1. Introduction

Sea level rise occurs as a result of many factors, one of which is global warming. Global warming occurs due to rising air temperatures by concentrations of gases known as greenhouse gases (GHGs). As a result of global warming, sea level continues to rise. Based on the report of the Intergovernmental Panel on Climate Change (IPCC), sea-level will increase 30-100 cm in 2100. [11].

Sea level rise has an impact on areas around the coast, one of which is Indonesia's capital city, Jakarta. Jakarta is one of the largest coastal cities in the world[4], [5]. Sea level rise in Jakarta is a serious problem. Almost every year, Jakarta experiences flood due to the impact of sea-level rise and also land subsidence. Sea level rise in Jakarta Bay reaches 0.57 cm per year [5] while land subsidence annually is around 9.5 - 21.5 cm per year from 2007 to 2009 [3]. In paper [1], it is predicted that in 2030 Jakarta sea level will increase as high as 2.88 m. The impact of rising sea levels is not only flooding but can also cause some islands around Jakarta to sink. Based on the paper [14], five small islands around Jakarta had sunk as a result of rising sea levels. Sea level forecasting is important in coastal activities, such as engineering, and naval navigation. Moreover, it can be used for making strategies for future coastal development and planning, and also for mitigating its serious consequences [6]. Forecasting methods commonly used are quantitative forecasting methods by using historical data about the variables to be predicted and assuming that historical data patterns will continue into the future. Many algorithms and methods can be used to forecast sea levels, such as statistical methods and neural networks. Srivastava [16] proposed sea-level forecasting using the Exponential Smoothing Models and Autoregressive integrated moving average (ARIMA) methods. Forecasting uses Arabian sea level data with 17 years of history data (1994-2010), the results of forecasting Exponential smoothing state-space models method are better than ARIMA. Meanwhile, Sepideh Karimi et al. [9] proposed sea-level forecasting in Darwin Harbor, Australia, using Adaptive Neuro-Fuzzy Inference (ANFIS) method, Artificial Neural Network (ANN) and ARMA. The ANN and ANFIS methods yield similar accuracy and better than ARMA.

Recently deep learning is increasingly popular for time series forecasting problems especially Recurrent Neural Network (RNN) based model. There are several variations of RNN based models. Most of these RNN based models differ mainly because of their capabilities in remembering input data. The common issues of vanilla RNN are the vanishing and exploding gradient problems. This issues make it hard for vanilla RNN to capture the long term dependencies. Since the issues of vanishing gradient and exploding gradient, then seem special type of RNN is called Long Short Term Memory (LSTM). The LSTM was made to enhance network memory to remember previous states and preserve long term dependencies. The LSTM has shown a outperform ability to learn long term dependencies by preserving a memory cell to determine which unnecessary features should be forgotten and which necessary features should be remembered during the learning process [12],[17]. An interesting question is whether or not its performance may be more improved by incorporating additional layers of training data into the LSTM.

To investigate whether incorporating additional layers of training into the LSTM improves its prediction, this paper analyze the performance of Bidirectional LSTM (BiLSTM). In the BiLSTM enables additional training data by traversing the input data twice(i.e., 1) left to right and 2) right to left). In specific, we would compare the performance of the three methods to prediction sea level.