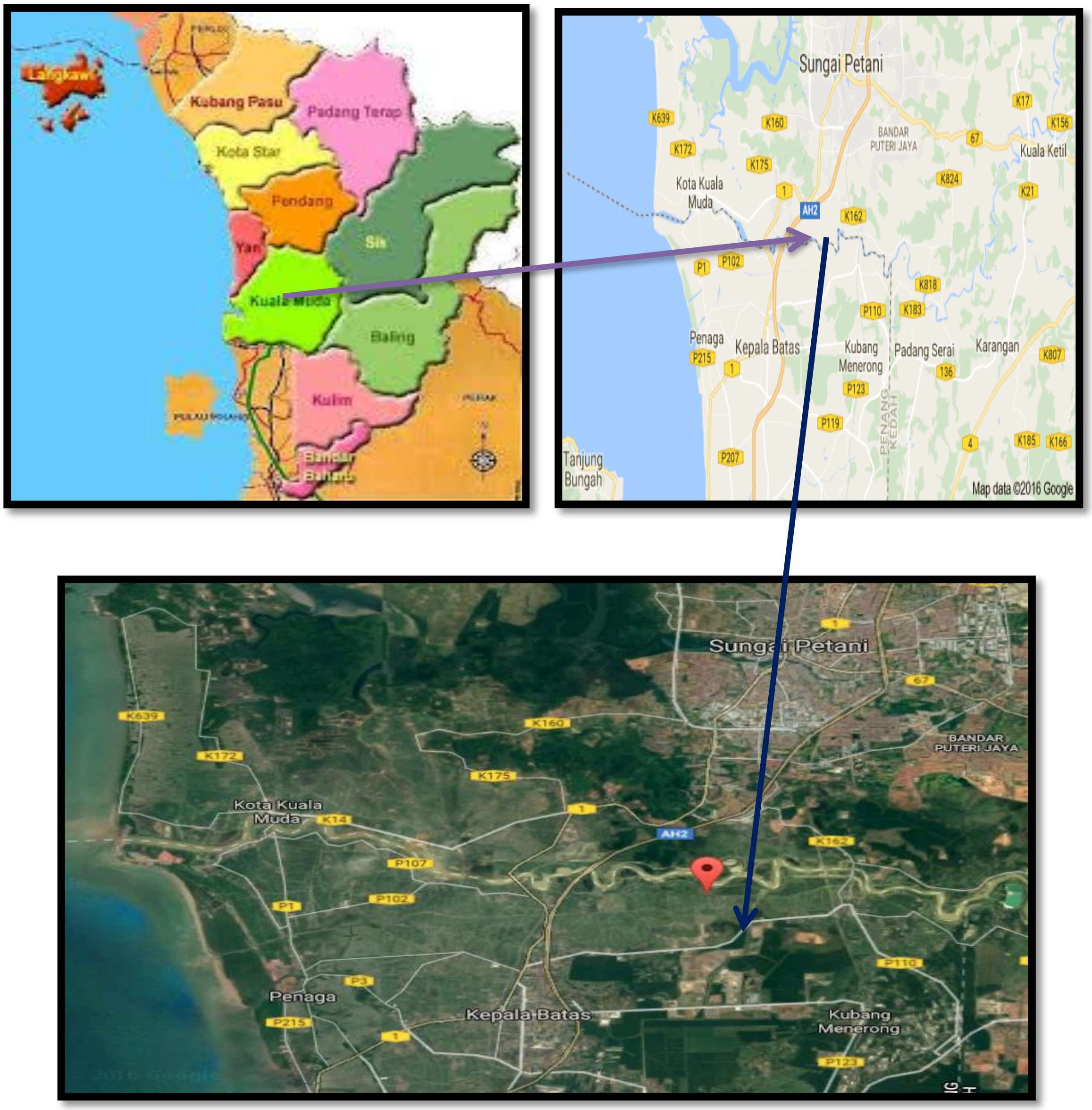


Figure 3.1: study area in Kuala Muda, Kedah

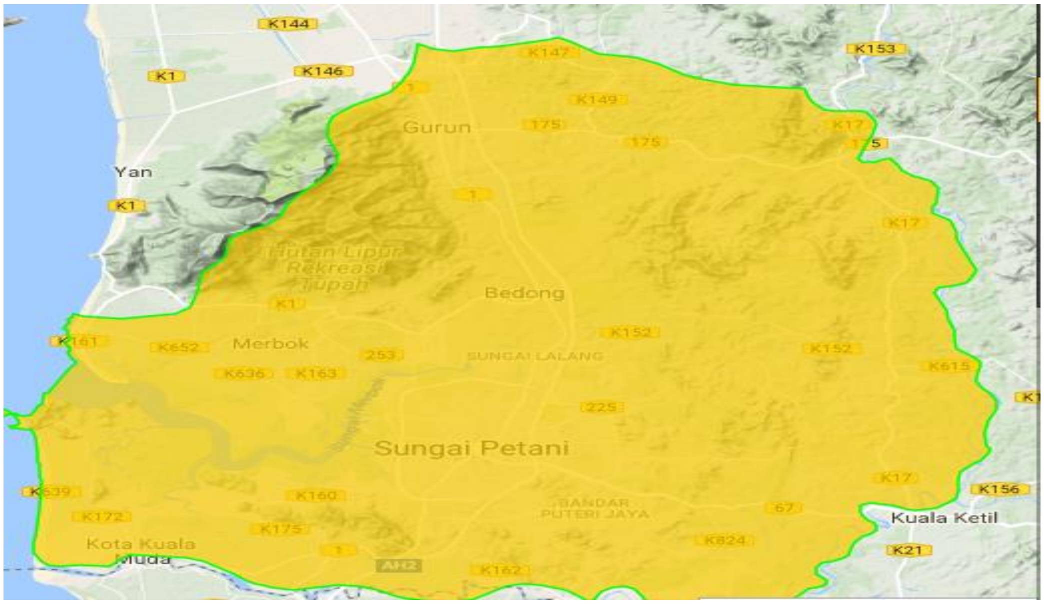


Figure 3.2: catchment area of Sungai Muda, Kuala Muda,Kedah

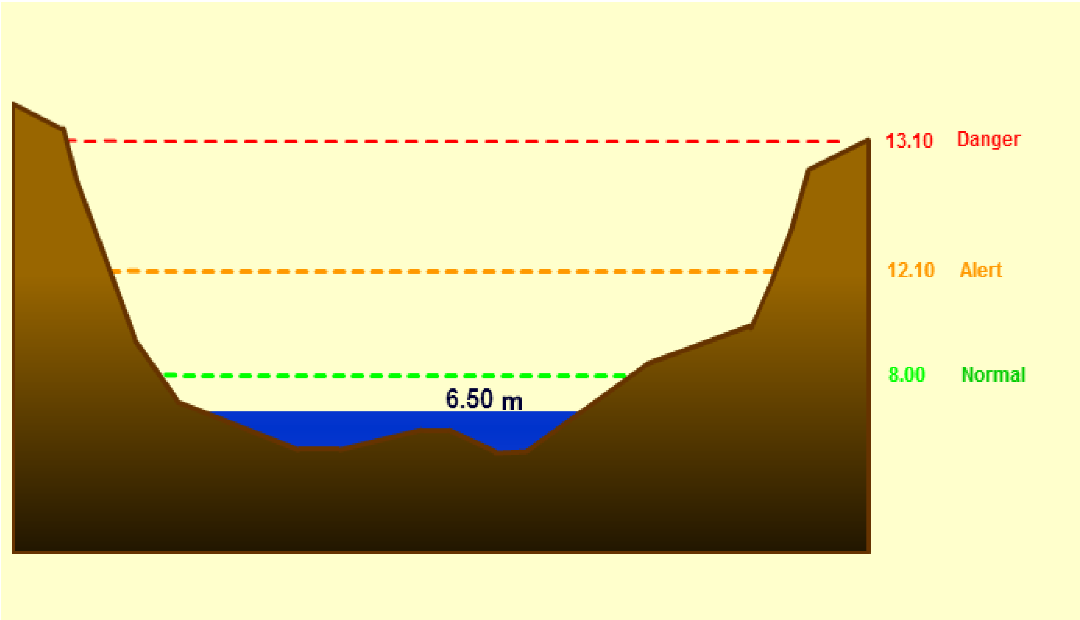


Figure 3.3: cross-section of Sungai Muda, at Jabatan Syed Omar

3.2: METHOD OF ANALYSIS

3.2.1 Introduction of Artificial Neural Network (ANN)

Making prediction for the future flood events in certain area, data analyzing the previous data pattern need to be done. Data reading of the rainfall and water level are considered as the important factors for future flood disaster occurrence and can be representing as a single or multiple events in a specific area. Based on Artificial Neural Network (ANN), an alternative have been found. Approach in flow flood forecasting and has been develop in recent years. In order to utilizing the data obtained to solve the problem. 'Study the relationship between the input and the output of the data'.

Artificial neural network (ANN), are modeled based on the operating behavior of the brain that are imprecision and are especially useful for approximation problems, which hard and fast rules cannot be applied easily (David, 2000, John, 2000). The fundamentally gains as a fact matter. The past few issues is the common conformation the extent of current machines are in resolvable by little vitality proficient bundles. The mind displaying likewise guarantees a less specialized approach to create machines arrangements. New approach to figuring additionally gives a more effortless debasement framework over-burden than it is more conventional partner.

These 'neural' systems as in they may have been propelled by neuroscience not so much in light of the fact that reliable models of neural. Dominant part of the system is nearly identified with conventional numerical or measurable model, as example, non-parametric example classifier, grouping calculation and nonlinear channels than they are to neurobiology models. Neural networks have been utilized for a wide mixture where factual routines are customarily utilized. The have been utilized as part of use issue, as an example, submerged recognizing sonar flaws, perceiving discourse and the optional structure participating of globular proteins. Within time arrangement applications, neural network have been utilized as a part of anticipating stock exchange execution.

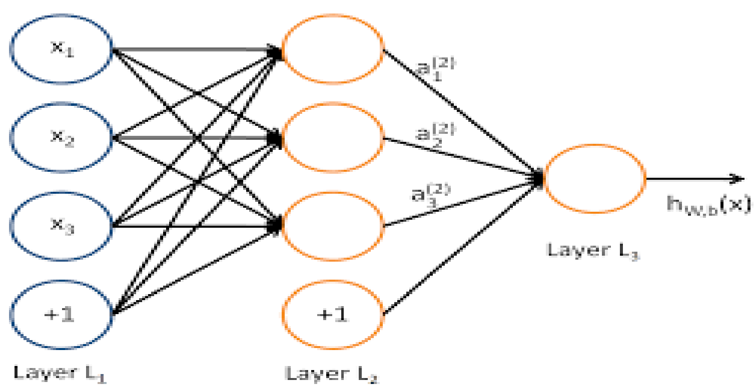


Figure 3.4: Diagram of Neural Network

3.2.2: Basic of Artificial Neural Network

A neuron is a real function of the input vector (y_1, ….. , y_k), while the output vector is obtained as

$$\boldsymbol{f\,(X_j) = f\,(a_j + \sum_I y_i\, W_{ij})}$$

Where y_i is the activity level of the y^{th} unit in the previous layer and W_{ij} is the weight of the connection between i^{th} and j^{th}

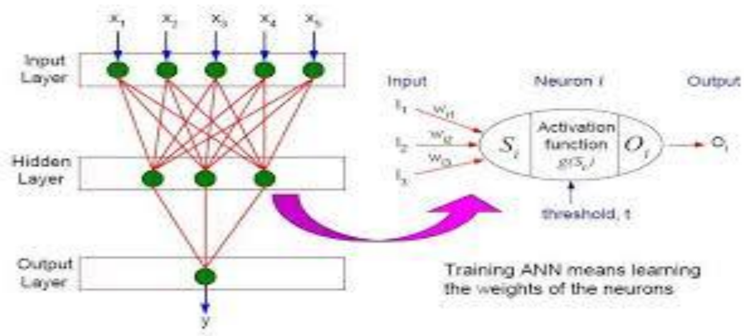


Figure 3.5: Artificial Neural Network

3.2.3: Characteristics of Artificial Neural Networks:

- The neural networks are robust systems and are fault tolerant. Therefore, they can repeat full patterns from incomplete, partial or complete patterns.
- The neural network can process in parallel at high speed in distribution manners.
- Take capability to conclude so that they can predict new result from previous results.

3.3 NEURAL NETWORK ARCHITECTURES

3.3.1 Types of architecture of ANNs

3.3.1.1 Recurrent Networks

These networks are quite different from feed forward network system because it has at least one feedback loop. Furthermore, these networks there may be exist one layer with feedback connections (figure 3.6)

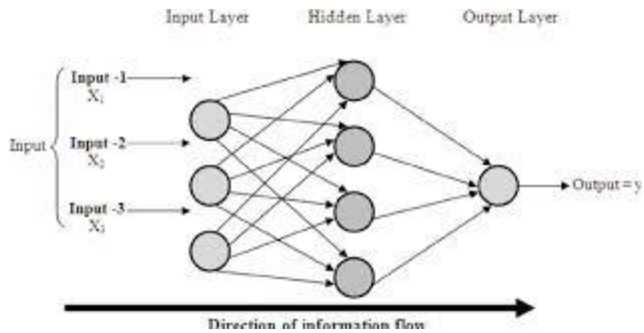


Figure 3.6: Recurrent network

3.3.2.1 Feed-Forward Networks

In this network, data flows in one direction along the pathways, from the input layer through hidden layer to the final output layer.

Types of feed-forward network:

a) Single- layer Perceptron:
   This single network consisted of single of output nodes. The data are input directly to the output through a series of weight.

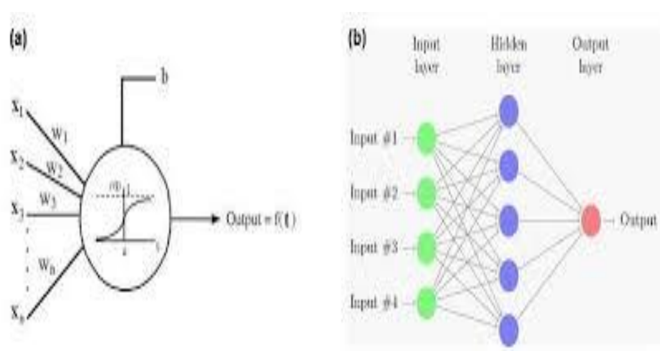


Figure 3.7: single feed-forward network

b) Multiple- layer Perceptron

This network is multi-layer of computational units and it usually interconnected in feed-forward way. Each neuron in one layer has directed the connections to the other neurons at the next layer. This behavior of unit network had applied a sigmoid function known as activation function.

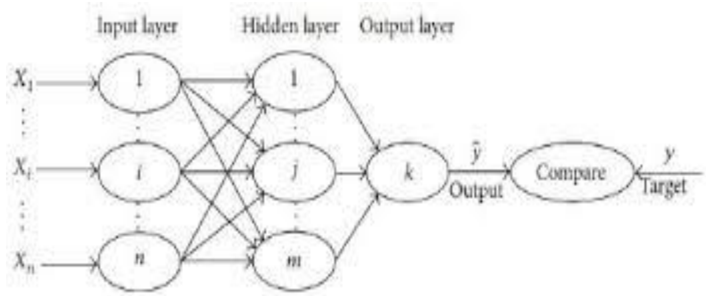


Figure 3. General framework of three-layered neural networks.

Figure 3.8: A multi-layer Feed-Forward Network

Through this report, the main setting to predict flood occurrence in the study area more to feed-forward artificial neural network. Using a simplest type of artificial neural network, the information from the input nodes just move in straight direction, forward through the hidden nodes and move out through the output nodes because this network does not have loop or cycle system.

3.4 ADVANTAGES OF UTILIZING ANNs

The advantages of utilizing ANNs following (Xu Jian-Hao, 2011 and Silverman and Dracup, 1999, Irfan Y. Khan, P.H. Zope, S.R. Suralkar,2013).

- It does not required priori knowledge of the underlying process.
- The existing relationship that occurred among the various aspects of the process does not need to be recognized.
- The network can perform tasks that a linear program cannot and when the element of the network fails, its can continue without any problem.
- It does not make assumption on constraint and priori solution structure.

3.5 DISADVANTAGES OF UTILIZING ANNs

Disadvantages by utilizing the ANNs following (Master, 1993, D.J Livingstone, D.T. Manallack and I.V. Tetko,1996).

- Adjustable parameters to produce desired output by adjust the strength connection between the neuron need involvement of training by compared target and output values.
- Information estimation provides probability the data matches or not with the characteristic that has been trained to recognize.
- The exponential of training time would be increased with the increased of dataset size value.
- It do not have the certainty about relationship that used by the network to produce the output

3.6 DATA COLLECTION

3.6.1 Flowchart

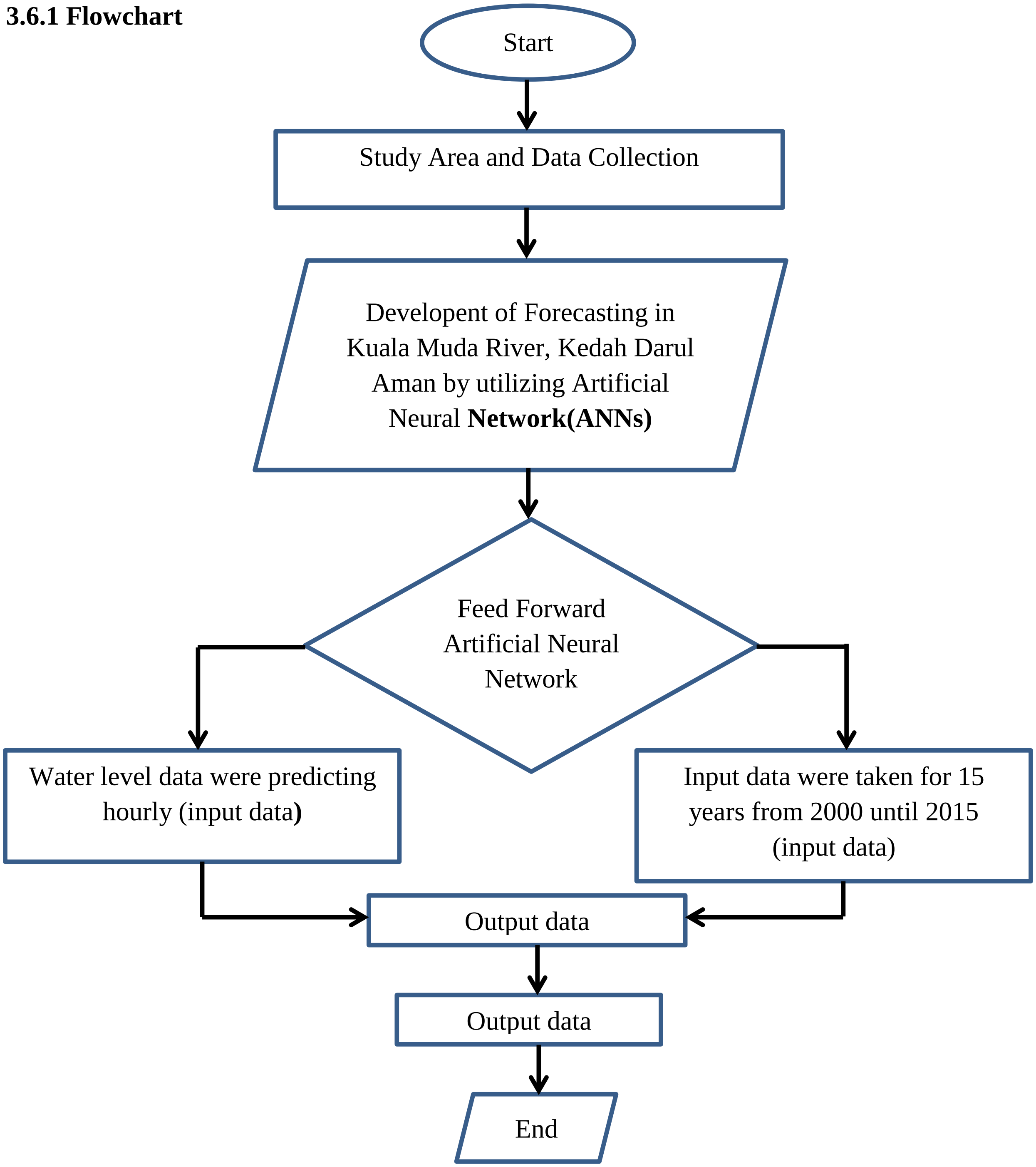


Figure 3.6.1

3.7 DATA PROCESS

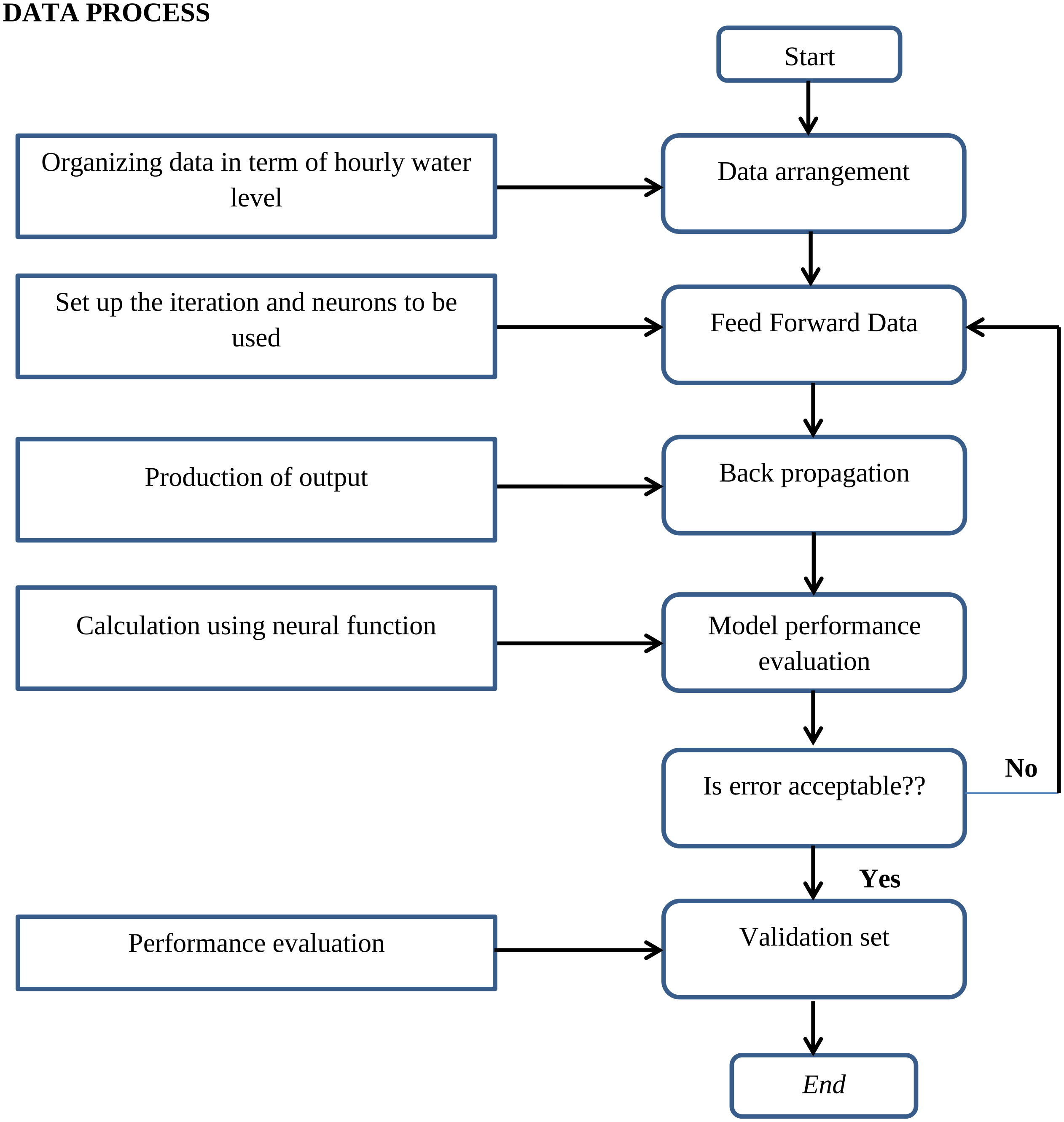


Figure 3.7.1

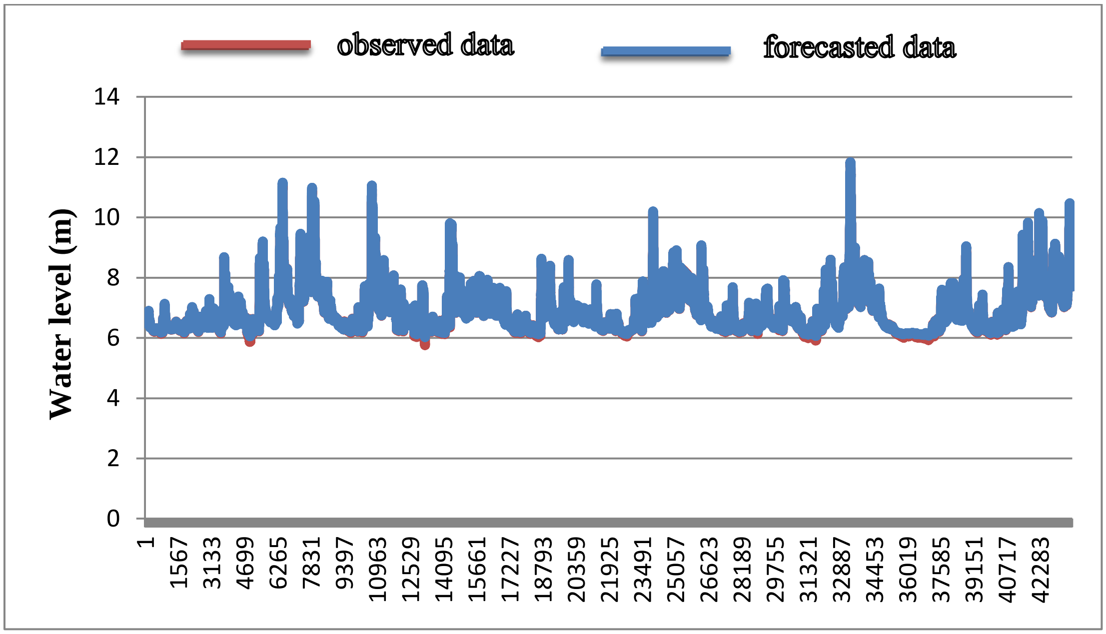
CHAPTER 4

RESULT AND DISSCUSSION

4.1 1 HOUR INTERVAL TIME.

4.1.1 1000 Iteration.

The data training and data validation results for the 1 hour interval time were having four inputs (3+1, 4+1, 5+1, and 6+1), which each input were using 1 type of iteration, 1000 were presented herein. Furthermore, Figure 4.1 until Figure 4.4 shows data validation results for four inputs that using 1000 iteration trained by utilizing Feed-forward Back Propagation ANN and also shows the error for each input would have. Table 4.1 shows that the validation DT of input 3+1, 4+1, 5+1, and 6+1 is 0.999, 0.998, 0.999 and 0.999 respectively. Meanwhile, validation DV of input 3+1, 4+1, 5+1, and 6+1 are 0.997, 0.997, 0.996 and 0.997 respectively. Moreover, the NSC value for 3+1, 4+1, 5+1, and 6+1 input are 0.997, 0.997, 0.996 and 0.997 respectively. Besides, from the iteration it also had showed the RMSE for 3+1, 4+1, 5+1, and 6+1 input for validation DT are 28.853, 26.283,30.261 and 32.471 respectively for the data validation DT, RMSE value are 37.361, 37.587, 37.696, and 38,414. The results indicate that more input used in the training, more accurate the trained pattern we could get. It indicates that for the 3+1 input had more scattered data than 6+1 input data



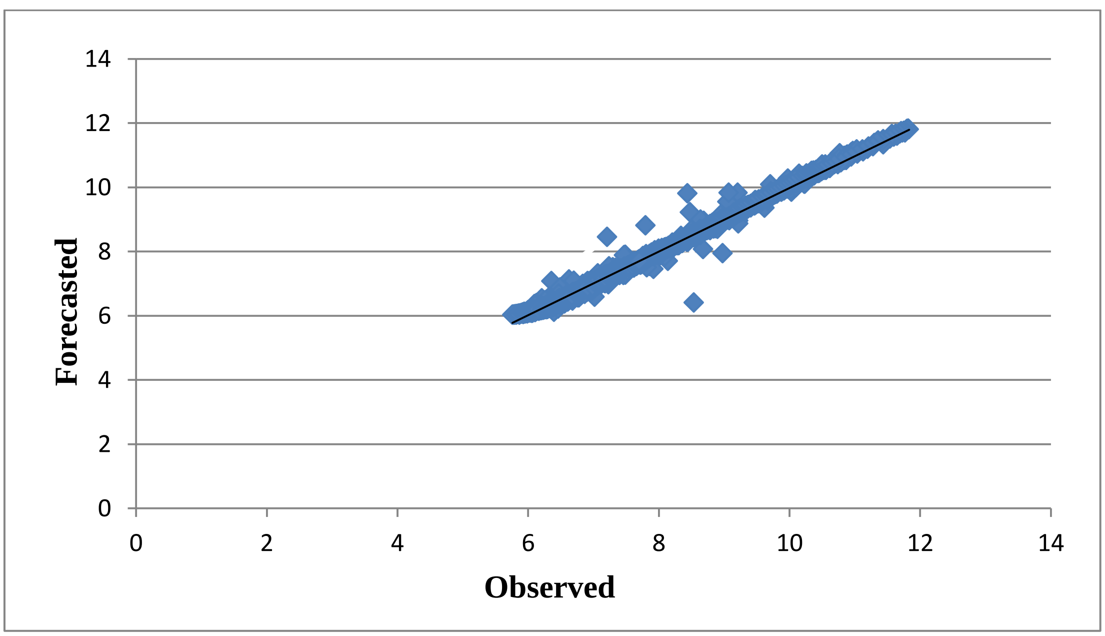
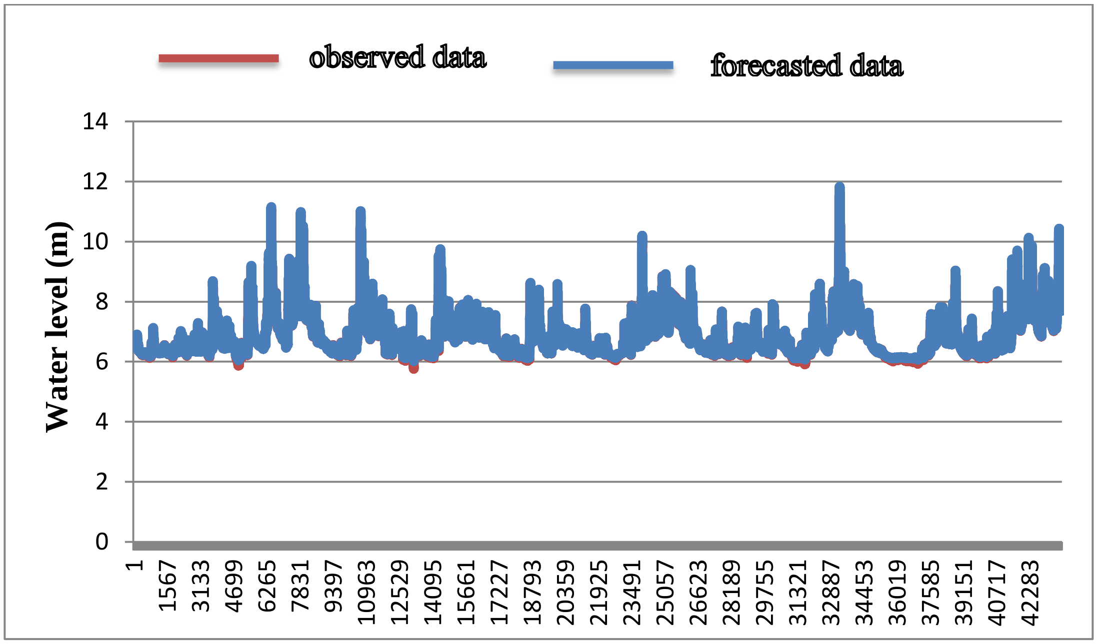


Figure 4.1: Data performance for 3 input with 1000 iterations.



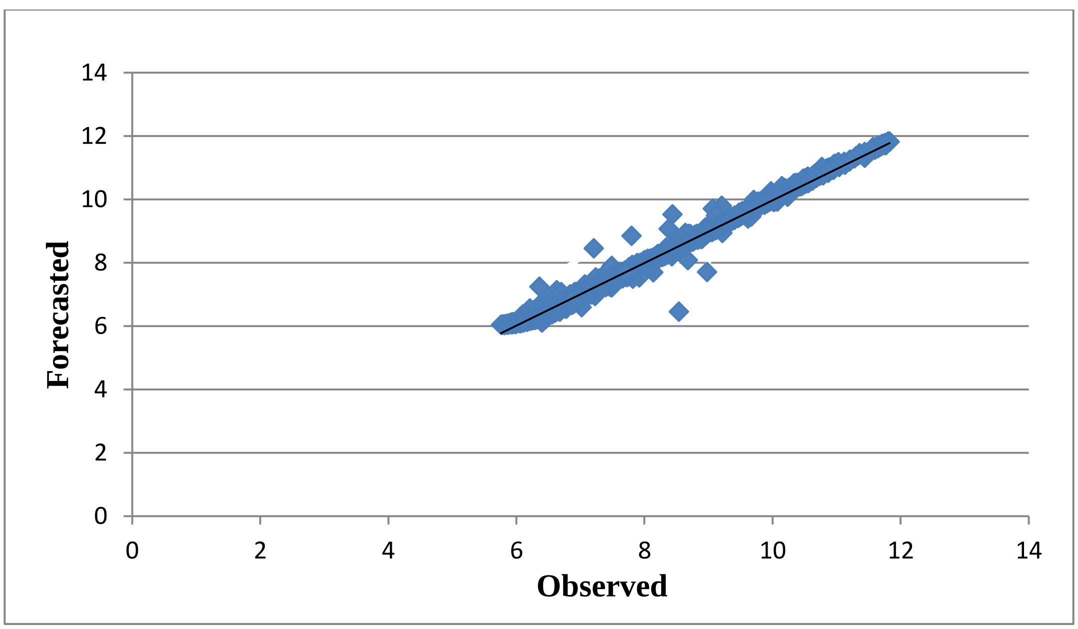
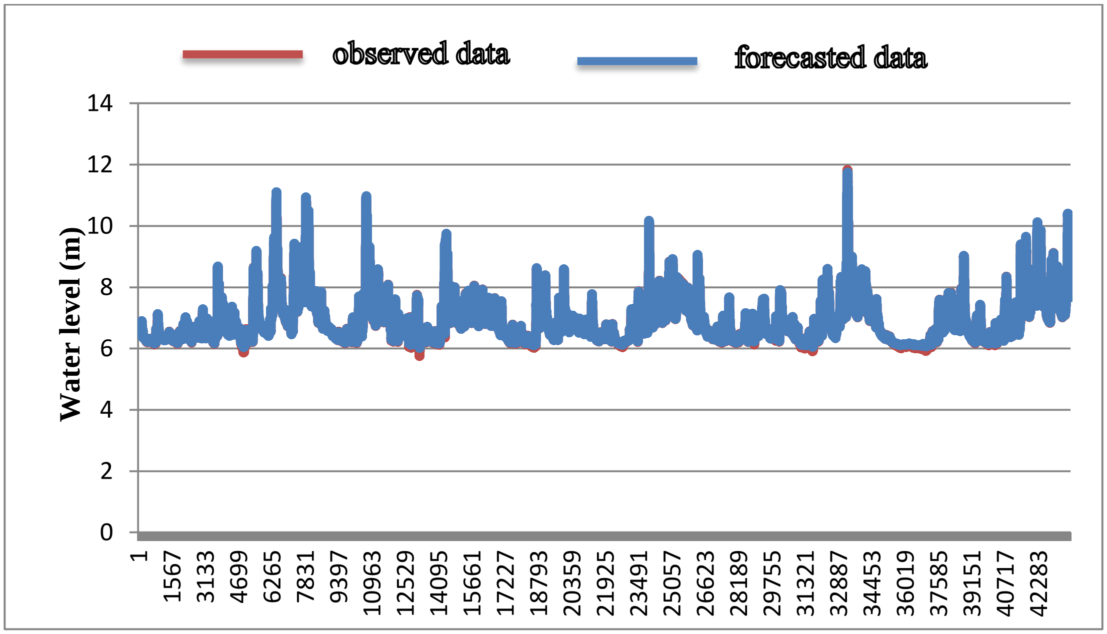


Figure 4.2: Data performance for 4 input with 1000 iterations.



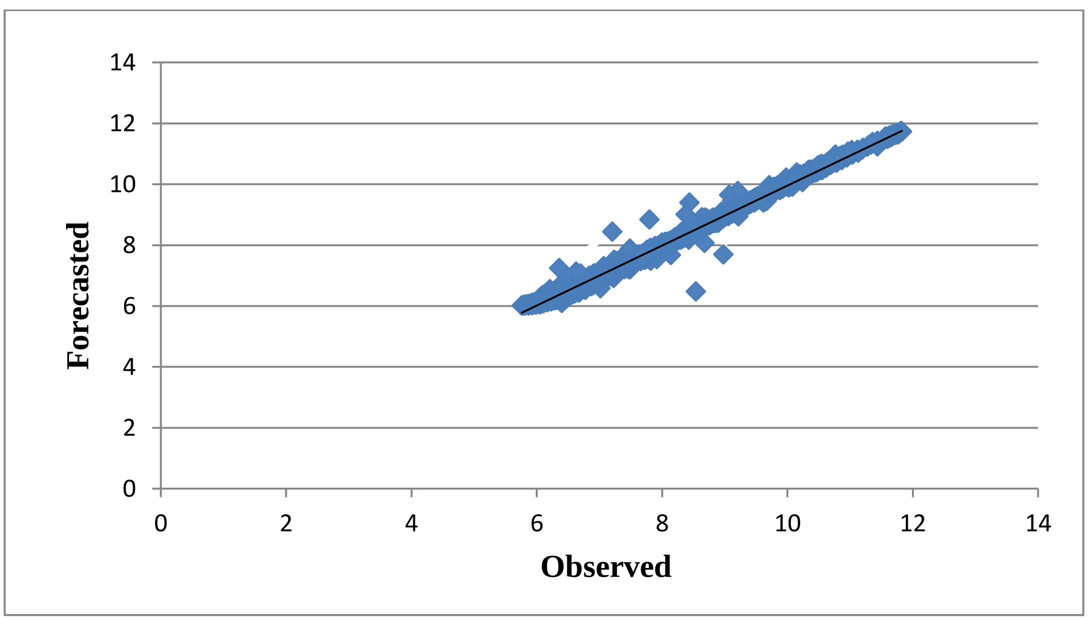
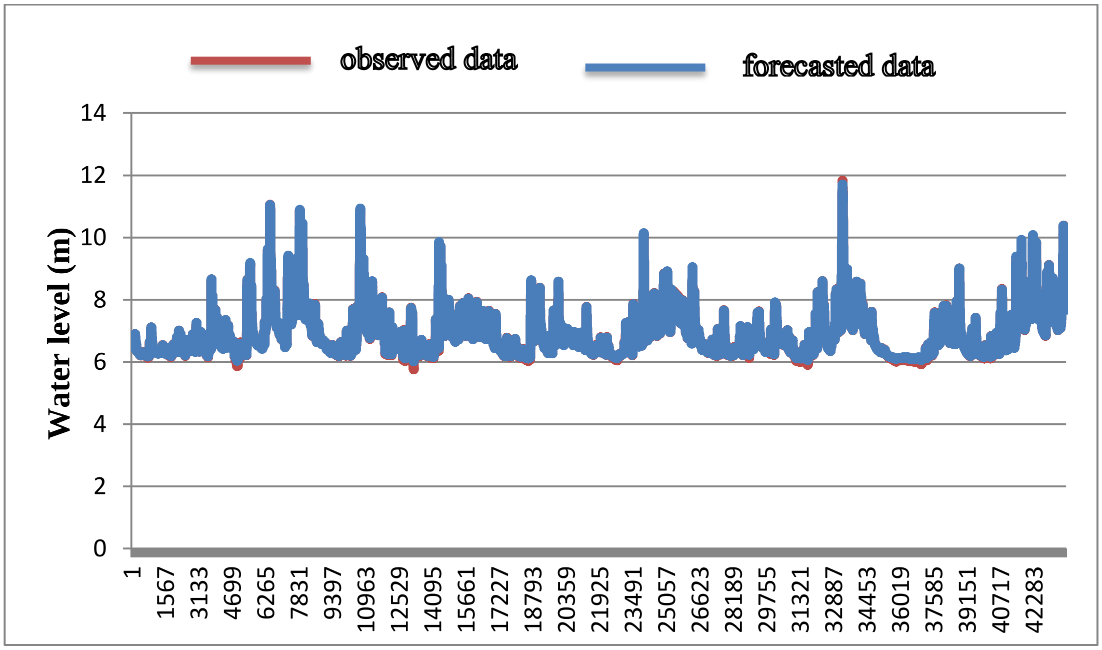


Figure 4.3: Data performance for 5 input with 1000 iterations.



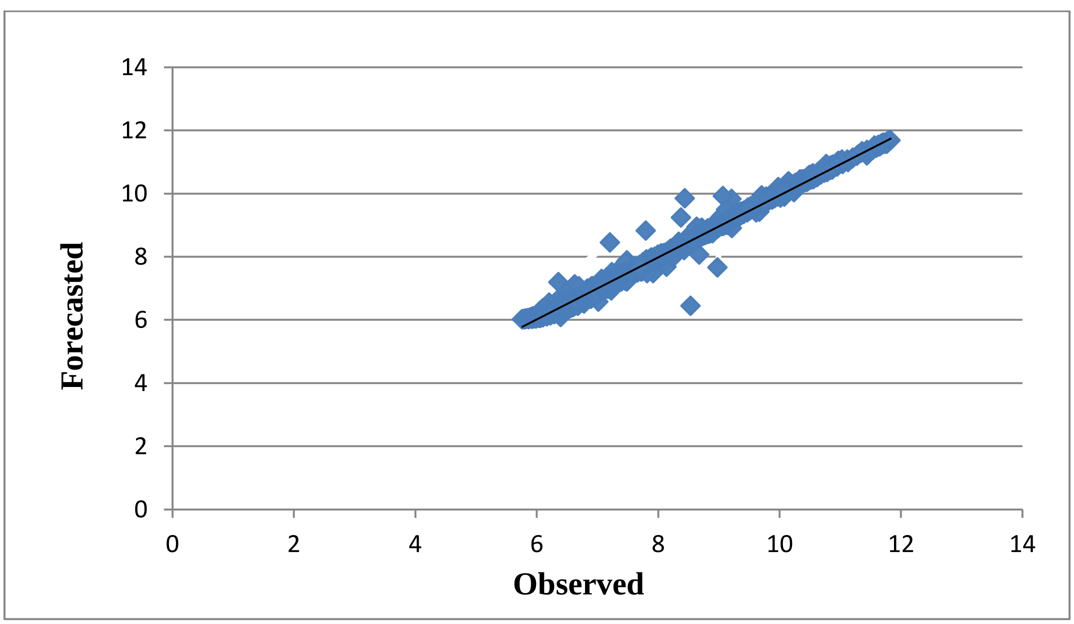


Figure 4.4: Data performance for 6 input with 1000 iteration

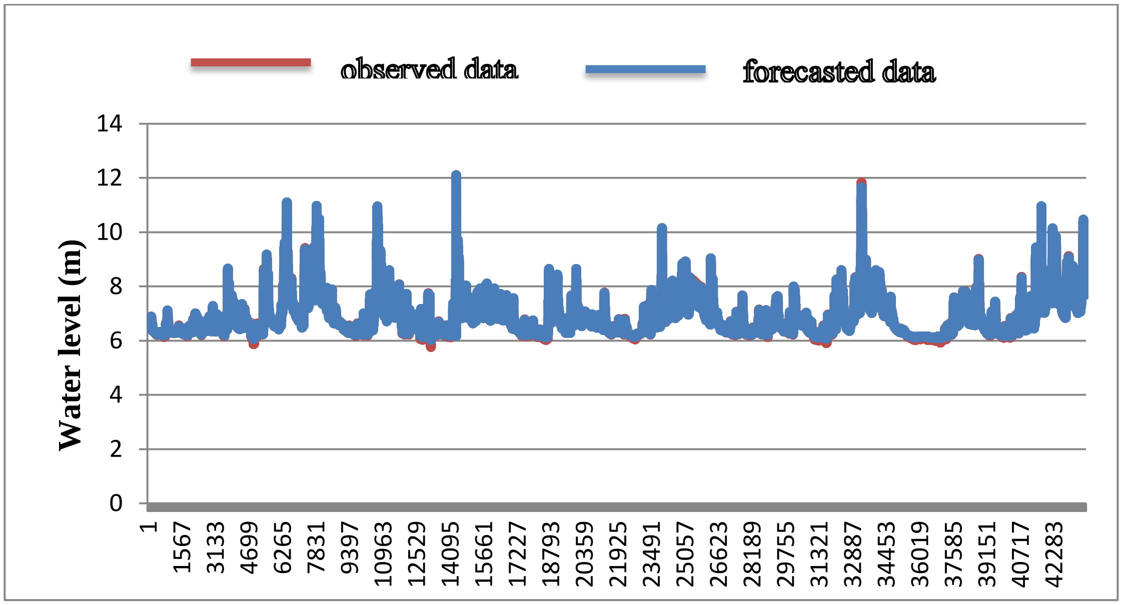
Table 4.1: Data training and data validation for all inputs trained for 1000 iteration 1 hour interval time

		VALIDATION		NSC		RMSE	
INPUT	ITERATION	DT	DV	DT	DV	DT	DV
3+1	1000	0.999	0.997	0.999	0.997	28.833	37.361
4+1	1000	0.998	0.997	0.998	0.997	26.283	37.587
5+1	1000	0.999	0.996	0.999	0.996	30.261	37.696
6+1	1000	0.999	0.997	0.999	0.997	32.471	38.414

4.2 3 HOUR INTERVAL TIME

4.2.1 1000 Iteration.

Other than 1 hour, 3 hour interval times also been used in this iteration. Just like 1 hour interval time, 3 hour interval time also been trained with the same training set in this research. For each 3+1, 4+1, 5+1, and 6+1 input were also trained with 1000 iteration as the minimum iteration. Furthermore, Figure 4.13 until Figure 4.5 shows data validation results for four inputs that using 1000 iteration trained by utilizing Feed-forward Back Propagation ANN and also shows the error for each input would have. Table 4.2 shows that the validation DT of input 3+1, 4+1, 5+1, and 6+1 is 0.995, 0.997, 0.997 and 0.987 respectively. Meanwhile, validation DV of 3+1, 4+1, 5+1, and 6+1 are 0.989, 0.997, 0.998 and 0.986 respectively. Besides, from the iteration it also had showed, the NSC values of data validation for 3+1, 4+1, 5+1, and 6+1 input are 0.995, 0.997, 0.997 and 0.987 respectively. Moreover, the RMSE for 3+1, 4+1, 5+1, and 6+1 input for validation DT are 63.448, 72.231, 88.653 and 104.634 respectively for the data validation DV, RMSE value are 74.461, 73.492, 78.692, and 81.54. The results indicate that more input used in the training, more accurate the trained pattern we could get. It indicates that for the 3+1 input had more scattered data than 6+1 input data.



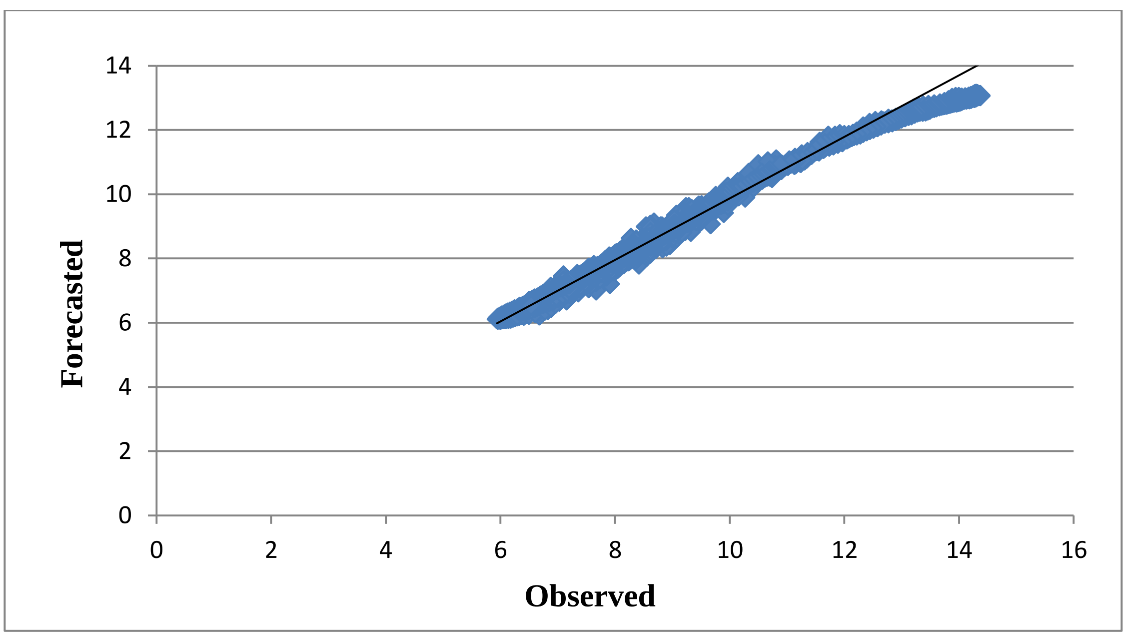
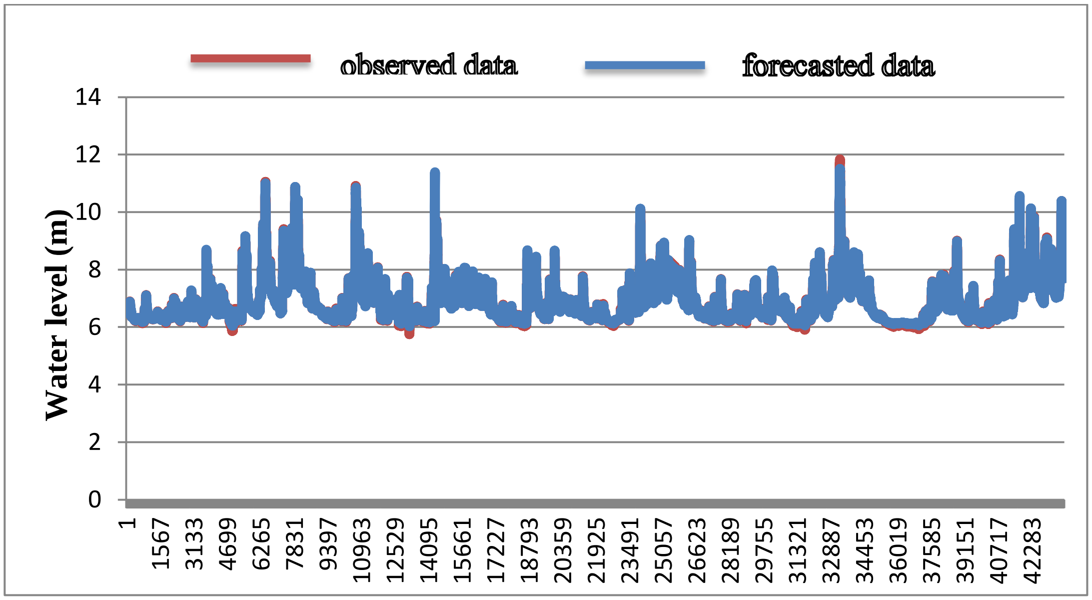


Figure 4.5: Data performance for 3 input with 1000 iterations.



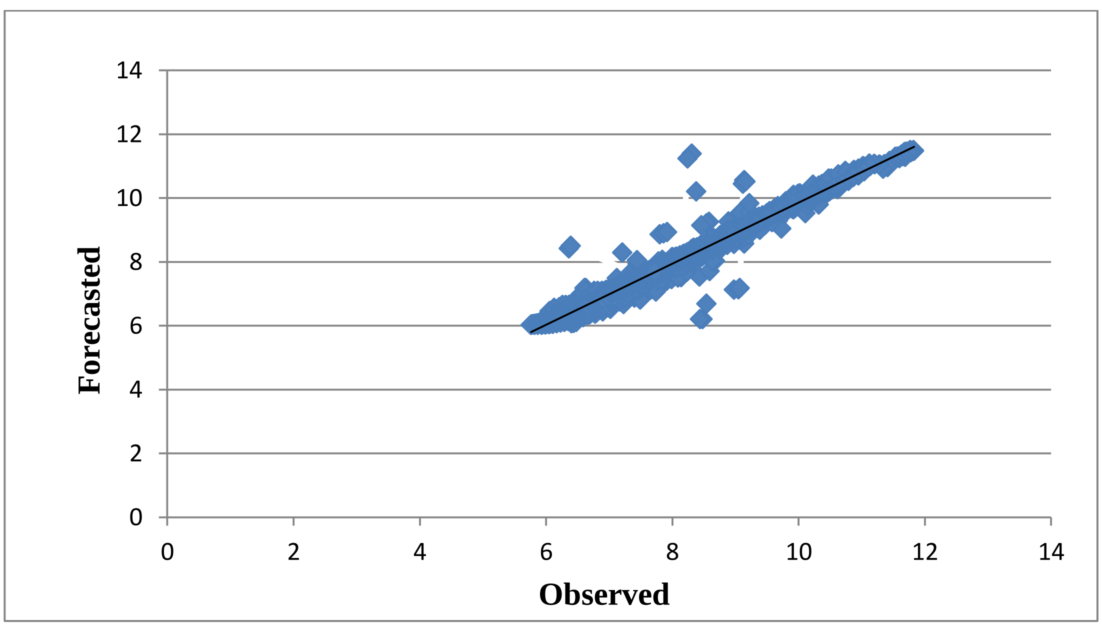
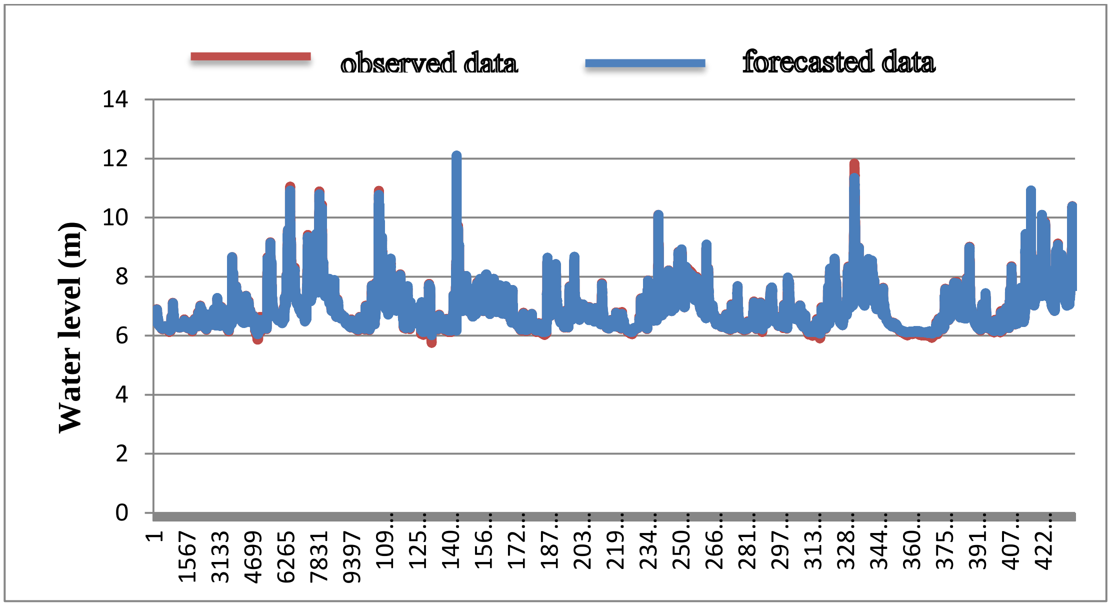


Figure 4.6: Data performance for 4 input with 1000 iterations.



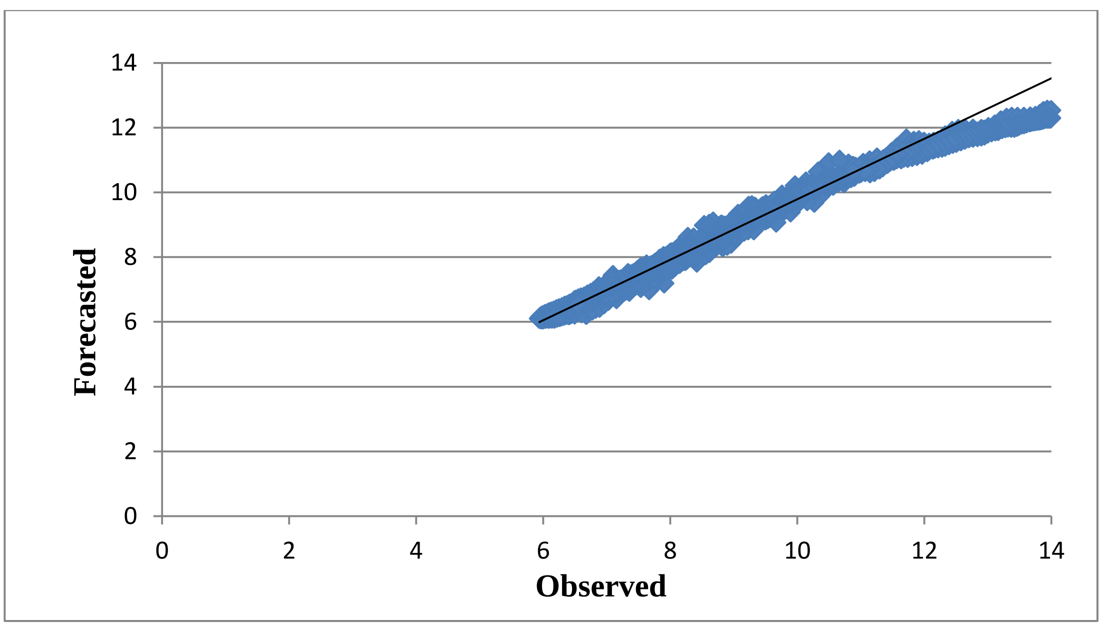
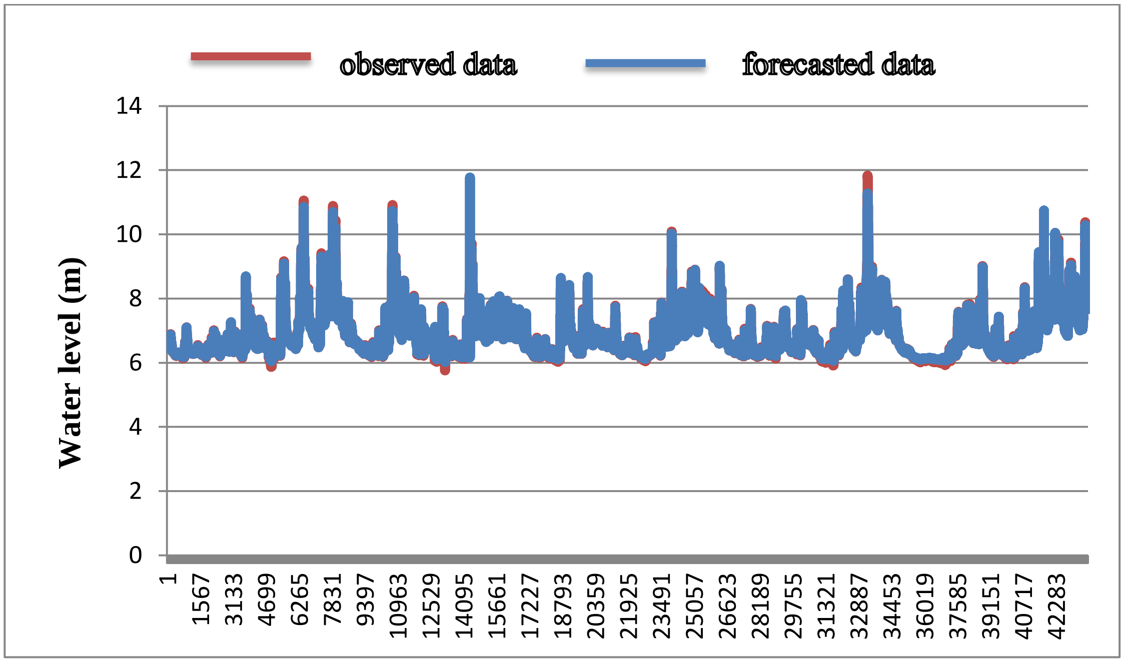


Figure 4.7: Data performance for 5 input with 1000 iterations.



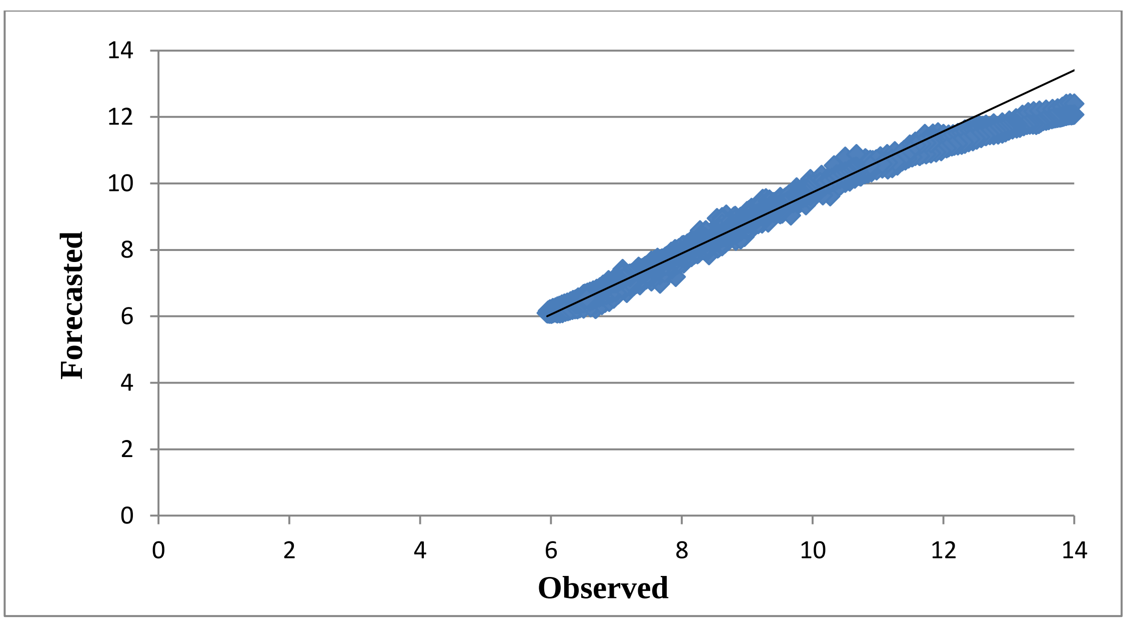


Figure 4.8: Data performance for 6 input with 1000 iterations.

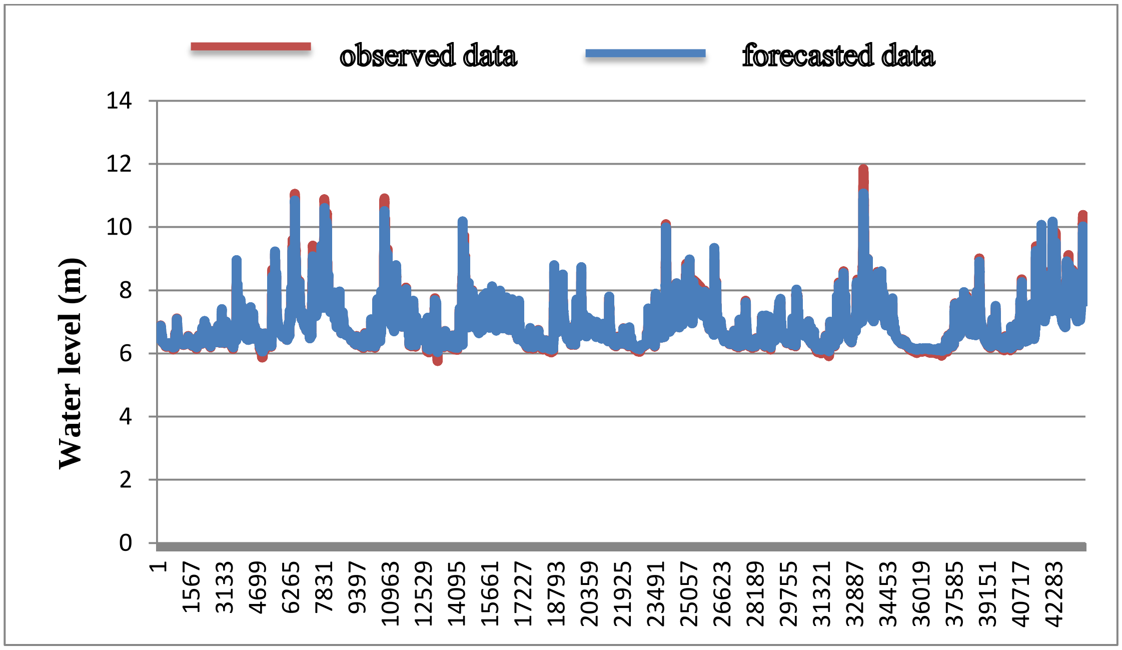
Table 4.2: Data training and data validation for all inputs trained for 1000 iteration 3 hour interval time

		VALIDATION		NSC		RMSE	
INPUT	ITERATION	DT	DV	DT	DV	DT	DV
3+1	1000	0.995	0.989	0.995	0.989	63.448	74.461
4+1	1000	0.997	0.997	0.997	0.997	72.231	73.492
5+1	1000	0.997	0.998	0.997	0.998	88.653	78.692
6+1	1000	0.987	0.986	0.987	0.986	104.634	81.54

4.3 6 HOUR INTERVAL TIME.

4.3.1 1000 Iteration.

Other than 1hour and 3 hour, 6 hour interval times also been used in this iteration. Just like 1 hour and 3 hour interval time, 6 hour interval time also been trained with the same training set in this research. For each 3+1, 4+1, 5+1, and 6+1 input were also trained with 1000 iteration as the minimum iteration. Furthermore, Figure 4.9 until Figure 5.1 shows data validation results for six inputs that using 1000 iteration trained by utilizing Feed-forward Back Propagation ANN and also shows the error for each input would have. Table 4.3 shows that the validation DT of input 3+1, 4+1, 5+1, and 6+1 is 0.965, 0.997, 0.900 and 0.878 respectively. Meanwhile, validation DV of input 3+1, 4+1, 5+1, and 6+1 are 0.964, 0.995, 0.941,and 0.932 respectively. Besides, from the iteration it also had showed, the NSC values of data validation for 3+1, 4+1, 5+1, and 6+1 input are 0.964, 0.995, 0.941 and 0.932 respectively. Moreover, the RMSE for 3+1, 4+1, 5+1, and 6+1 input for validation DT are 173.023, 205.404, 292.132 and 323.209 respectively for the data validation DV, RMSE value are 133.754, 143.412, 170.011, and 183.081. The results indicate that more input used in the training, more accurate the trained pattern we could get. It indicates that for the 3+1 input had more scattered data than 6+1 input data.



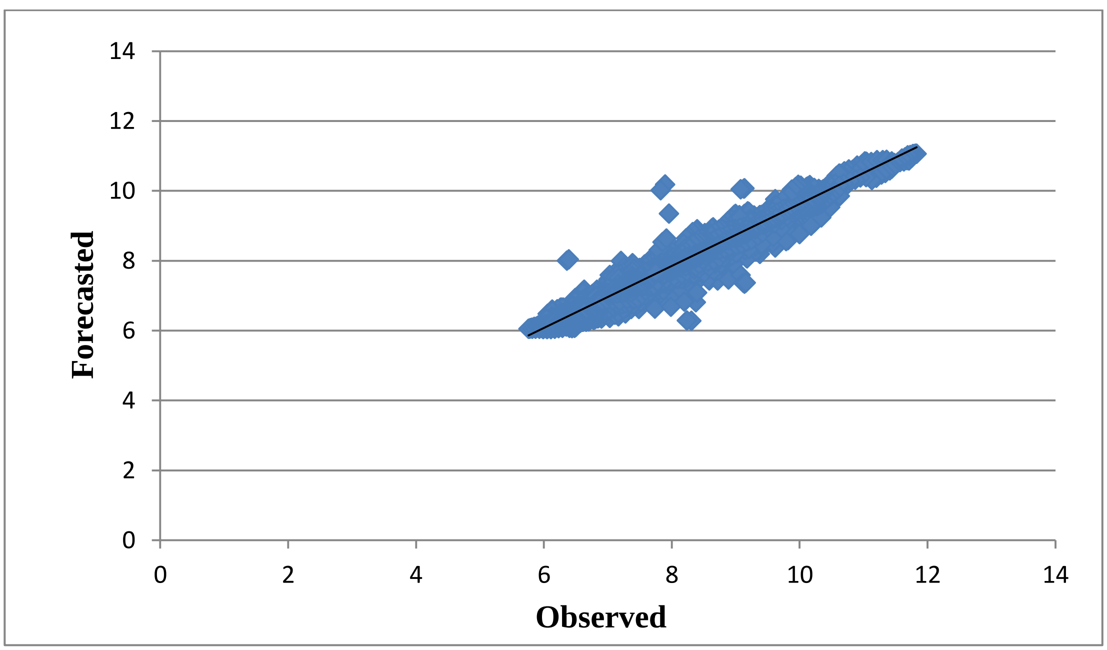
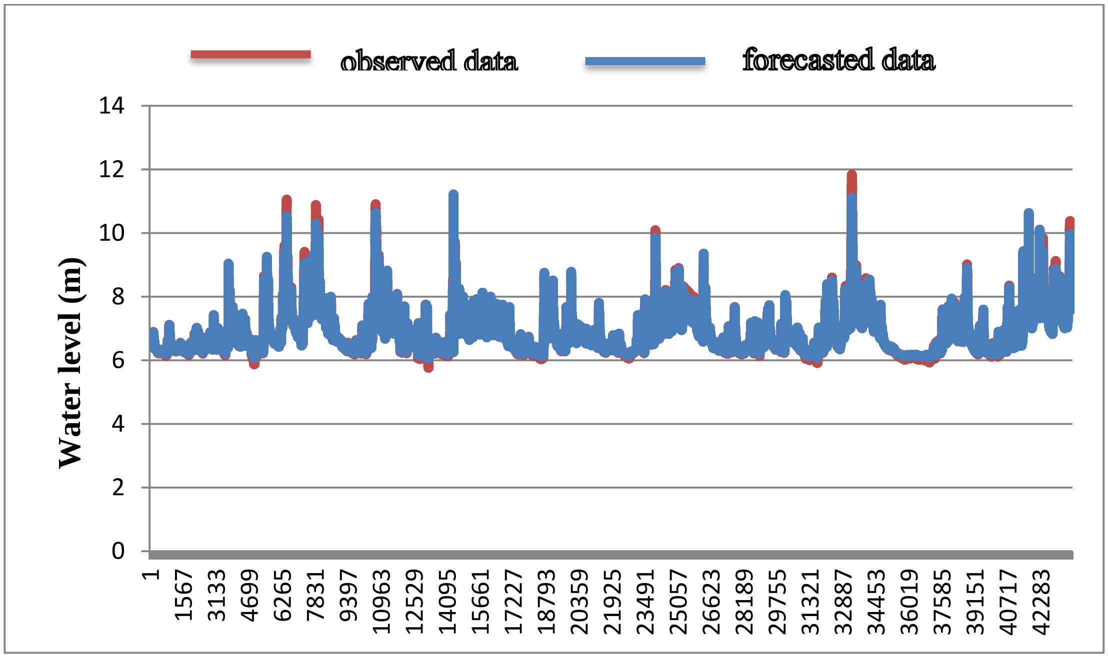


Figure 4.9: Data performance for 3 input with 1000 iterations.



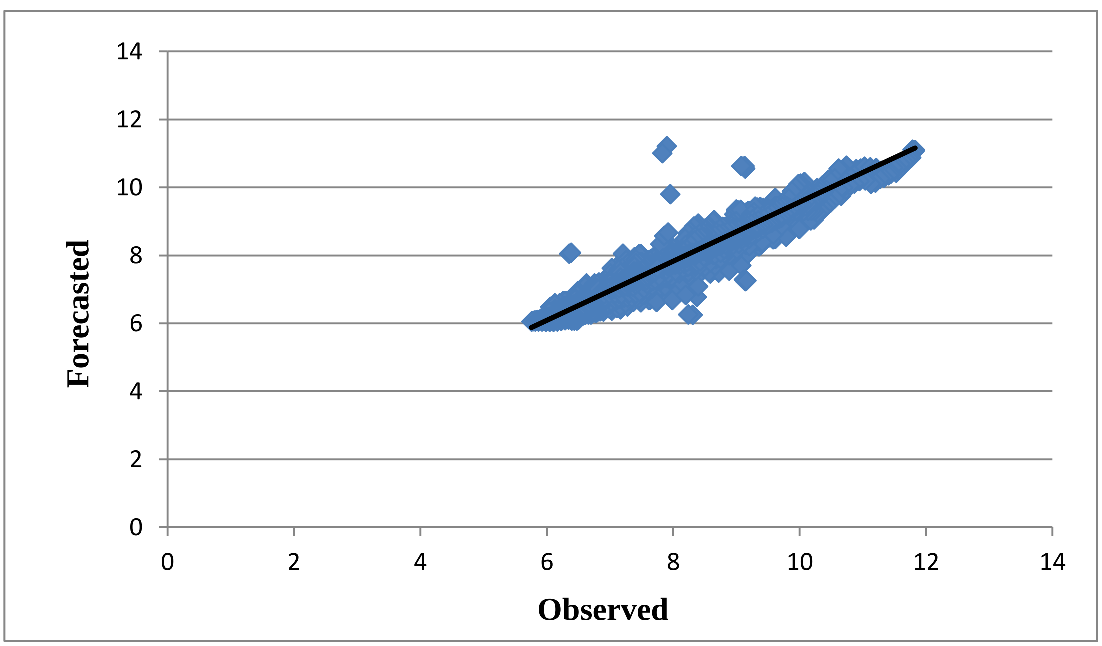
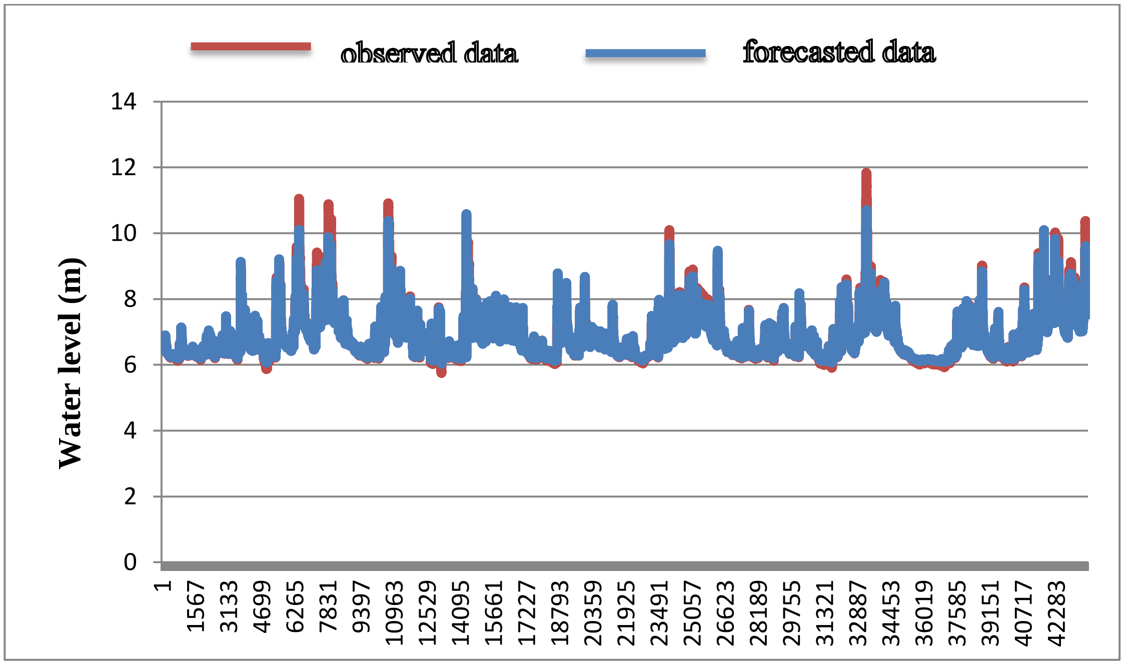


Figure 4.10: Data performance for 4 input with 1000 iterations.



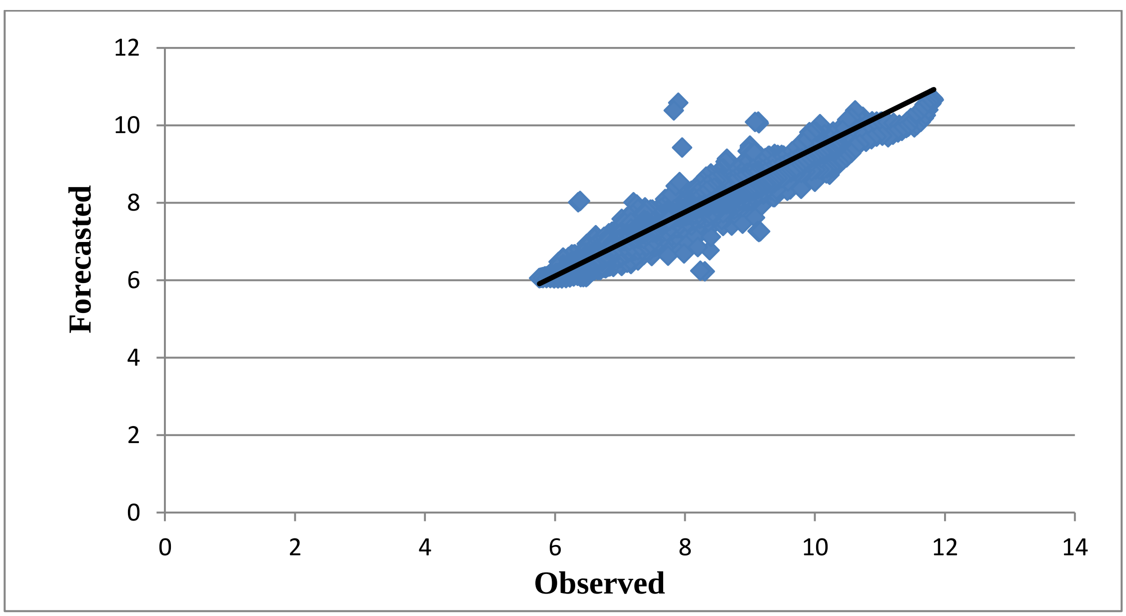
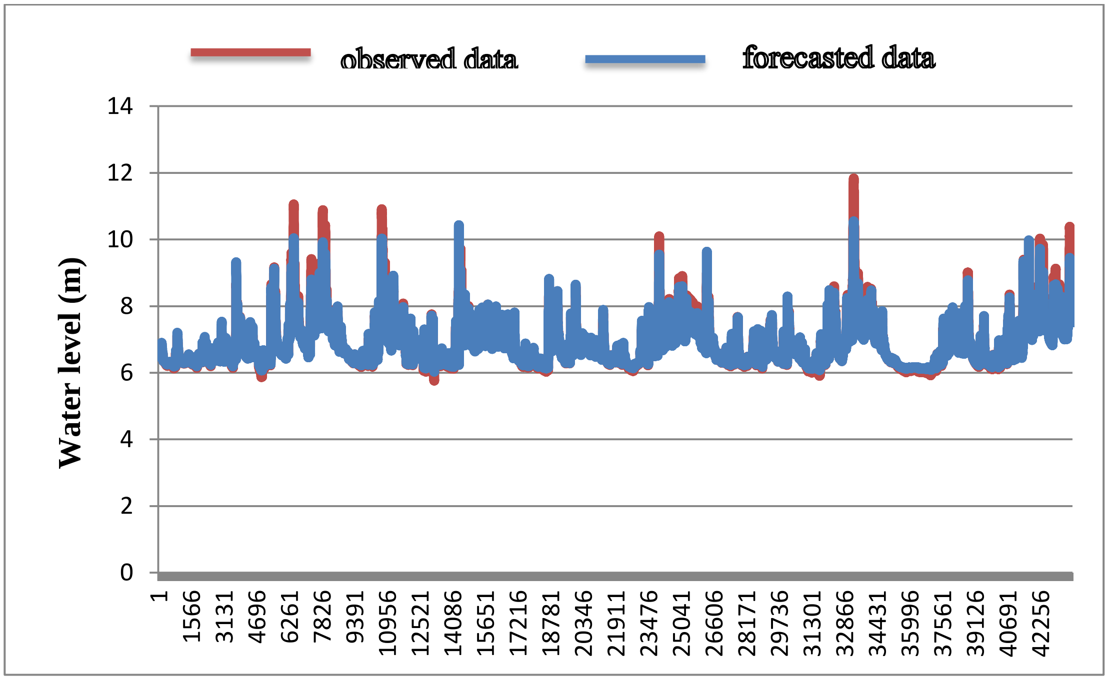


Figure 4.11: Data performance for 5 input with 1000 iteration



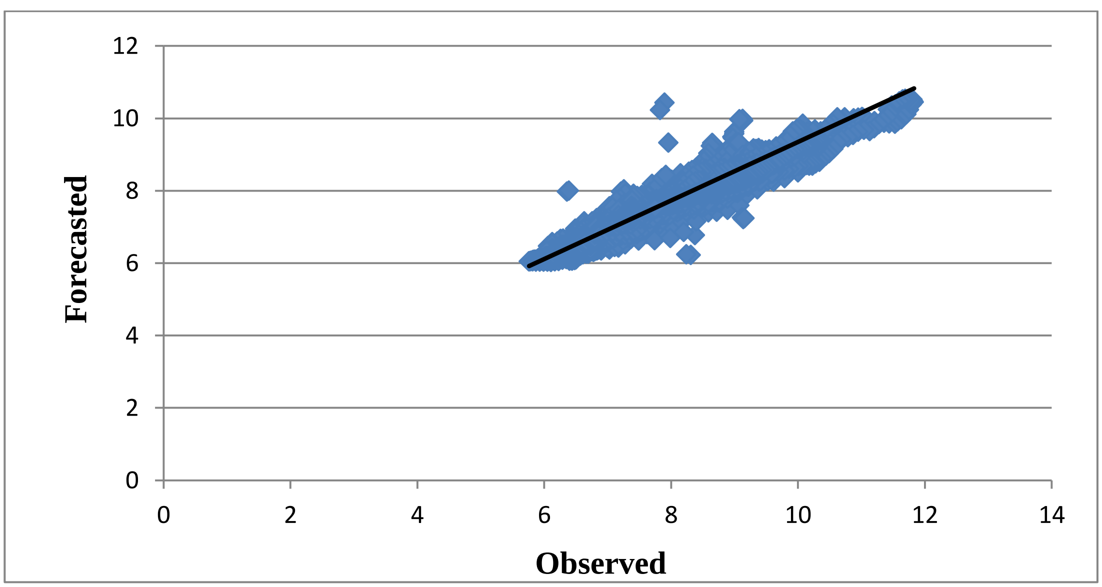


Figure 4.12: Data performance for 6 input with 1000 iterations.

Table 4.3: Data training and data validation for all inputs trained for 1000 iteration 6 hour interval time

		VALIDATION		NSC		RMSE	
INPUT	ITERATION	DT	DV	DT	DV	DT	DV
3+1	1000	0.965	0.964	0.965	0.964	173.023	133.754
4+1	1000	0.997	0.995	0.997	0.995	205.404	143.412
5+1	1000	0.9	0.941	0.9	0.941	292.132	170.011
6+1	1000	0.932	0.932	0.932	0.932	323.209	183.081

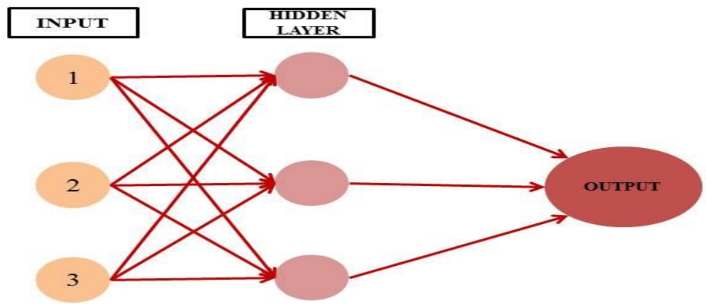


Figure 4.13: 3 input with 1 output

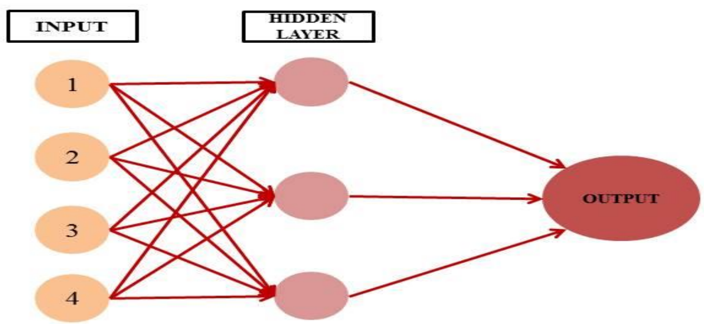


Figure 4.14: 4 input with 1 output

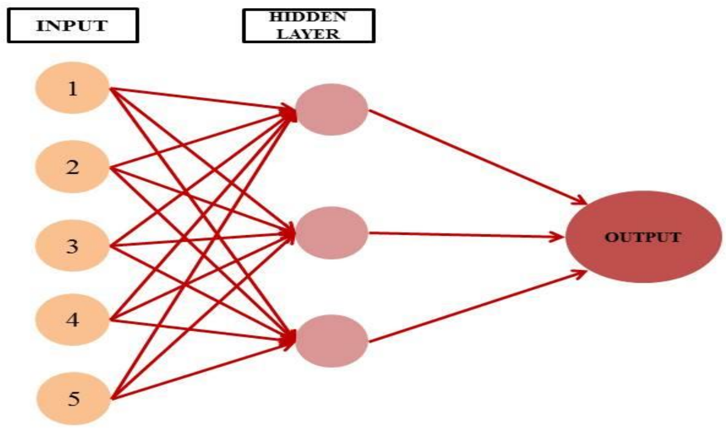


Figure 5.15: 5 input with 1 output

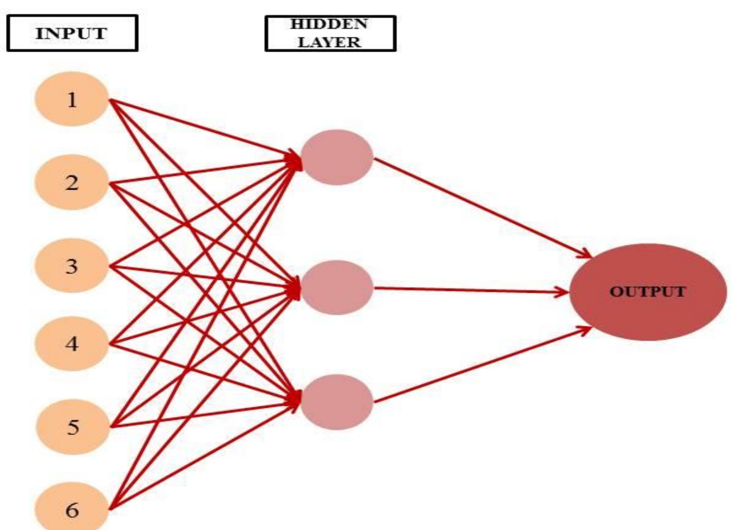


Figure 4.16: 6 input with 1 output

CHAPTER 5

CONCLUSION

5.1 INTRODUCTION

5.1.2 Conclusion 1 Hour, 3 Hour And 6 Hour Interval Time

The using of Artificial Neural Network model for prediction of Kuala Muda River water level have achieve high level of flood forecasting for 1 hour, 3 hour and 6 hours interval of time with different input. The result will become more accurate but when it increased the head-time of forecasting data, the result will have a bit error. Most high accuracy of data from 3 hour head-time 1000 iteration compared to 1 hour head-time and 6 hour head-time that same iteration.

From this research the best prediction for water level data at Kuala Muda River is 3 hour head-time with 3 input 1 output in 1000 iteration because it produced the best NSC with 0.989. Most the result different between observed data and forecasted data also very near from what we can see in the plotted graph at the result. Based on the result the average RMSE between all three head-time obtain only small differences in percentages of error. In conclusion ANN model can be used as a tool to predict accurately water level data at Kuala Muda River for 1 hour, 3 hour and 6 hour interval forecasted time.

Lastly, this result show the prediction of the water level data using ANN model method, shown that accuracy of forecasting result at the station 5606410 Kuala Muda River (Jabatan Syed Omar) at Kedah, Darul Aman

APPENDIX

data+1hr

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.75	7.75	7.75							
2	7.75	7.75	7.75	7.75							
3	7.75	7.75	7.75	7.76							
4	7.75	7.75	7.76	7.76							
5	7.75	7.76	7.76	7.76							
6	7.76	7.76	7.76	7.77							
7	7.76	7.76	7.77	7.77							
8	7.76	7.77	7.77	7.77							
9	7.77	7.77	7.77	7.78							
10	7.77	7.77	7.78	7.78							
11	7.77	7.78	7.78	7.78							
12	7.78	7.78	7.78	7.78							
13	7.78	7.78	7.78	7.77							
14	7.78	7.78	7.77	7.77							
15	7.78	7.77	7.77	7.77							
16	7.77	7.77	7.77	7.77							
17	7.77	7.77	7.77	7.77							
18	7.77	7.77	7.77	7.77							
19	7.77	7.77	7.77	7.78							
20	7.77	7.77	7.78	7.78							

4 Column (3 Input) For 1 Hour Interval

DT Prediction 3-3-1 1000 Iteration

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.75	7.75	7.75	7.74						
2	7.75	7.75	7.75	7.75	7.74						
3	7.75	7.75	7.75	7.76	7.74						
4	7.75	7.75	7.76	7.76	7.76						
5	7.75	7.76	7.76	7.76	7.76						
6	7.76	7.76	7.76	7.77	7.75						
7	7.76	7.76	7.77	7.77	7.77						
8	7.76	7.77	7.77	7.77	7.77						
9	7.77	7.77	7.77	7.78	7.76						
10	7.77	7.77	7.78	7.78	7.78						
11	7.77	7.78	7.78	7.78	7.78						
12	7.78	7.78	7.78	7.78	7.77						
13	7.78	7.78	7.78	7.77	7.77						
14	7.78	7.78	7.77	7.77	7.76						
15	7.78	7.77	7.77	7.77	7.76						
16	7.77	7.77	7.77	7.77	7.76						
17	7.77	7.77	7.77	7.77	7.76						
18	7.77	7.77	7.77	7.77	7.76						
19	7.77	7.77	7.77	7.78	7.76						
20	7.77	7.77	7.78	7.78	7.78						

4+1 Data Training

	A	B	C	D	E	F	G	H	I	J	K
1	6.54	6.53	6.53	6.54	6.52						
2	6.53	6.53	6.54	6.54	6.52						
3	6.53	6.54	6.54	6.55	6.53						
4	6.54	6.54	6.55	6.55	6.54						
5	6.54	6.55	6.55	6.56	6.54						
6	6.55	6.55	6.56	6.56	6.55						
7	6.55	6.56	6.56	6.57	6.55						
8	6.56	6.56	6.57	6.57	6.56						
9	6.56	6.57	6.57	6.57	6.56						
10	6.57	6.57	6.57	6.57	6.56						
11	6.57	6.57	6.57	6.56	6.56						
12	6.57	6.57	6.56	6.56	6.55						
13	6.57	6.56	6.56	6.55	6.55						
14	6.56	6.56	6.55	6.55	6.54						
15	6.56	6.55	6.55	6.55	6.54						
16	6.55	6.55	6.55	6.54	6.54						
17	6.55	6.55	6.54	6.54	6.53						
18	6.55	6.54	6.54	6.53	6.53						
19	6.54	6.54	6.53	6.53	6.52						
20	6.54	6.53	6.53	6.52	6.52						

4+1 Data Validation

NormalizedTraining

	A	B	C	D	E	F	G	H	I	J	K
1	0.12596	0.12596	0.12596	0.12596	0.1256						
2	0.12596	0.12596	0.12596	0.12596	0.1256						
3	0.12596	0.12596	0.12596	0.12665	0.1256						
4	0.12596	0.12596	0.12665	0.12665	0.12643						
5	0.12596	0.12665	0.12665	0.12665	0.12656						
6	0.12665	0.12665	0.12665	0.12735	0.12626						
7	0.12665	0.12665	0.12735	0.12735	0.1271						
8	0.12665	0.12735	0.12735	0.12735	0.12722						
9	0.12735	0.12735	0.12735	0.12804	0.12692						
10	0.12735	0.12735	0.12804	0.12804	0.12776						
11	0.12735	0.12804	0.12804	0.12804	0.12789						
12	0.12804	0.12804	0.12804	0.12804	0.12758						
13	0.12804	0.12804	0.12804	0.12735	0.12758						
14	0.12804	0.12804	0.12735	0.12735	0.12675						
15	0.12804	0.12735	0.12735	0.12735	0.12662						
16	0.12735	0.12735	0.12735	0.12735	0.12692						
17	0.12735	0.12735	0.12735	0.12735	0.12692						
18	0.12735	0.12735	0.12735	0.12735	0.12692						
19	0.12735	0.12735	0.12735	0.12804	0.12692						
20	0.12735	0.12735	0.12804	0.12804	0.12776						

4+1 Normalized Data Training

NormalizedValidation

	A	B	C	D	E
1	0.04175	0.04106	0.04106	0.04175	0.04024
2	0.04106	0.04106	0.04175	0.04175	0.0407
3	0.04106	0.04175	0.04175	0.04245	0.0409
4	0.04175	0.04175	0.04245	0.04245	0.04142
5	0.04175	0.04245	0.04245	0.04315	0.04162
6	0.04245	0.04245	0.04315	0.04315	0.04214
7	0.04245	0.04315	0.04315	0.04384	0.04234
8	0.04315	0.04315	0.04384	0.04384	0.04286
9	0.04315	0.04384	0.04384	0.04384	0.04307
10	0.04384	0.04384	0.04384	0.04384	0.04309
11	0.04384	0.04384	0.04384	0.04315	0.04309
12	0.04384	0.04384	0.04315	0.04315	0.04259
13	0.04384	0.04315	0.04315	0.04245	0.04239
14	0.04315	0.04315	0.04245	0.04245	0.04187
15	0.04315	0.04245	0.04245	0.04245	0.04167
16	0.04245	0.04245	0.04245	0.04175	0.04164
17	0.04245	0.04245	0.04175	0.04175	0.04115
18	0.04245	0.04175	0.04175	0.04106	0.04095
19	0.04175	0.04175	0.04106	0.04106	0.04044
20	0.04175	0.04106	0.04106	0.04036	0.04024

4+1 Normalized Data Validation

data+3hr

	A	B	C	D
1	7.75	7.75	7.76	7.77
2	7.75	7.75	7.76	7.77
3	7.75	7.76	7.77	7.78
4	7.75	7.76	7.77	7.78
5	7.75	7.76	7.77	7.78
6	7.76	7.77	7.78	7.78
7	7.76	7.77	7.78	7.77
8	7.76	7.77	7.78	7.77
9	7.77	7.78	7.78	7.77
10	7.77	7.78	7.77	7.77
11	7.77	7.78	7.77	7.77
12	7.78	7.78	7.77	7.77
13	7.78	7.77	7.77	7.78
14	7.78	7.77	7.77	7.78
15	7.78	7.77	7.77	7.78
16	7.77	7.77	7.78	7.78
17	7.77	7.77	7.78	7.78
18	7.77	7.77	7.78	7.78
19	7.77	7.78	7.78	7.78
20	7.77	7.78	7.78	7.77

4 Column (3 Input) For 3 Hour Interval

DT Prediction 3-3-1 1000 Iteration

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.75	7.76	7.77	7.73						
2	7.75	7.75	7.76	7.77	7.73						
3	7.75	7.76	7.77	7.78	7.73						
4	7.75	7.76	7.77	7.78	7.73						
5	7.75	7.76	7.77	7.78	7.73						
6	7.76	7.77	7.78	7.78	7.74						
7	7.76	7.77	7.78	7.77	7.74						
8	7.76	7.77	7.78	7.77	7.74						
9	7.77	7.78	7.78	7.77	7.73						
10	7.77	7.78	7.77	7.77	7.71						
11	7.77	7.78	7.77	7.77	7.71						
12	7.78	7.78	7.77	7.77	7.72						
13	7.78	7.77	7.77	7.78	7.73						
14	7.78	7.77	7.77	7.78	7.73						
15	7.78	7.77	7.77	7.78	7.73						
16	7.77	7.77	7.78	7.78	7.74						
17	7.77	7.77	7.78	7.78	7.74						
18	7.77	7.77	7.78	7.78	7.74						
19	7.77	7.78	7.78	7.78	7.73						
20	7.77	7.78	7.78	7.77	7.73						

4+3 Data Training

DV Prediction 3-3-1 1000 Iteration

	A	B	C	D	E	F	G	H	I	J	K
1	6.56	6.54	6.53	6.54	6.52						
2	6.55	6.54	6.53	6.55	6.52						
3	6.55	6.54	6.54	6.55	6.53						
4	6.54	6.53	6.54	6.56	6.53						
5	6.54	6.53	6.55	6.56	6.54						
6	6.54	6.54	6.55	6.57	6.54						
7	6.53	6.54	6.56	6.57	6.55						
8	6.53	6.55	6.56	6.57	6.55						
9	6.54	6.55	6.57	6.57	6.56						
10	6.54	6.56	6.57	6.56	6.56						
11	6.55	6.56	6.57	6.56	6.56						
12	6.55	6.57	6.57	6.55	6.56						
13	6.56	6.57	6.56	6.55	6.55						
14	6.56	6.57	6.56	6.55	6.55						
15	6.57	6.57	6.55	6.54	6.54						
16	6.57	6.56	6.55	6.54	6.54						
17	6.57	6.56	6.55	6.53	6.54						
18	6.57	6.55	6.54	6.53	6.53						
19	6.56	6.55	6.54	6.52	6.53						
20	6.56	6.55	6.53	6.52	6.52						

4+3 Data Validation

NormalizedTraining

	A	B	C	D	E	F	G	H	I	J	K
1	0.12596	0.12596	0.12665	0.12735	0.12427						
2	0.12596	0.12596	0.12665	0.12735	0.12427						
3	0.12596	0.12665	0.12735	0.12804	0.12469						
4	0.12596	0.12665	0.12735	0.12804	0.12469						
5	0.12596	0.12665	0.12735	0.12804	0.12469						
6	0.12665	0.12735	0.12804	0.12804	0.12532						
7	0.12665	0.12735	0.12804	0.12735	0.12532						
8	0.12665	0.12735	0.12804	0.12735	0.12532						
9	0.12735	0.12804	0.12804	0.12735	0.12467						
10	0.12735	0.12804	0.12735	0.12735	0.1234						
11	0.12735	0.12804	0.12735	0.12735	0.1234						
12	0.12804	0.12804	0.12735	0.12735	0.12361						
13	0.12804	0.12735	0.12735	0.12804	0.12446						
14	0.12804	0.12735	0.12735	0.12804	0.12446						
15	0.12804	0.12735	0.12735	0.12804	0.12446						
16	0.12735	0.12735	0.12804	0.12804	0.12553						
17	0.12735	0.12735	0.12804	0.12804	0.12553						
18	0.12735	0.12735	0.12804	0.12804	0.12553						
19	0.12735	0.12804	0.12804	0.12804	0.12467						
20	0.12735	0.12804	0.12804	0.12735	0.12467						

4+3 Normalized Data Training

NormalizedValidation

	A	B	C	D	E	F	G	H	I	J	K
1	0.04315	0.04175	0.04106	0.04175	0.04062						
2	0.04245	0.04175	0.04106	0.04245	0.04045						
3	0.04245	0.04175	0.04175	0.04245	0.04118						
4	0.04175	0.04106	0.04175	0.04315	0.0412						
5	0.04175	0.04106	0.04245	0.04315	0.04194						
6	0.04175	0.04175	0.04245	0.04384	0.04174						
7	0.04106	0.04175	0.04315	0.04384	0.04231						
8	0.04106	0.04245	0.04315	0.04384	0.04212						
9	0.04175	0.04245	0.04384	0.04384	0.04304						
10	0.04175	0.04315	0.04384	0.04315	0.04284						
11	0.04245	0.04315	0.04384	0.04315	0.04302						
12	0.04245	0.04384	0.04384	0.04245	0.04281						
13	0.04315	0.04384	0.04315	0.04245	0.04224						
14	0.04315	0.04384	0.04315	0.04245	0.04224						
15	0.04384	0.04384	0.04245	0.04175	0.04167						
16	0.04384	0.04315	0.04245	0.04175	0.04187						
17	0.04384	0.04315	0.04245	0.04106	0.04187						
18	0.04384	0.04245	0.04175	0.04106	0.04133						
19	0.04315	0.04245	0.04175	0.04036	0.04116						
20	0.04315	0.04245	0.04106	0.04036	0.04044						

4+3 Normalized Data Validation

data+6hr

	A	B	C	D
1	7.75	7.76	7.78	7.77
2	7.75	7.76	7.78	7.77
3	7.75	7.77	7.78	7.77
4	7.75	7.77	7.77	7.78
5	7.75	7.77	7.77	7.78
6	7.76	7.78	7.77	7.78
7	7.76	7.78	7.77	7.78
8	7.76	7.78	7.77	7.78
9	7.77	7.78	7.77	7.78
10	7.77	7.77	7.78	7.78
11	7.77	7.77	7.78	7.77
12	7.78	7.77	7.78	7.77
13	7.78	7.77	7.78	7.77
14	7.78	7.77	7.78	7.76
15	7.78	7.77	7.78	7.76
16	7.77	7.78	7.78	7.76
17	7.77	7.78	7.77	7.76
18	7.77	7.78	7.77	7.75
19	7.77	7.78	7.77	7.75
20	7.77	7.78	7.76	7.75

4 Column (3 Input) For 6 Hour Interval

DT Prediction 3-3-1 1000 Iteration

	A	B	C	D	E
1	7.75	7.76	7.78	7.77	7.68
2	7.75	7.76	7.78	7.77	7.68
3	7.75	7.77	7.78	7.77	7.67
4	7.75	7.77	7.77	7.78	7.66
5	7.75	7.77	7.77	7.78	7.66
6	7.76	7.78	7.77	7.78	7.65
7	7.76	7.78	7.77	7.78	7.65
8	7.76	7.78	7.77	7.78	7.65
9	7.77	7.78	7.77	7.78	7.65
10	7.77	7.77	7.78	7.78	7.68
11	7.77	7.77	7.78	7.77	7.68
12	7.78	7.77	7.78	7.77	7.68
13	7.78	7.77	7.78	7.77	7.68
14	7.78	7.77	7.78	7.76	7.68
15	7.78	7.77	7.78	7.76	7.68
16	7.77	7.78	7.78	7.76	7.67
17	7.77	7.78	7.77	7.76	7.65
18	7.77	7.78	7.77	7.75	7.65
19	7.77	7.78	7.77	7.75	7.65
20	7.77	7.78	7.76	7.75	7.64

4+6 Data Training

DV Prediction 3-3-1 1000 Iteration

	A	B	C	D	E	F	G	H	I	J	K
1	6.58	6.57	6.54	6.55	6.53						
2	6.58	6.56	6.54	6.55	6.53						
3	6.58	6.56	6.53	6.56	6.52						
4	6.58	6.55	6.53	6.56	6.53						
5	6.58	6.55	6.54	6.57	6.54						
6	6.58	6.54	6.54	6.57	6.54						
7	6.57	6.54	6.55	6.57	6.55						
8	6.56	6.54	6.55	6.57	6.55						
9	6.56	6.53	6.56	6.56	6.56						
10	6.55	6.53	6.56	6.56	6.56						
11	6.55	6.54	6.57	6.55	6.56						
12	6.54	6.54	6.57	6.55	6.56						
13	6.54	6.55	6.57	6.55	6.56						
14	6.54	6.55	6.57	6.54	6.56						
15	6.53	6.56	6.56	6.54	6.55						
16	6.53	6.56	6.56	6.53	6.55						
17	6.54	6.57	6.55	6.53	6.54						
18	6.54	6.57	6.55	6.52	6.54						
19	6.55	6.57	6.55	6.52	6.54						
20	6.55	6.57	6.54	6.52	6.53						

4+6 Data Validation

NormalizedTraining

	A	B	C	D	E	F	G	H	I	J	K
1	0.12596	0.12665	0.12804	0.12735	0.12107						
2	0.12596	0.12665	0.12804	0.12735	0.12107						
3	0.12596	0.12735	0.12804	0.12735	0.12051						
4	0.12596	0.12735	0.12735	0.12804	0.11952						
5	0.12596	0.12735	0.12735	0.12804	0.11952						
6	0.12665	0.12804	0.12735	0.12804	0.11909						
7	0.12665	0.12804	0.12735	0.12804	0.11909						
8	0.12665	0.12804	0.12735	0.12804	0.11909						
9	0.12735	0.12804	0.12735	0.12804	0.11921						
10	0.12735	0.12735	0.12804	0.12804	0.12076						
11	0.12735	0.12735	0.12804	0.12735	0.12076						
12	0.12804	0.12735	0.12804	0.12735	0.12088						
13	0.12804	0.12735	0.12804	0.12735	0.12088						
14	0.12804	0.12735	0.12804	0.12665	0.12088						
15	0.12804	0.12735	0.12804	0.12665	0.12088						
16	0.12735	0.12804	0.12804	0.12665	0.12019						
17	0.12735	0.12804	0.12735	0.12665	0.11921						
18	0.12735	0.12804	0.12735	0.12596	0.11921						
19	0.12735	0.12804	0.12735	0.12596	0.11921						
20	0.12735	0.12804	0.12665	0.12596	0.11823						

4+6 Normalized Data Training

NormalizedValidation

	A	B	C	D	E	F	G	H	I	J	K
1	0.04454	0.04384	0.04175	0.04245	0.04126						
2	0.04454	0.04315	0.04175	0.04245	0.04138						
3	0.04454	0.04315	0.04106	0.04315	0.04067						
4	0.04454	0.04245	0.04106	0.04315	0.04079						
5	0.04454	0.04245	0.04175	0.04384	0.0415						
6	0.04454	0.04175	0.04175	0.04384	0.04162						
7	0.04384	0.04175	0.04245	0.04384	0.04224						
8	0.04315	0.04175	0.04245	0.04384	0.04213						
9	0.04315	0.04106	0.04315	0.04315	0.04299						
10	0.04245	0.04106	0.04315	0.04315	0.04288						
11	0.04245	0.04175	0.04384	0.04245	0.04349						
12	0.04175	0.04175	0.04384	0.04245	0.04338						
13	0.04175	0.04245	0.04384	0.04245	0.04325						
14	0.04175	0.04245	0.04384	0.04175	0.04325						
15	0.04106	0.04315	0.04315	0.04175	0.04229						
16	0.04106	0.04315	0.04315	0.04106	0.04229						
17	0.04175	0.04384	0.04245	0.04106	0.04155						
18	0.04175	0.04384	0.04245	0.04036	0.04155						
19	0.04245	0.04384	0.04245	0.04036	0.04166						
20	0.04245	0.04384	0.04175	0.04036	0.04095						

4+6 Normalized Data Validation

data+1hr+5

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.75	7.75	7.75	7.75						
2	7.75	7.75	7.75	7.75	7.76						
3	7.75	7.75	7.75	7.76	7.76						
4	7.75	7.75	7.76	7.76	7.76						
5	7.75	7.76	7.76	7.76	7.77						
6	7.76	7.76	7.76	7.77	7.77						
7	7.76	7.76	7.77	7.77	7.77						
8	7.76	7.77	7.77	7.77	7.78						
9	7.77	7.77	7.77	7.78	7.78						
10	7.77	7.77	7.78	7.78	7.78						
11	7.77	7.78	7.78	7.78	7.78						
12	7.78	7.78	7.78	7.78	7.77						
13	7.78	7.78	7.78	7.77	7.77						
14	7.78	7.78	7.77	7.77	7.77						
15	7.78	7.77	7.77	7.77	7.77						
16	7.77	7.77	7.77	7.77	7.77						
17	7.77	7.77	7.77	7.77	7.77						
18	7.77	7.77	7.77	7.77	7.78						
19	7.77	7.77	7.77	7.78	7.78						
20	7.77	7.77	7.78	7.78	7.78						

5 Column (4 Input) For 1 Hour Interval

DT Prediction 4-4-1 1000 Iteration

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.75	7.75	7.75	7.75	7.74					
2	7.75	7.75	7.75	7.75	7.76	7.74					
3	7.75	7.75	7.75	7.76	7.76	7.75					
4	7.75	7.75	7.76	7.76	7.76	7.75					
5	7.75	7.76	7.76	7.76	7.77	7.75					
6	7.76	7.76	7.76	7.77	7.77	7.76					
7	7.76	7.76	7.77	7.77	7.77	7.76					
8	7.76	7.77	7.77	7.77	7.78	7.76					
9	7.77	7.77	7.77	7.78	7.78	7.77					
10	7.77	7.77	7.78	7.78	7.78	7.77					
11	7.77	7.78	7.78	7.78	7.78	7.77					
12	7.78	7.78	7.78	7.78	7.77	7.77					
13	7.78	7.78	7.78	7.77	7.77	7.76					
14	7.78	7.78	7.77	7.77	7.77	7.75					
15	7.78	7.77	7.77	7.77	7.77	7.75					
16	7.77	7.77	7.77	7.77	7.77	7.76					
17	7.77	7.77	7.77	7.77	7.77	7.76					
18	7.77	7.77	7.77	7.77	7.78	7.76					
19	7.77	7.77	7.77	7.78	7.78	7.77					
20	7.77	7.77	7.78	7.78	7.78	7.77					

5+1 Data Training

DV Prediction 4-4-1 1000 Iteration

	A	B	C	D	E	F	G	H	I	J	K
1	6.54	6.54	6.53	6.53	6.54	6.52					
2	6.54	6.53	6.53	6.54	6.54	6.53					
3	6.53	6.53	6.54	6.54	6.55	6.53					
4	6.53	6.54	6.54	6.55	6.55	6.53					
5	6.54	6.54	6.55	6.55	6.56	6.54					
6	6.54	6.55	6.55	6.56	6.56	6.55					
7	6.55	6.55	6.56	6.56	6.57	6.55					
8	6.55	6.56	6.56	6.57	6.57	6.56					
9	6.56	6.56	6.57	6.57	6.57	6.56					
10	6.56	6.57	6.57	6.57	6.57	6.56					
11	6.57	6.57	6.57	6.57	6.56	6.56					
12	6.57	6.57	6.57	6.56	6.56	6.55					
13	6.57	6.57	6.56	6.56	6.55	6.55					
14	6.57	6.56	6.56	6.55	6.55	6.54					
15	6.56	6.56	6.55	6.55	6.55	6.54					
16	6.56	6.55	6.55	6.55	6.54	6.54					
17	6.55	6.55	6.55	6.54	6.54	6.53					
18	6.55	6.55	6.54	6.54	6.53	6.53					
19	6.55	6.54	6.54	6.53	6.53	6.52					
20	6.54	6.54	6.53	6.53	6.52	6.52					

5+1 Data Validation

NormalizedTraining

	A	B	C	D	E	F	G	H	I	J	K
1	0.12596	0.12596	0.12596	0.12596	0.12596	0.12508					
2	0.12596	0.12596	0.12596	0.12596	0.12665	0.12508					
3	0.12596	0.12596	0.12596	0.12665	0.12665	0.12579					
4	0.12596	0.12596	0.12665	0.12665	0.12665	0.12597					
5	0.12596	0.12665	0.12665	0.12665	0.12735	0.1259					
6	0.12665	0.12665	0.12665	0.12735	0.12735	0.12645					
7	0.12665	0.12665	0.12735	0.12735	0.12735	0.12664					
8	0.12665	0.12735	0.12735	0.12735	0.12804	0.12656					
9	0.12735	0.12735	0.12735	0.12804	0.12804	0.12712					
10	0.12735	0.12735	0.12804	0.12804	0.12804	0.1273					
11	0.12735	0.12804	0.12804	0.12804	0.12804	0.12722					
12	0.12804	0.12804	0.12804	0.12804	0.12735	0.12707					
13	0.12804	0.12804	0.12804	0.12735	0.12735	0.12635					
14	0.12804	0.12804	0.12735	0.12735	0.12735	0.12617					
15	0.12804	0.12735	0.12735	0.12735	0.12735	0.12625					
16	0.12735	0.12735	0.12735	0.12735	0.12735	0.1264					
17	0.12735	0.12735	0.12735	0.12735	0.12735	0.1264					
18	0.12735	0.12735	0.12735	0.12735	0.12804	0.1264					
19	0.12735	0.12735	0.12735	0.12804	0.12804	0.12712					
20	0.12735	0.12735	0.12804	0.12804	0.12804	0.1273					

5+1 Normalized Data

NormalizedValidation

	A	B	C	D	E	F	G	H	I	J	K
1	0.04175	0.04175	0.04106	0.04106	0.04175	0.0404					
2	0.04175	0.04106	0.04106	0.04175	0.04175	0.04073					
3	0.04106	0.04106	0.04175	0.04175	0.04245	0.04089					
4	0.04106	0.04175	0.04175	0.04245	0.04245	0.04139					
5	0.04175	0.04175	0.04245	0.04245	0.04315	0.04162					
6	0.04175	0.04245	0.04245	0.04315	0.04315	0.04212					
7	0.04245	0.04245	0.04315	0.04315	0.04384	0.04234					
8	0.04245	0.04315	0.04315	0.04384	0.04384	0.04284					
9	0.04315	0.04315	0.04384	0.04384	0.04384	0.04307					
10	0.04315	0.04384	0.04384	0.04384	0.04384	0.04315					
11	0.04384	0.04384	0.04384	0.04384	0.04315	0.04318					
12	0.04384	0.04384	0.04384	0.04315	0.04315	0.04276					
13	0.04384	0.04384	0.04315	0.04315	0.04245	0.04256					
14	0.04384	0.04315	0.04315	0.04245	0.04245	0.04206					
15	0.04315	0.04315	0.04245	0.04245	0.04245	0.04184					
16	0.04315	0.04245	0.04245	0.04245	0.04175	0.04176					
17	0.04245	0.04245	0.04245	0.04175	0.04175	0.04131					
18	0.04245	0.04245	0.04175	0.04175	0.04106	0.04112					
19	0.04245	0.04175	0.04175	0.04106	0.04106	0.04063					
20	0.04175	0.04175	0.04106	0.04106	0.04036	0.0404					

5+1 Normalized Data Validation

data+3hr+5

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.75	7.76	7.77	7.78						
2	7.75	7.75	7.76	7.77	7.78						
3	7.75	7.76	7.77	7.78	7.78						
4	7.75	7.76	7.77	7.78	7.77						
5	7.75	7.76	7.77	7.78	7.77						
6	7.76	7.77	7.78	7.78	7.77						
7	7.76	7.77	7.78	7.77	7.77						
8	7.76	7.77	7.78	7.77	7.77						
9	7.77	7.78	7.78	7.77	7.77						
10	7.77	7.78	7.77	7.77	7.78						
11	7.77	7.78	7.77	7.77	7.78						
12	7.78	7.78	7.77	7.77	7.78						
13	7.78	7.77	7.77	7.78	7.78						
14	7.78	7.77	7.77	7.78	7.78						
15	7.78	7.77	7.77	7.78	7.78						
16	7.77	7.77	7.78	7.78	7.78						
17	7.77	7.77	7.78	7.78	7.77						
18	7.77	7.77	7.78	7.78	7.77						
19	7.77	7.78	7.78	7.78	7.77						
20	7.77	7.78	7.78	7.77	7.76						

5 Column (4 Input) For 3 Hour Interval

DT Prediction 4-4-1 1000 Iteration

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.75	7.76	7.77	7.78	7.72					
2	7.75	7.75	7.76	7.77	7.78	7.72					
3	7.75	7.76	7.77	7.78	7.78	7.73					
4	7.75	7.76	7.77	7.78	7.77	7.73					
5	7.75	7.76	7.77	7.78	7.77	7.73					
6	7.76	7.77	7.78	7.78	7.77	7.72					
7	7.76	7.77	7.78	7.77	7.77	7.71					
8	7.76	7.77	7.78	7.77	7.77	7.71					
9	7.77	7.78	7.78	7.77	7.77	7.71					
10	7.77	7.78	7.77	7.77	7.78	7.72					
11	7.77	7.78	7.77	7.77	7.78	7.72					
12	7.78	7.78	7.77	7.77	7.78	7.72					
13	7.78	7.77	7.77	7.78	7.78	7.73					
14	7.78	7.77	7.77	7.78	7.78	7.73					
15	7.78	7.77	7.77	7.78	7.78	7.73					
16	7.77	7.77	7.78	7.78	7.78	7.72					
17	7.77	7.77	7.78	7.78	7.77	7.72					
18	7.77	7.77	7.78	7.78	7.77	7.72					
19	7.77	7.78	7.78	7.78	7.77	7.72					
20	7.77	7.78	7.78	7.77	7.76	7.71					

5+3 Data Training

DV Prediction 4-4-1 1000 Iteration

	A	B	C	D	E	F	G	H	I	J	K
1	6.57	6.55	6.54	6.53	6.55	6.53					
2	6.56	6.55	6.54	6.54	6.55	6.53					
3	6.56	6.54	6.53	6.54	6.56	6.53					
4	6.55	6.54	6.53	6.55	6.56	6.54					
5	6.55	6.54	6.54	6.55	6.57	6.54					
6	6.54	6.53	6.54	6.56	6.57	6.55					
7	6.54	6.53	6.55	6.56	6.57	6.55					
8	6.54	6.54	6.55	6.57	6.57	6.56					
9	6.53	6.54	6.56	6.57	6.56	6.56					
10	6.53	6.55	6.56	6.57	6.56	6.56					
11	6.54	6.55	6.57	6.57	6.55	6.56					
12	6.54	6.56	6.57	6.56	6.55	6.55					
13	6.55	6.56	6.57	6.56	6.55	6.55					
14	6.55	6.57	6.57	6.55	6.54	6.54					
15	6.56	6.57	6.56	6.55	6.54	6.54					
16	6.56	6.57	6.56	6.55	6.53	6.54					
17	6.57	6.57	6.55	6.54	6.53	6.54					
18	6.57	6.56	6.55	6.54	6.52	6.53					
19	6.57	6.56	6.55	6.53	6.52	6.52					
20	6.57	6.55	6.54	6.53	6.52	6.53					

5+3 Data Validation

NormalizedTraining

	A	B	C	D	E	F	G	H	I	J	K
1	0.12596	0.12596	0.12665	0.12735	0.12804	0.12408					
2	0.12596	0.12596	0.12665	0.12735	0.12804	0.12408					
3	0.12596	0.12665	0.12735	0.12804	0.12804	0.12464					
4	0.12596	0.12665	0.12735	0.12804	0.12735	0.12464					
5	0.12596	0.12665	0.12735	0.12804	0.12735	0.12464					
6	0.12665	0.12735	0.12804	0.12804	0.12735	0.12408					
7	0.12665	0.12735	0.12804	0.12735	0.12735	0.12289					
8	0.12665	0.12735	0.12804	0.12735	0.12735	0.12289					
9	0.12735	0.12804	0.12804	0.12735	0.12735	0.12295					
10	0.12735	0.12804	0.12735	0.12735	0.12804	0.12358					
11	0.12735	0.12804	0.12735	0.12735	0.12804	0.12358					
12	0.12804	0.12804	0.12735	0.12735	0.12804	0.12365					
13	0.12804	0.12735	0.12735	0.12804	0.12804	0.12485					
14	0.12804	0.12735	0.12735	0.12804	0.12804	0.12485					
15	0.12804	0.12735	0.12735	0.12804	0.12804	0.12485					
16	0.12735	0.12735	0.12804	0.12804	0.12804	0.12415					
17	0.12735	0.12735	0.12804	0.12804	0.12735	0.12415					
18	0.12735	0.12735	0.12804	0.12804	0.12735	0.12415					
19	0.12735	0.12804	0.12804	0.12804	0.12735	0.12415					
20	0.12735	0.12804	0.12804	0.12735	0.12665	0.12295					

5+3 Normalized Data Training

NormalizedValidation

	A	B	C	D	E	F	G	H	I	J	K
1	0.04384	0.04245	0.04175	0.04106	0.04245	0.04075					
2	0.04315	0.04245	0.04175	0.04175	0.04245	0.04135					
3	0.04315	0.04175	0.04106	0.04175	0.04315	0.0414					
4	0.04245	0.04175	0.04106	0.04245	0.04315	0.04202					
5	0.04245	0.04175	0.04175	0.04245	0.04384	0.04189					
6	0.04175	0.04106	0.04175	0.04315	0.04384	0.04244					
7	0.04175	0.04106	0.04245	0.04315	0.04384	0.04231					
8	0.04175	0.04175	0.04245	0.04384	0.04384	0.04309					
9	0.04106	0.04175	0.04315	0.04384	0.04315	0.04288					
10	0.04106	0.04245	0.04315	0.04384	0.04315	0.04296					
11	0.04175	0.04245	0.04384	0.04384	0.04245	0.0429					
12	0.04175	0.04315	0.04384	0.04315	0.04245	0.04228					
13	0.04245	0.04315	0.04384	0.04315	0.04245	0.04236					
14	0.04245	0.04384	0.04384	0.04245	0.04175	0.04174					
15	0.04315	0.04384	0.04315	0.04245	0.04175	0.04194					
16	0.04315	0.04384	0.04315	0.04245	0.04106	0.04194					
17	0.04384	0.04384	0.04245	0.04175	0.04106	0.04145					
18	0.04384	0.04315	0.04245	0.04175	0.04036	0.04138					
19	0.04384	0.04315	0.04245	0.04106	0.04036	0.0407					
20	0.04384	0.04245	0.04175	0.04106	0.04036	0.04075					

5+3 Normalized Data Validation

data+6hr+5

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.76	7.78	7.77	7.78						
2	7.75	7.76	7.78	7.77	7.78						
3	7.75	7.77	7.78	7.77	7.78						
4	7.75	7.77	7.77	7.78	7.78						
5	7.75	7.77	7.77	7.78	7.77						
6	7.76	7.78	7.77	7.78	7.77						
7	7.76	7.78	7.77	7.78	7.77						
8	7.76	7.78	7.77	7.78	7.76						
9	7.77	7.78	7.77	7.78	7.76						
10	7.77	7.77	7.78	7.78	7.76						
11	7.77	7.77	7.78	7.77	7.76						
12	7.78	7.77	7.78	7.77	7.75						
13	7.78	7.77	7.78	7.77	7.75						
14	7.78	7.77	7.78	7.76	7.75						
15	7.78	7.77	7.78	7.76	7.74						
16	7.77	7.78	7.78	7.76	7.74						
17	7.77	7.78	7.77	7.76	7.74						
18	7.77	7.78	7.77	7.75	7.73						
19	7.77	7.78	7.77	7.75	7.73						
20	7.77	7.78	7.76	7.75	7.72						

5 Column (4 Input) For 6 Hour Interval

DT Prediction 4-4-1 1000 Iteration

	A	B	C	D	E	F
1	7.75	7.76	7.78	7.77	7.78	7.63
2	7.75	7.76	7.78	7.77	7.78	7.63
3	7.75	7.77	7.78	7.77	7.78	7.64
4	7.75	7.77	7.77	7.78	7.78	7.66
5	7.75	7.77	7.77	7.78	7.77	7.66
6	7.76	7.78	7.77	7.78	7.77	7.67
7	7.76	7.78	7.77	7.78	7.77	7.67
8	7.76	7.78	7.77	7.78	7.76	7.67
9	7.77	7.78	7.77	7.78	7.76	7.66
10	7.77	7.77	7.78	7.78	7.76	7.65
11	7.77	7.77	7.78	7.77	7.76	7.63
12	7.78	7.77	7.78	7.77	7.75	7.63
13	7.78	7.77	7.78	7.77	7.75	7.63
14	7.78	7.77	7.78	7.76	7.75	7.62
15	7.78	7.77	7.78	7.76	7.74	7.62
16	7.77	7.78	7.78	7.76	7.74	7.62
17	7.77	7.78	7.77	7.76	7.74	7.63
18	7.77	7.78	7.77	7.75	7.73	7.62
19	7.77	7.78	7.77	7.75	7.73	7.62
20	7.77	7.78	7.76	7.75	7.72	7.63

5+6 Data Training

DV Prediction 4-4-1 1000 Iteration

	A	B	C	D	E	F
1	6.56	6.58	6.56	6.53	6.56	6.53
2	6.57	6.58	6.55	6.53	6.56	6.53
3	6.57	6.58	6.55	6.54	6.57	6.54
4	6.57	6.58	6.54	6.54	6.57	6.54
5	6.58	6.57	6.54	6.55	6.57	6.55
6	6.58	6.56	6.54	6.55	6.57	6.55
7	6.58	6.56	6.53	6.56	6.56	6.56
8	6.58	6.55	6.53	6.56	6.56	6.56
9	6.58	6.55	6.54	6.57	6.55	6.57
10	6.58	6.54	6.54	6.57	6.55	6.56
11	6.57	6.54	6.55	6.57	6.55	6.56
12	6.56	6.54	6.55	6.57	6.54	6.56
13	6.56	6.53	6.56	6.56	6.54	6.54
14	6.55	6.53	6.56	6.56	6.53	6.55
15	6.55	6.54	6.57	6.55	6.53	6.54
16	6.54	6.54	6.57	6.55	6.52	6.54
17	6.54	6.55	6.57	6.55	6.52	6.54
18	6.54	6.55	6.57	6.54	6.52	6.53
19	6.53	6.56	6.56	6.54	6.51	6.53
20	6.53	6.56	6.56	6.53	6.51	6.52

5+6 Data Validation

NormalizedTraining

	A	B	C	D	E	F	G	H	I	J	K
1	0.12596	0.12665	0.12804	0.12735	0.12804	0.11773					
2	0.12596	0.12665	0.12804	0.12735	0.12804	0.11773					
3	0.12596	0.12735	0.12804	0.12735	0.12804	0.11814					
4	0.12596	0.12735	0.12735	0.12804	0.12804	0.1199					
5	0.12596	0.12735	0.12735	0.12804	0.12735	0.1199					
6	0.12665	0.12804	0.12735	0.12804	0.12735	0.12013					
7	0.12665	0.12804	0.12735	0.12804	0.12735	0.12013					
8	0.12665	0.12804	0.12735	0.12804	0.12665	0.12013					
9	0.12735	0.12804	0.12735	0.12804	0.12665	0.11995					
10	0.12735	0.12735	0.12804	0.12804	0.12665	0.1188					
11	0.12735	0.12735	0.12804	0.12735	0.12665	0.11778					
12	0.12804	0.12735	0.12804	0.12735	0.12596	0.1176					
13	0.12804	0.12735	0.12804	0.12735	0.12596	0.1176					
14	0.12804	0.12735	0.12804	0.12665	0.12596	0.11659					
15	0.12804	0.12735	0.12804	0.12665	0.12526	0.11659					
16	0.12735	0.12804	0.12804	0.12665	0.12526	0.11718					
17	0.12735	0.12804	0.12735	0.12665	0.12526	0.1179					
18	0.12735	0.12804	0.12735	0.12596	0.12457	0.11688					
19	0.12735	0.12804	0.12735	0.12596	0.12457	0.11688					
20	0.12735	0.12804	0.12665	0.12596	0.12387	0.1176					

5+6 Normalized Data Training

NormalizedValidation

	A	B	C	D	E	F	G	H	I	J	K
1	0.04315	0.04454	0.04315	0.04106	0.04315	0.04089					
2	0.04384	0.04454	0.04245	0.04106	0.04315	0.04101					
3	0.04384	0.04454	0.04245	0.04175	0.04384	0.04175					
4	0.04384	0.04454	0.04175	0.04175	0.04384	0.04193					
5	0.04454	0.04384	0.04175	0.04245	0.04384	0.04242					
6	0.04454	0.04315	0.04175	0.04245	0.04384	0.04221					
7	0.04454	0.04315	0.04106	0.04315	0.04315	0.04315					
8	0.04454	0.04245	0.04106	0.04315	0.04315	0.04295					
9	0.04454	0.04245	0.04175	0.04384	0.04245	0.04351					
10	0.04454	0.04175	0.04175	0.04384	0.04245	0.0433					
11	0.04384	0.04175	0.04245	0.04384	0.04245	0.04316					
12	0.04315	0.04175	0.04245	0.04384	0.04175	0.04322					
13	0.04315	0.04106	0.04315	0.04315	0.04175	0.04207					
14	0.04245	0.04106	0.04315	0.04315	0.04106	0.04213					
15	0.04245	0.04175	0.04384	0.04245	0.04106	0.04141					
16	0.04175	0.04175	0.04384	0.04245	0.04036	0.04147					
17	0.04175	0.04245	0.04384	0.04245	0.04036	0.04167					
18	0.04175	0.04245	0.04384	0.04175	0.04036	0.04094					
19	0.04106	0.04315	0.04315	0.04175	0.03967	0.04138					
20	0.04106	0.04315	0.04315	0.04106	0.03967	0.04065					

5+6 Normalized Data Validation

data+1hr+6

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.75	7.75	7.75	7.75	7.76					
2	7.75	7.75	7.75	7.75	7.76	7.76					
3	7.75	7.75	7.75	7.76	7.76	7.76					
4	7.75	7.75	7.76	7.76	7.76	7.77					
5	7.75	7.76	7.76	7.76	7.77	7.77					
6	7.76	7.76	7.76	7.77	7.77	7.77					
7	7.76	7.76	7.77	7.77	7.77	7.78					
8	7.76	7.77	7.77	7.77	7.78	7.78					
9	7.77	7.77	7.77	7.78	7.78	7.78					
10	7.77	7.77	7.78	7.78	7.78	7.78					
11	7.77	7.78	7.78	7.78	7.78	7.77					
12	7.78	7.78	7.78	7.78	7.77	7.77					
13	7.78	7.78	7.78	7.77	7.77	7.77					
14	7.78	7.78	7.77	7.77	7.77	7.77					
15	7.78	7.77	7.77	7.77	7.77	7.77					
16	7.77	7.77	7.77	7.77	7.77	7.77					
17	7.77	7.77	7.77	7.77	7.77	7.78					
18	7.77	7.77	7.77	7.77	7.78	7.78					
19	7.77	7.77	7.77	7.78	7.78	7.78					
20	7.77	7.77	7.78	7.78	7.78	7.78					

6 Column (5 Input) For 1 Hour Interval

DT Prediction 5-5-1 1000 Iteration

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.75	7.75	7.75	7.75	7.76	7.73				
2	7.75	7.75	7.75	7.75	7.76	7.76	7.74				
3	7.75	7.75	7.75	7.76	7.76	7.76	7.74				
4	7.75	7.75	7.76	7.76	7.76	7.77	7.74				
5	7.75	7.76	7.76	7.76	7.77	7.77	7.75				
6	7.76	7.76	7.76	7.77	7.77	7.77	7.75				
7	7.76	7.76	7.77	7.77	7.77	7.78	7.75				
8	7.76	7.77	7.77	7.77	7.78	7.78	7.76				
9	7.77	7.77	7.77	7.78	7.78	7.78	7.76				
10	7.77	7.77	7.78	7.78	7.78	7.78	7.76				
11	7.77	7.78	7.78	7.78	7.78	7.77	7.76				
12	7.78	7.78	7.78	7.78	7.77	7.77	7.75				
13	7.78	7.78	7.78	7.77	7.77	7.77	7.74				
14	7.78	7.78	7.77	7.77	7.77	7.77	7.75				
15	7.78	7.77	7.77	7.77	7.77	7.77	7.75				
16	7.77	7.77	7.77	7.77	7.77	7.77	7.75				
17	7.77	7.77	7.77	7.77	7.77	7.78	7.75				
18	7.77	7.77	7.77	7.77	7.78	7.78	7.76				
19	7.77	7.77	7.77	7.78	7.78	7.78	7.76				
20	7.77	7.77	7.78	7.78	7.78	7.78	7.76				

6+1 Data Validation

DV Prediction 5-5-1 1000 Iteration

	A	B	C	D	E	F	G	H	I	J	K
1	6.54	6.54	6.53	6.53	6.54	6.54	6.53				
2	6.54	6.53	6.53	6.54	6.54	6.55	6.53				
3	6.53	6.53	6.54	6.54	6.55	6.55	6.54				
4	6.53	6.54	6.54	6.55	6.55	6.56	6.54				
5	6.54	6.54	6.55	6.55	6.56	6.56	6.55				
6	6.54	6.55	6.55	6.56	6.56	6.57	6.55				
7	6.55	6.55	6.56	6.56	6.57	6.57	6.56				
8	6.55	6.56	6.56	6.57	6.57	6.57	6.56				
9	6.56	6.56	6.57	6.57	6.57	6.57	6.56				
10	6.56	6.57	6.57	6.57	6.57	6.56	6.56				
11	6.57	6.57	6.57	6.57	6.56	6.56	6.56				
12	6.57	6.57	6.57	6.56	6.56	6.55	6.55				
13	6.57	6.57	6.56	6.56	6.55	6.55	6.55				
14	6.57	6.56	6.56	6.55	6.55	6.55	6.54				
15	6.56	6.56	6.55	6.55	6.55	6.54	6.54				
16	6.56	6.55	6.55	6.55	6.54	6.54	6.54				
17	6.55	6.55	6.55	6.54	6.54	6.53	6.53				
18	6.55	6.55	6.54	6.54	6.53	6.53	6.53				
19	6.55	6.54	6.54	6.53	6.53	6.52	6.52				
20	6.54	6.54	6.53	6.53	6.52	6.52	6.52				

6+1 Data Validation

NormalizedTraining

	A	B	C	D	E	F	G	H	I	J	K
1	0.12596	0.12596	0.12596	0.12596	0.12596	0.12665	0.12448				
2	0.12596	0.12596	0.12596	0.12596	0.12665	0.12665	0.12518				
3	0.12596	0.12596	0.12596	0.12665	0.12665	0.12665	0.12536				
4	0.12596	0.12596	0.12665	0.12665	0.12665	0.12735	0.12529				
5	0.12596	0.12665	0.12665	0.12665	0.12735	0.12735	0.12588				
6	0.12665	0.12665	0.12665	0.12735	0.12735	0.12735	0.12603				
7	0.12665	0.12665	0.12735	0.12735	0.12735	0.12804	0.12595				
8	0.12665	0.12735	0.12735	0.12735	0.12804	0.12804	0.12654				
9	0.12735	0.12735	0.12735	0.12804	0.12804	0.12804	0.12669				
10	0.12735	0.12735	0.12804	0.12804	0.12804	0.12804	0.12662				
11	0.12735	0.12804	0.12804	0.12804	0.12804	0.12735	0.1265				
12	0.12804	0.12804	0.12804	0.12804	0.12735	0.12735	0.12576				
13	0.12804	0.12804	0.12804	0.12735	0.12735	0.12735	0.12558				
14	0.12804	0.12804	0.12735	0.12735	0.12735	0.12735	0.12565				
15	0.12804	0.12735	0.12735	0.12735	0.12735	0.12735	0.12577				
16	0.12735	0.12735	0.12735	0.12735	0.12735	0.12735	0.1258				
17	0.12735	0.12735	0.12735	0.12735	0.12735	0.12804	0.1258				
18	0.12735	0.12735	0.12735	0.12735	0.12804	0.12804	0.12651				
19	0.12735	0.12735	0.12735	0.12804	0.12804	0.12804	0.12669				
20	0.12735	0.12735	0.12804	0.12804	0.12804	0.12804	0.12662				

6+1 Normalized Data Training

NormalizedValidation

	A	B	C	D	E	F	G	H	I	J	K
1	0.04175	0.04175	0.04106	0.04106	0.04175	0.04175	0.04085				
2	0.04175	0.04106	0.04106	0.04175	0.04175	0.04245	0.041				
3	0.04106	0.04106	0.04175	0.04175	0.04245	0.04245	0.04141				
4	0.04106	0.04175	0.04175	0.04245	0.04245	0.04315	0.04162				
5	0.04175	0.04175	0.04245	0.04245	0.04315	0.04315	0.04214				
6	0.04175	0.04245	0.04245	0.04315	0.04315	0.04384	0.04235				
7	0.04245	0.04245	0.04315	0.04315	0.04384	0.04384	0.04287				
8	0.04245	0.04315	0.04315	0.04384	0.04384	0.04384	0.04308				
9	0.04315	0.04315	0.04384	0.04384	0.04384	0.04384	0.04319				
10	0.04315	0.04384	0.04384	0.04384	0.04384	0.04315	0.04322				
11	0.04384	0.04384	0.04384	0.04384	0.04315	0.04315	0.04286				
12	0.04384	0.04384	0.04384	0.04315	0.04315	0.04245	0.04268				
13	0.04384	0.04384	0.04315	0.04315	0.04245	0.04245	0.04222				
14	0.04384	0.04315	0.04315	0.04245	0.04245	0.04245	0.04201				
15	0.04315	0.04315	0.04245	0.04245	0.04245	0.04175	0.0419				
16	0.04315	0.04245	0.04245	0.04245	0.04175	0.04175	0.04147				
17	0.04245	0.04245	0.04245	0.04175	0.04175	0.04106	0.04124				
18	0.04245	0.04245	0.04175	0.04175	0.04106	0.04106	0.04078				
19	0.04245	0.04175	0.04175	0.04106	0.04106	0.04036	0.04057				
20	0.04175	0.04175	0.04106	0.04106	0.04036	0.04036	0.04006				

6+1 Normalized Data Validation

data+3hr+6

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.75	7.76	7.77	7.78	7.77					
2	7.75	7.75	7.76	7.77	7.78	7.77					
3	7.75	7.76	7.77	7.78	7.78	7.77					
4	7.75	7.76	7.77	7.78	7.77	7.77					
5	7.75	7.76	7.77	7.78	7.77	7.77					
6	7.76	7.77	7.78	7.78	7.77	7.77					
7	7.76	7.77	7.78	7.77	7.77	7.78					
8	7.76	7.77	7.78	7.77	7.77	7.78					
9	7.77	7.78	7.78	7.77	7.77	7.78					
10	7.77	7.78	7.77	7.77	7.78	7.78					
11	7.77	7.78	7.77	7.77	7.78	7.78					
12	7.78	7.78	7.77	7.77	7.78	7.78					
13	7.78	7.77	7.77	7.78	7.78	7.78					
14	7.78	7.77	7.77	7.78	7.78	7.77					
15	7.78	7.77	7.77	7.78	7.78	7.77					
16	7.77	7.77	7.78	7.78	7.78	7.77					
17	7.77	7.77	7.78	7.78	7.77	7.76					
18	7.77	7.77	7.78	7.78	7.77	7.76					
19	7.77	7.78	7.78	7.78	7.77	7.76					
20	7.77	7.78	7.78	7.77	7.76	7.76					

6 Column (5 Input) For 3 Hour Interval

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.75	7.76	7.77	7.78	7.77	7.72				
2	7.75	7.75	7.76	7.77	7.78	7.77	7.72				
3	7.75	7.76	7.77	7.78	7.78	7.77	7.71				
4	7.75	7.76	7.77	7.78	7.77	7.77	7.69				
5	7.75	7.76	7.77	7.78	7.77	7.77	7.69				
6	7.76	7.77	7.78	7.78	7.77	7.77	7.7				
7	7.76	7.77	7.78	7.77	7.77	7.78	7.71				
8	7.76	7.77	7.78	7.77	7.77	7.78	7.71				
9	7.77	7.78	7.78	7.77	7.77	7.78	7.71				
10	7.77	7.78	7.77	7.77	7.78	7.78	7.73				
11	7.77	7.78	7.77	7.77	7.78	7.78	7.73				
12	7.78	7.78	7.77	7.77	7.78	7.78	7.72				
13	7.78	7.77	7.77	7.78	7.78	7.78	7.71				
14	7.78	7.77	7.77	7.78	7.78	7.77	7.71				
15	7.78	7.77	7.77	7.78	7.78	7.77	7.71				
16	7.77	7.77	7.78	7.78	7.78	7.77	7.71				
17	7.77	7.77	7.78	7.78	7.77	7.76	7.69				
18	7.77	7.77	7.78	7.78	7.77	7.76	7.69				
19	7.77	7.78	7.78	7.78	7.77	7.76	7.7				
20	7.77	7.78	7.78	7.77	7.76	7.76	7.69				

6+3 Data Training

DV Prediction 5-5-1 1000 Iteration

	A	B	C	D	E	F	G	H	I	J	K
1	6.58	6.56	6.55	6.54	6.54	6.55	6.54				
2	6.58	6.56	6.54	6.53	6.54	6.56	6.54				
3	6.57	6.55	6.54	6.53	6.55	6.56	6.55				
4	6.56	6.55	6.54	6.54	6.55	6.57	6.54				
5	6.56	6.54	6.53	6.54	6.56	6.57	6.55				
6	6.55	6.54	6.53	6.55	6.56	6.57	6.55				
7	6.55	6.54	6.54	6.55	6.57	6.57	6.56				
8	6.54	6.53	6.54	6.56	6.57	6.56	6.56				
9	6.54	6.53	6.55	6.56	6.57	6.56	6.56				
10	6.54	6.54	6.55	6.57	6.57	6.55	6.56				
11	6.53	6.54	6.56	6.57	6.56	6.55	6.55				
12	6.53	6.55	6.56	6.57	6.56	6.55	6.55				
13	6.54	6.55	6.57	6.57	6.55	6.54	6.54				
14	6.54	6.56	6.57	6.56	6.55	6.54	6.54				
15	6.55	6.56	6.57	6.56	6.55	6.53	6.54				
16	6.55	6.57	6.57	6.55	6.54	6.53	6.54				
17	6.56	6.57	6.56	6.55	6.54	6.52	6.54				
18	6.56	6.57	6.56	6.55	6.53	6.52	6.53				
19	6.57	6.57	6.55	6.54	6.53	6.52	6.53				
20	6.57	6.56	6.55	6.54	6.52	6.51	6.52				

6+3 Data Validation

NormalizedTraining

	A	B	C	D	E	F	G	H	I	J	K
1	0.12596	0.12596	0.12665	0.12735	0.12804	0.12735	0.12378				
2	0.12596	0.12596	0.12665	0.12735	0.12804	0.12735	0.12378				
3	0.12596	0.12665	0.12735	0.12804	0.12804	0.12735	0.12327				
4	0.12596	0.12665	0.12735	0.12804	0.12735	0.12735	0.12202				
5	0.12596	0.12665	0.12735	0.12804	0.12735	0.12735	0.12202				
6	0.12665	0.12735	0.12804	0.12804	0.12735	0.12735	0.12213				
7	0.12665	0.12735	0.12804	0.12735	0.12735	0.12804	0.12286				
8	0.12665	0.12735	0.12804	0.12735	0.12735	0.12804	0.12286				
9	0.12735	0.12804	0.12804	0.12735	0.12735	0.12804	0.12297				
10	0.12735	0.12804	0.12735	0.12735	0.12804	0.12804	0.12423				
11	0.12735	0.12804	0.12735	0.12735	0.12804	0.12804	0.12423				
12	0.12804	0.12804	0.12735	0.12735	0.12804	0.12804	0.12412				
13	0.12804	0.12735	0.12735	0.12804	0.12804	0.12804	0.12317				
14	0.12804	0.12735	0.12735	0.12804	0.12804	0.12735	0.12317				
15	0.12804	0.12735	0.12735	0.12804	0.12804	0.12735	0.12317				
16	0.12735	0.12735	0.12804	0.12804	0.12804	0.12735	0.12328				
17	0.12735	0.12735	0.12804	0.12804	0.12735	0.12665	0.12203				
18	0.12735	0.12735	0.12804	0.12804	0.12735	0.12665	0.12203				
19	0.12735	0.12804	0.12804	0.12804	0.12735	0.12665	0.12225				
20	0.12735	0.12804	0.12804	0.12735	0.12665	0.12665	0.12173				

6+3 Normalized Data Training

NormalizedValidation

	A	B	C	D	E	F	G	H	I	J	K
1	0.04454	0.04315	0.04245	0.04175	0.04175	0.04245	0.04153				
2	0.04454	0.04315	0.04175	0.04106	0.04175	0.04315	0.04163				
3	0.04384	0.04245	0.04175	0.04106	0.04245	0.04315	0.04221				
4	0.04315	0.04245	0.04175	0.04175	0.04245	0.04384	0.04205				
5	0.04315	0.04175	0.04106	0.04175	0.04315	0.04384	0.04256				
6	0.04245	0.04175	0.04106	0.04245	0.04315	0.04384	0.04239				
7	0.04245	0.04175	0.04175	0.04245	0.04384	0.04384	0.04317				
8	0.04175	0.04106	0.04175	0.04315	0.04384	0.04315	0.04287				
9	0.04175	0.04106	0.04245	0.04315	0.04384	0.04315	0.04293				
10	0.04175	0.04175	0.04245	0.04384	0.04384	0.04245	0.04289				
11	0.04106	0.04175	0.04315	0.04384	0.04315	0.04245	0.04226				
12	0.04106	0.04245	0.04315	0.04384	0.04315	0.04245	0.04239				
13	0.04175	0.04245	0.04384	0.04384	0.04245	0.04175	0.04174				
14	0.04175	0.04315	0.04384	0.04315	0.04245	0.04175	0.04205				
15	0.04245	0.04315	0.04384	0.04315	0.04245	0.04106	0.04204				
16	0.04245	0.04384	0.04384	0.04245	0.04175	0.04106	0.04164				
17	0.04315	0.04384	0.04315	0.04245	0.04175	0.04036	0.04157				
18	0.04315	0.04384	0.04315	0.04245	0.04106	0.04036	0.04088				
19	0.04384	0.04384	0.04245	0.04175	0.04106	0.04036	0.04098				
20	0.04384	0.04315	0.04245	0.04175	0.04036	0.03967	0.04017				

6+3 Normalized Data Validation

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.76	7.78	7.77	7.78	7.77					
2	7.75	7.76	7.78	7.77	7.78	7.76					
3	7.75	7.77	7.78	7.77	7.78	7.76					
4	7.75	7.77	7.77	7.78	7.78	7.76					
5	7.75	7.77	7.77	7.78	7.77	7.76					
6	7.76	7.78	7.77	7.78	7.77	7.75					
7	7.76	7.78	7.77	7.78	7.77	7.75					
8	7.76	7.78	7.77	7.78	7.76	7.75					
9	7.77	7.78	7.77	7.78	7.76	7.74					
10	7.77	7.77	7.78	7.78	7.76	7.74					
11	7.77	7.77	7.78	7.77	7.76	7.74					
12	7.78	7.77	7.78	7.77	7.75	7.73					
13	7.78	7.77	7.78	7.77	7.75	7.73					
14	7.78	7.77	7.78	7.76	7.75	7.72					
15	7.78	7.77	7.78	7.76	7.74	7.72					
16	7.77	7.78	7.78	7.76	7.74	7.71					
17	7.77	7.78	7.77	7.76	7.74	7.71					
18	7.77	7.78	7.77	7.75	7.73	7.71					
19	7.77	7.78	7.77	7.75	7.73	7.71					
20	7.77	7.78	7.76	7.75	7.72	7.7					

6 Column (5 Input) For 6 Hour Interval

	A	B	C	D	E	F	G	H	I	J	K
1	7.75	7.76	7.78	7.77	7.78	7.77	7.61				
2	7.75	7.76	7.78	7.77	7.78	7.76	7.61				
3	7.75	7.77	7.78	7.77	7.78	7.76	7.61				
4	7.75	7.77	7.77	7.78	7.78	7.76	7.6				
5	7.75	7.77	7.77	7.78	7.77	7.76	7.59				
6	7.76	7.78	7.77	7.78	7.77	7.75	7.58				
7	7.76	7.78	7.77	7.78	7.77	7.75	7.58				
8	7.76	7.78	7.77	7.78	7.76	7.75	7.57				
9	7.77	7.78	7.77	7.78	7.76	7.74	7.57				
10	7.77	7.77	7.78	7.78	7.76	7.74	7.57				
11	7.77	7.77	7.78	7.77	7.76	7.74	7.58				
12	7.78	7.77	7.78	7.77	7.75	7.73	7.57				
13	7.78	7.77	7.78	7.77	7.75	7.73	7.57				
14	7.78	7.77	7.78	7.76	7.75	7.72	7.58				
15	7.78	7.77	7.78	7.76	7.74	7.72	7.56				
16	7.77	7.78	7.78	7.76	7.74	7.71	7.56				
17	7.77	7.78	7.77	7.76	7.74	7.71	7.56				
18	7.77	7.78	7.77	7.75	7.73	7.71	7.55				
19	7.77	7.78	7.77	7.75	7.73	7.71	7.55				
20	7.77	7.78	7.76	7.75	7.72	7.7	7.54				

6+6 Data Training

	A	B	C	D	E	F	G	H	I	J	K
1	6.56	6.57	6.58	6.55	6.54	6.57	6.54				
2	6.56	6.57	6.58	6.54	6.54	6.57	6.54				
3	6.56	6.58	6.57	6.54	6.55	6.57	6.55				
4	6.56	6.58	6.56	6.54	6.55	6.57	6.55				
5	6.56	6.58	6.56	6.53	6.56	6.56	6.56				
6	6.57	6.58	6.55	6.53	6.56	6.56	6.56				
7	6.57	6.58	6.55	6.54	6.57	6.55	6.57				
8	6.57	6.58	6.54	6.54	6.57	6.55	6.57				
9	6.58	6.57	6.54	6.55	6.57	6.55	6.56				
10	6.58	6.56	6.54	6.55	6.57	6.54	6.56				
11	6.58	6.56	6.53	6.56	6.56	6.54	6.55				
12	6.58	6.55	6.53	6.56	6.56	6.53	6.55				
13	6.58	6.55	6.54	6.57	6.55	6.53	6.54				
14	6.58	6.54	6.54	6.57	6.55	6.52	6.54				
15	6.57	6.54	6.55	6.57	6.55	6.52	6.54				
16	6.56	6.54	6.55	6.57	6.54	6.52	6.53				
17	6.56	6.53	6.56	6.56	6.54	6.51	6.53				
18	6.55	6.53	6.56	6.56	6.53	6.51	6.52				
19	6.55	6.54	6.57	6.55	6.53	6.51	6.53				
20	6.54	6.54	6.57	6.55	6.52	6.51	6.52				

6+6 Data Validation

	A	B	C	D	E	F	G	H	I	J	K
1	0.12596	0.12665	0.12804	0.12735	0.12804	0.12735	0.11644				
2	0.12596	0.12665	0.12804	0.12735	0.12804	0.12665	0.11644				
3	0.12596	0.12735	0.12804	0.12735	0.12804	0.12665	0.11643				
4	0.12596	0.12735	0.12735	0.12804	0.12804	0.12665	0.11552				
5	0.12596	0.12735	0.12735	0.12804	0.12735	0.12665	0.11455				
6	0.12665	0.12804	0.12735	0.12804	0.12735	0.12596	0.11443				
7	0.12665	0.12804	0.12735	0.12804	0.12735	0.12596	0.11443				
8	0.12665	0.12804	0.12735	0.12804	0.12665	0.12596	0.11347				
9	0.12735	0.12804	0.12735	0.12804	0.12665	0.12526	0.11336				
10	0.12735	0.12735	0.12804	0.12804	0.12665	0.12526	0.11363				
11	0.12735	0.12735	0.12804	0.12735	0.12665	0.12526	0.11427				
12	0.12804	0.12735	0.12804	0.12735	0.12596	0.12457	0.1132				
13	0.12804	0.12735	0.12804	0.12735	0.12596	0.12457	0.1132				
14	0.12804	0.12735	0.12804	0.12665	0.12596	0.12387	0.11384				
15	0.12804	0.12735	0.12804	0.12665	0.12526	0.12387	0.11287				
16	0.12735	0.12804	0.12804	0.12665	0.12526	0.12317	0.11296				
17	0.12735	0.12804	0.12735	0.12665	0.12526	0.12317	0.11271				
18	0.12735	0.12804	0.12735	0.12596	0.12457	0.12317	0.11238				
19	0.12735	0.12804	0.12735	0.12596	0.12457	0.12317	0.11238				
20	0.12735	0.12804	0.12665	0.12596	0.12387	0.12248	0.11117				

6+6 Normalized Data Training

A1 fx 0.04315

	A	B	C	D	E	F	G	H	I	J	K
1	0.04315	0.04384	0.04454	0.04245	0.04175	0.04384	0.04168				
2	0.04315	0.04384	0.04454	0.04175	0.04175	0.04384	0.04186				
3	0.04315	0.04454	0.04384	0.04175	0.04245	0.04384	0.04249				
4	0.04315	0.04454	0.04315	0.04175	0.04245	0.04384	0.04235				
5	0.04315	0.04454	0.04315	0.04106	0.04315	0.04315	0.04332				
6	0.04384	0.04454	0.04245	0.04106	0.04315	0.04315	0.04314				
7	0.04384	0.04454	0.04245	0.04175	0.04384	0.04245	0.04374				
8	0.04384	0.04454	0.04175	0.04175	0.04384	0.04245	0.04359				
9	0.04454	0.04384	0.04175	0.04245	0.04384	0.04245	0.04336				
10	0.04454	0.04315	0.04175	0.04245	0.04384	0.04175	0.04336				
11	0.04454	0.04315	0.04106	0.04315	0.04315	0.04175	0.04224				
12	0.04454	0.04245	0.04106	0.04315	0.04315	0.04106	0.04224				
13	0.04454	0.04245	0.04175	0.04384	0.04245	0.04106	0.04143				
14	0.04454	0.04175	0.04175	0.04384	0.04245	0.04036	0.04143				
15	0.04384	0.04175	0.04245	0.04384	0.04245	0.04036	0.04161				
16	0.04315	0.04175	0.04245	0.04384	0.04175	0.04036	0.04088				
17	0.04315	0.04106	0.04315	0.04315	0.04175	0.03967	0.0412				
18	0.04245	0.04106	0.04315	0.04315	0.04106	0.03967	0.04048				
19	0.04245	0.04175	0.04384	0.04245	0.04106	0.03967	0.0408				
20	0.04175	0.04175	0.04384	0.04245	0.04036	0.03967	0.04008				

6+6 Normalized Data Validation

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