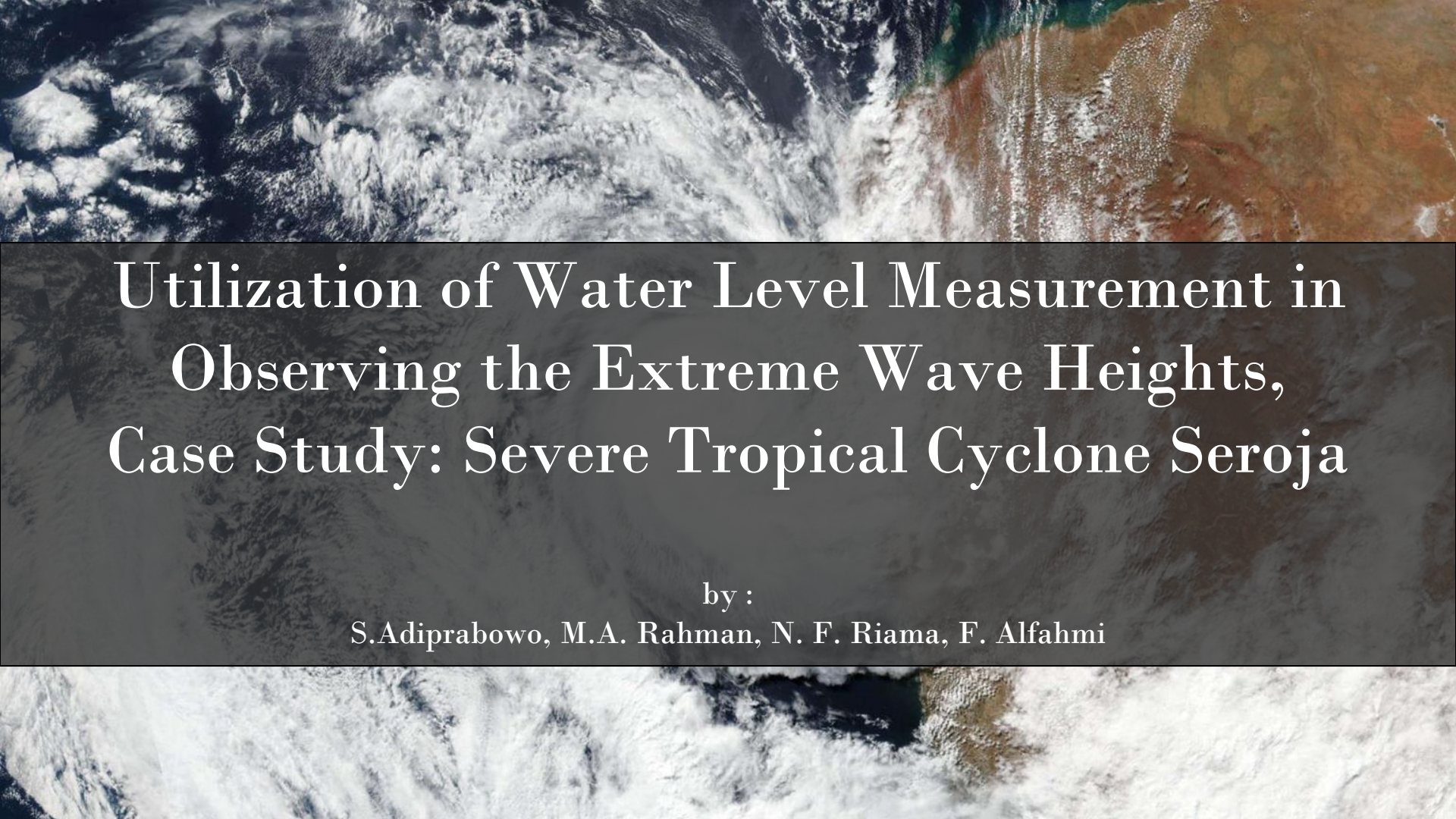


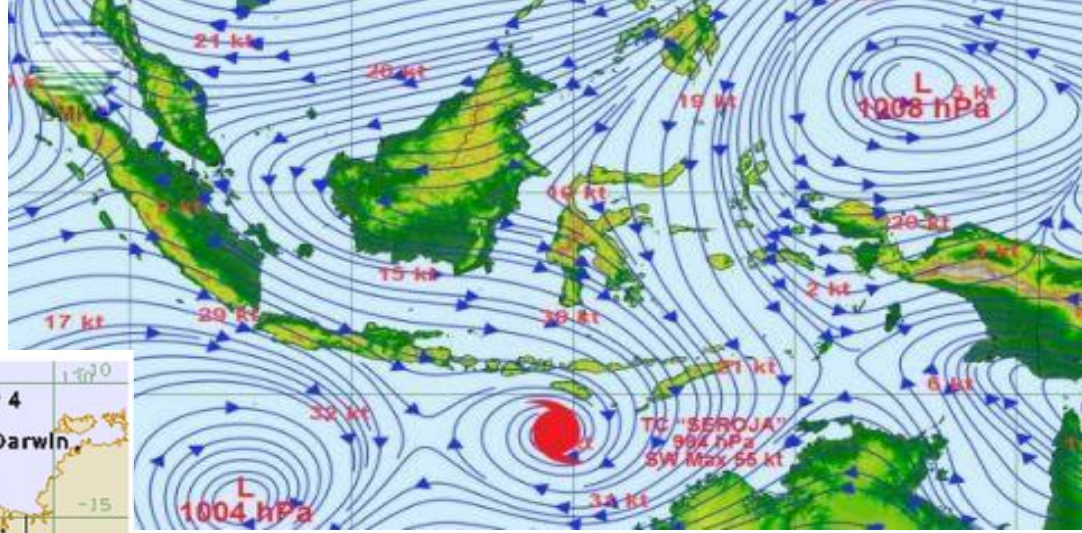
Utilization of Water Level Measurement in Observing the Extreme Wave Heights, Case Study: Severe Tropical Cyclone Seroja

by :
S.Adiprabowo, M.A. Rahman, N. F. Riama, F. Alfahmi

Severe Tropical Cyclone Seroja

The death toll of this event in East Nusa Tenggara is 181 victims.

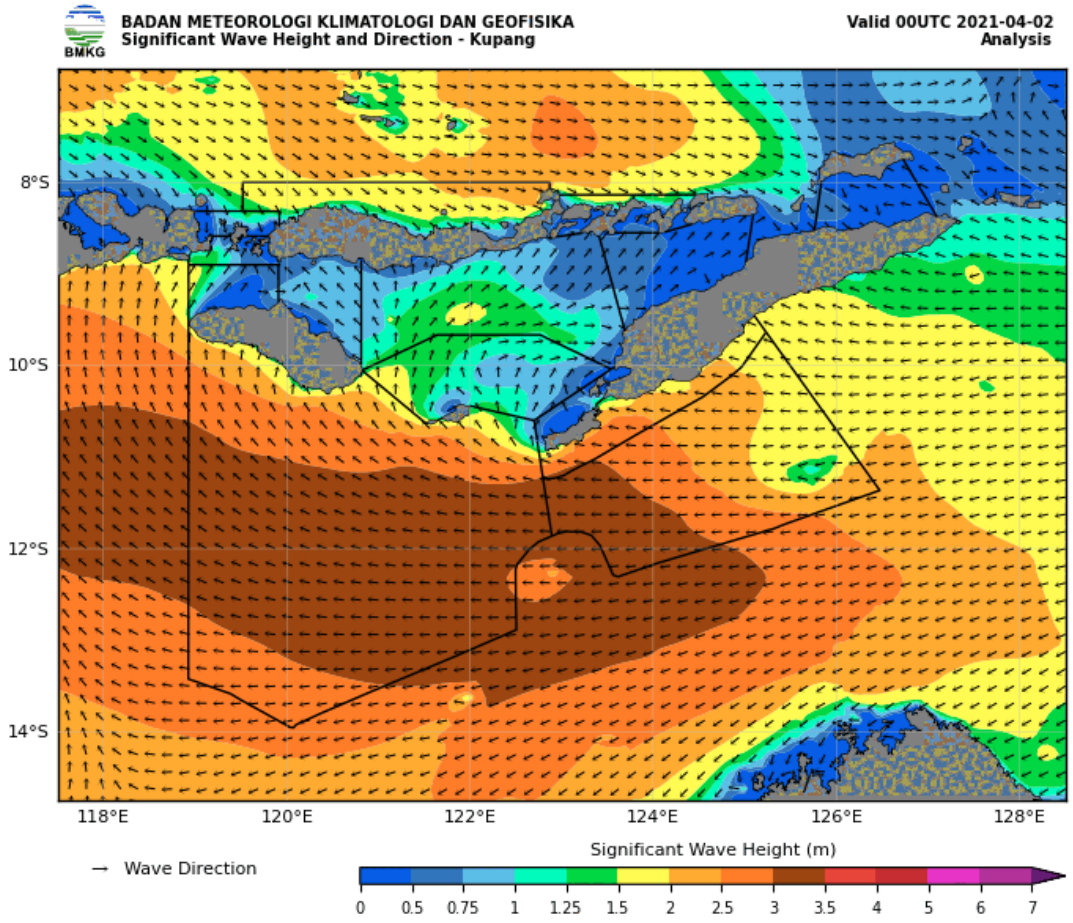
coutesy: BOM, Aurtralia



coutesy: bmkg.go.id

Wave model shows the significant wave height during TC Seroja event.

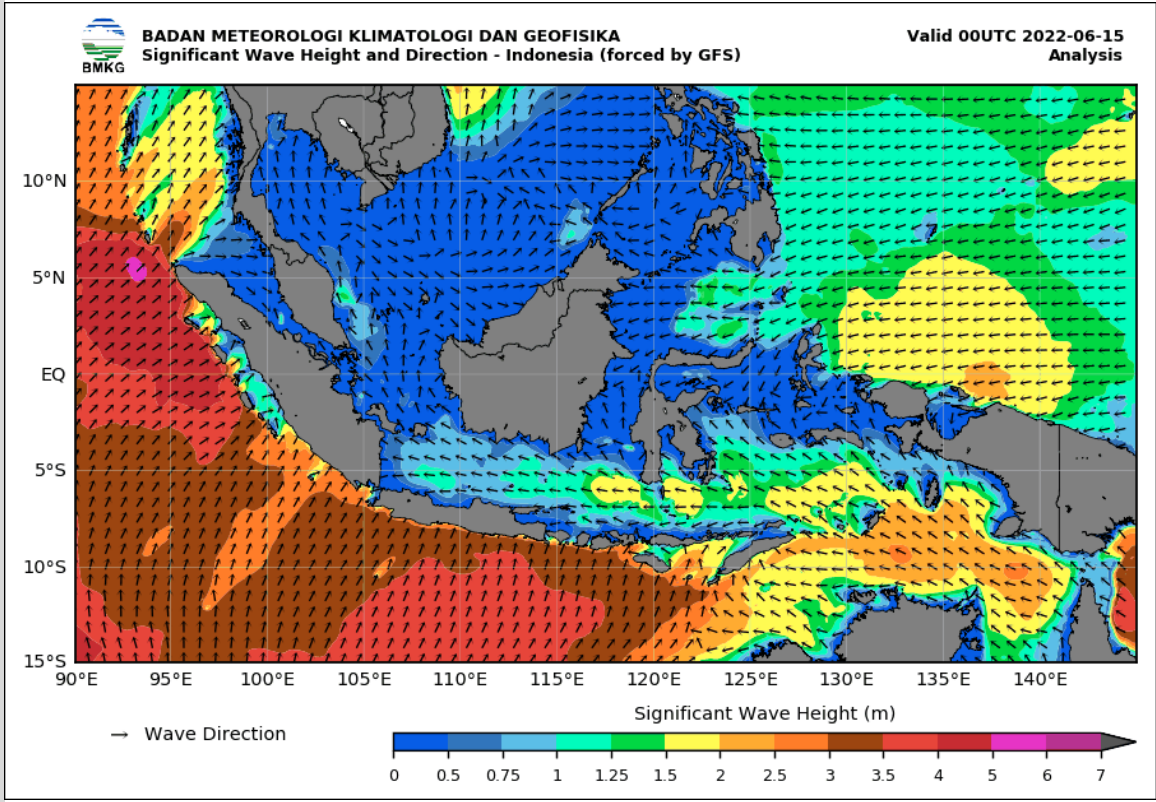
The rough wave height (4.0 - 6.0) is detected during TC Seroja event.



Existing systems

to look over wave height conditions and sea state

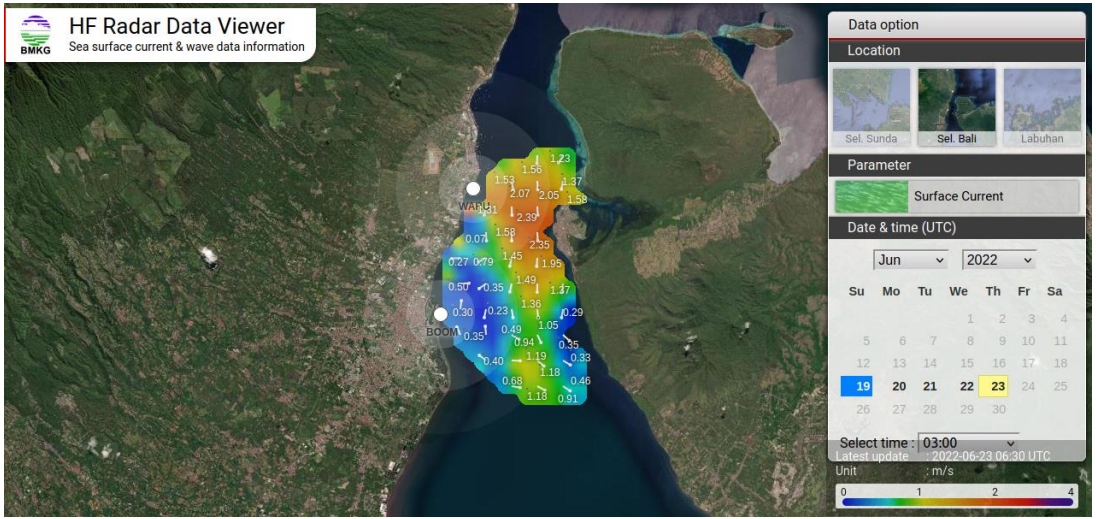
- BMKG InaWave Forecast (Wave Model Forecast) and hindcast datas (Wave Data Hindcast)



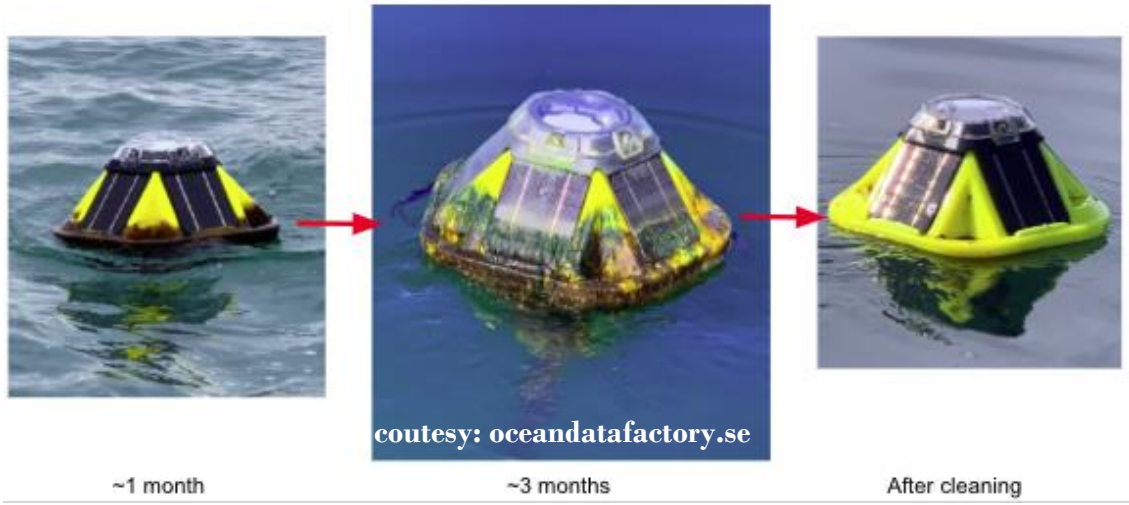
Existing systems

to look over wave height conditions and sea state

- HFRadar, MAWS, and VAWS Obsevation



Reliable and safe wave heights observation?



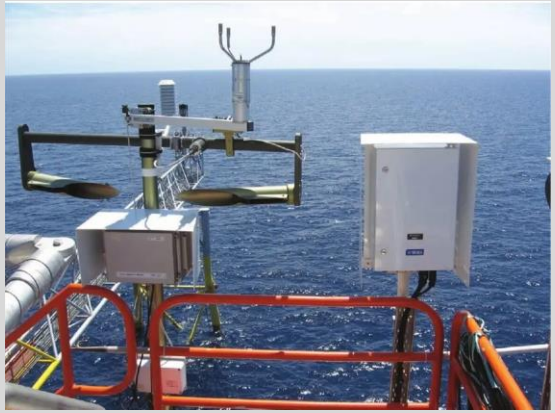
BMKG Observation Network

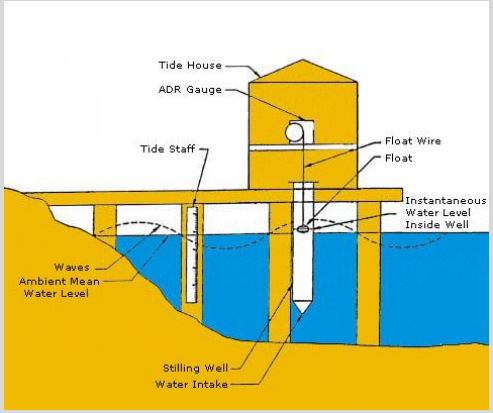
1. Water Level Tide Gauges

2. Marine AWS (Automatic Weather Station)

3. Vessel AWS

4. ADCP?



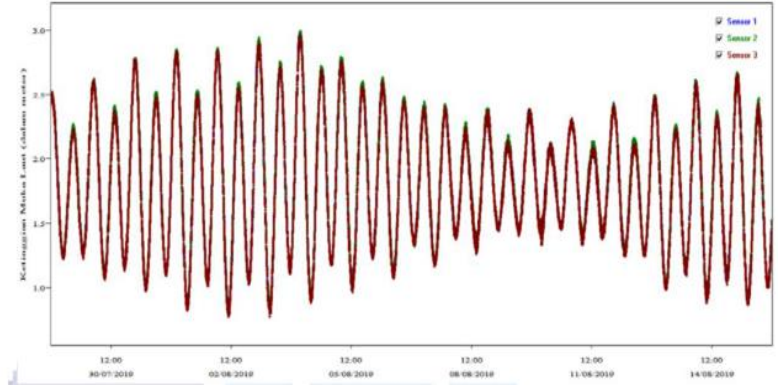


coutesy: www.swellnet.com

The demand of reliable observation in remote area

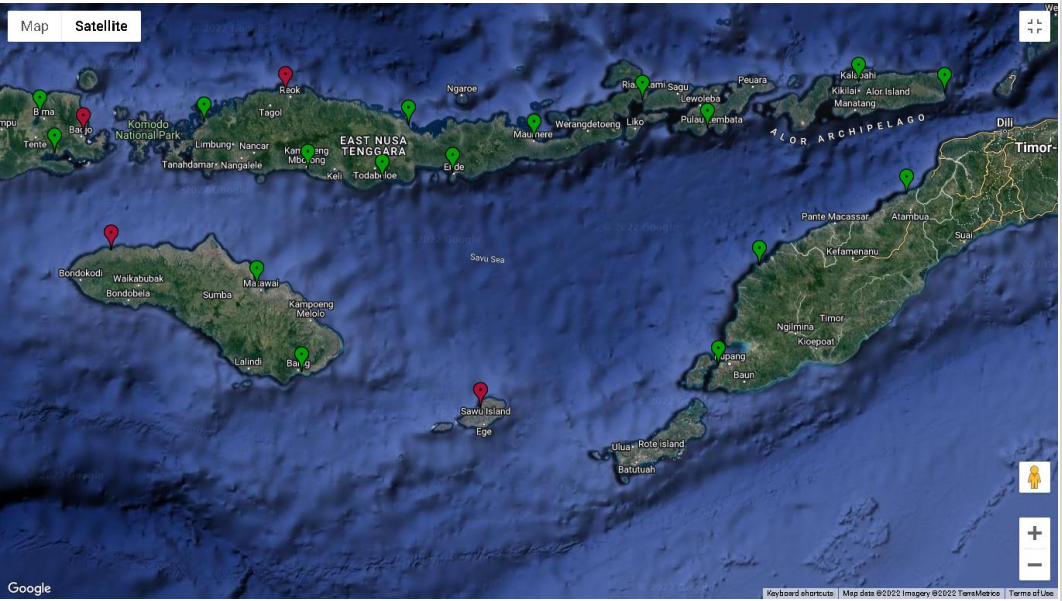
coutesy: www.himiofots.gr

How to fill the wave heights observations gap in the community?



Water Level

A potential of the high-frequency water level recorder data may seems promising.
Madsen et al. (2015) and Pascual et al. (2008) evaluates the tidal harmonic components and predict with Pawlowicz et al. (2002) to eliminate the the tidal harmonic component and extract the sea level anomaly and storm surge.



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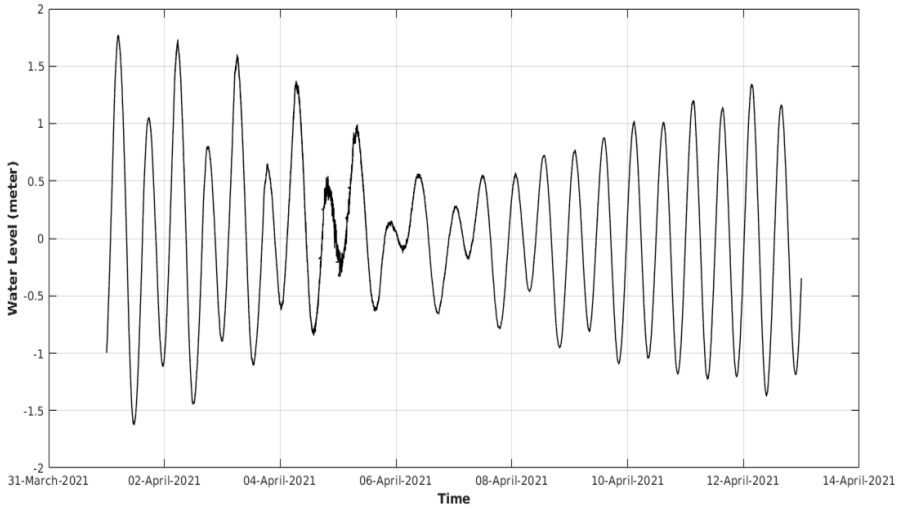
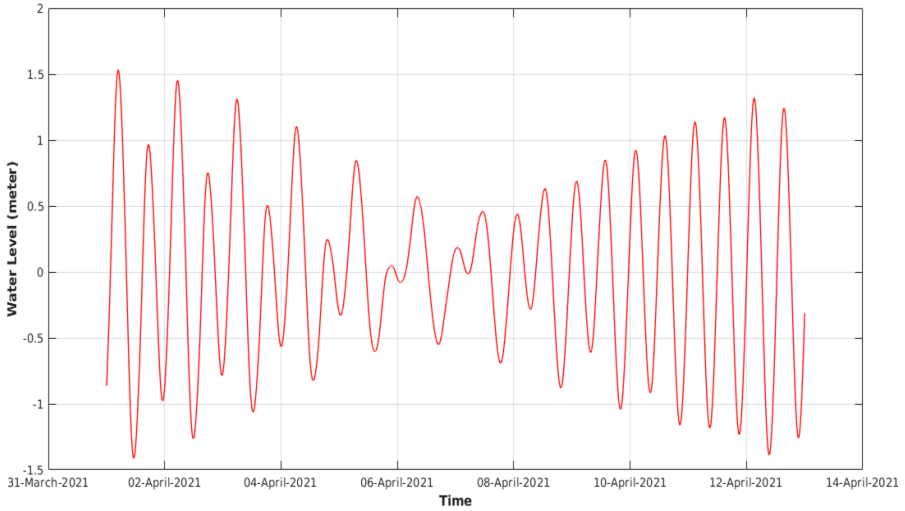


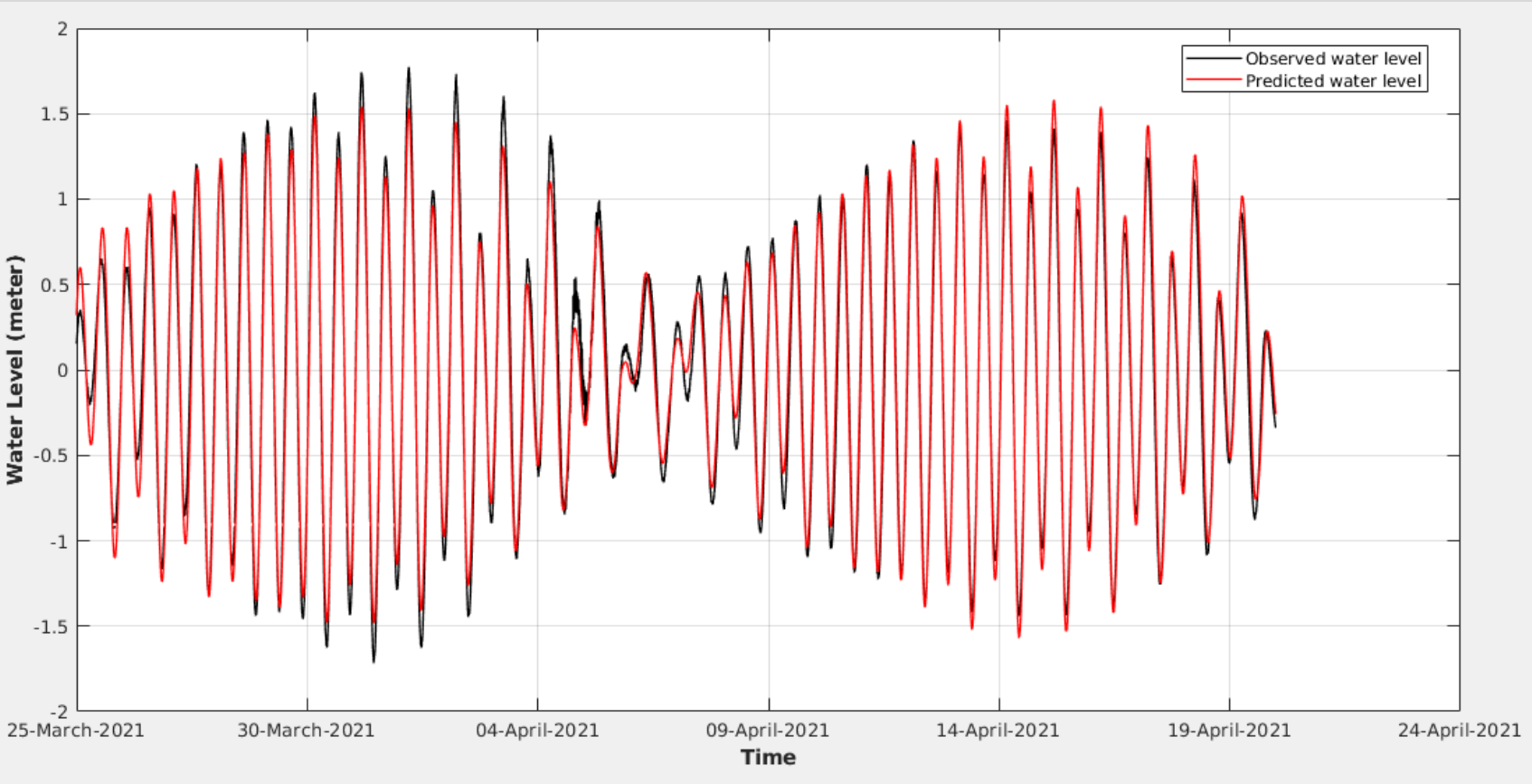


How?

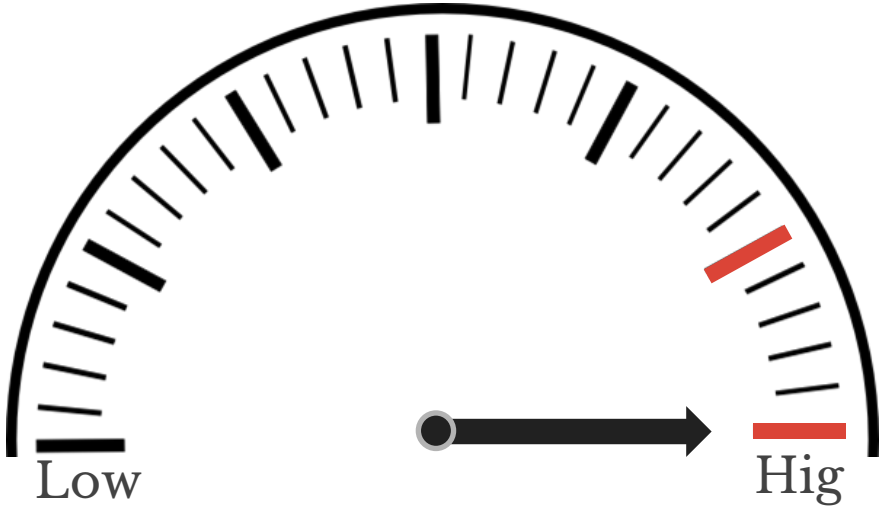
1. Looking for the noises from high-frequency water elevation data.

2.The noises is expected to clearly seen by eliminating astronomical or harmonic components of tide on the data.

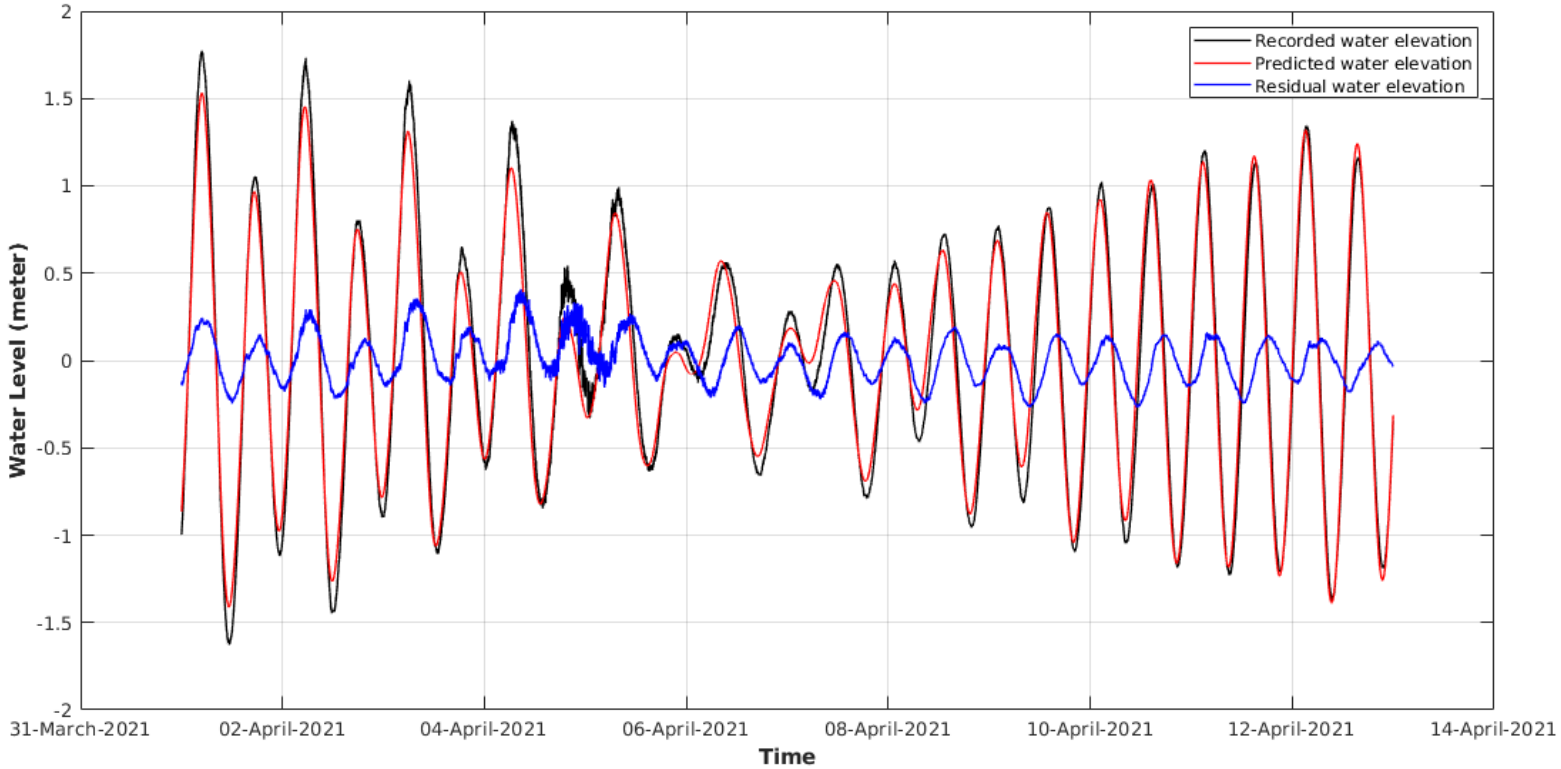
3.T-Tide (Pawlowicz, 2002) provides the tool to predict the harmonic tide.



The high frequency (1/60Hz) water elevation data



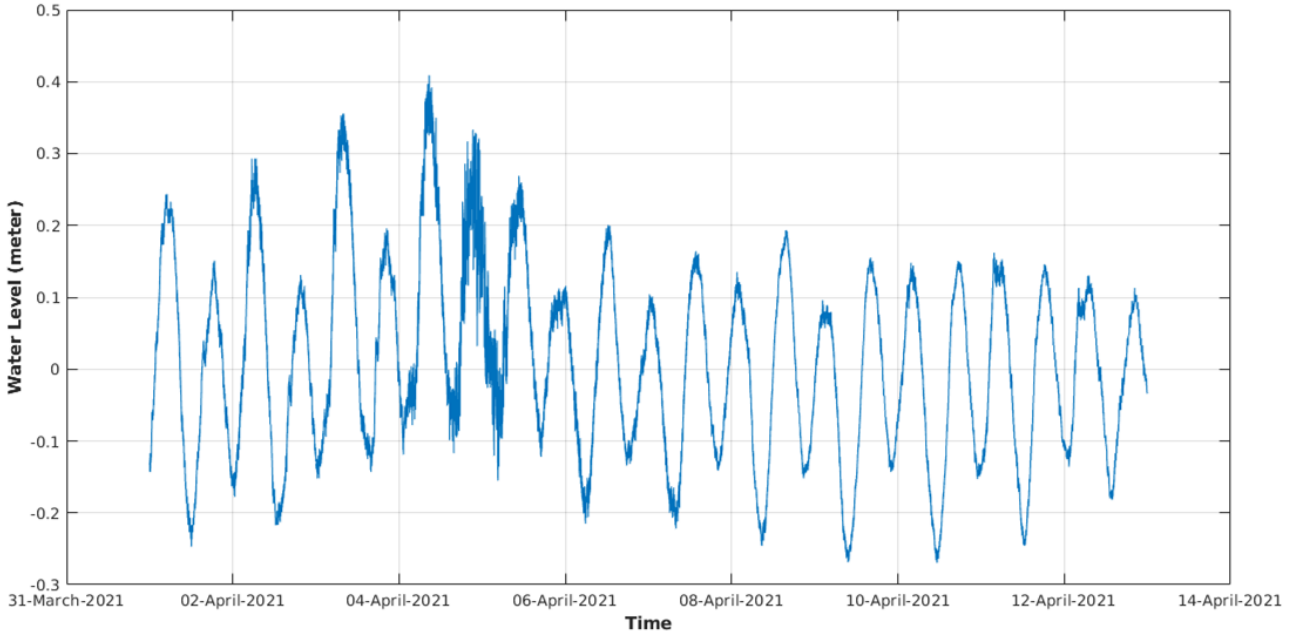
After the harmonic analysis and tide prediction…

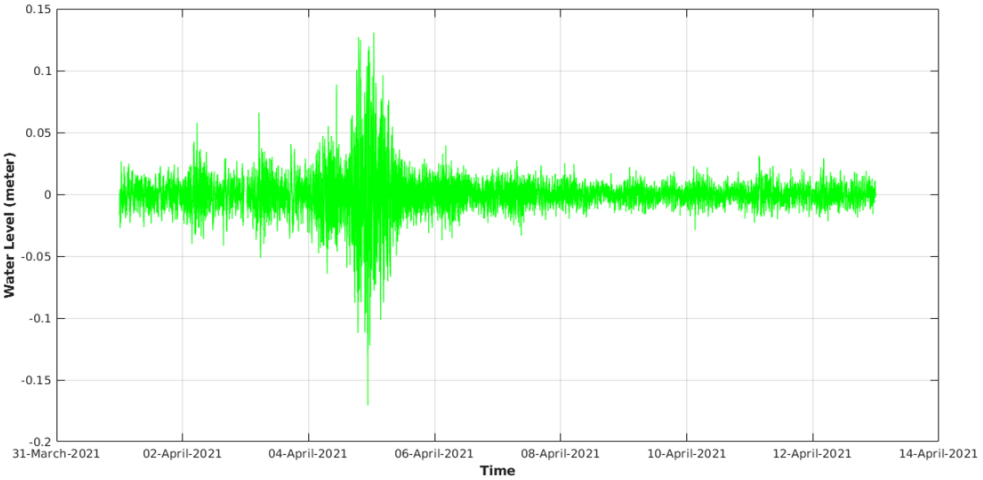


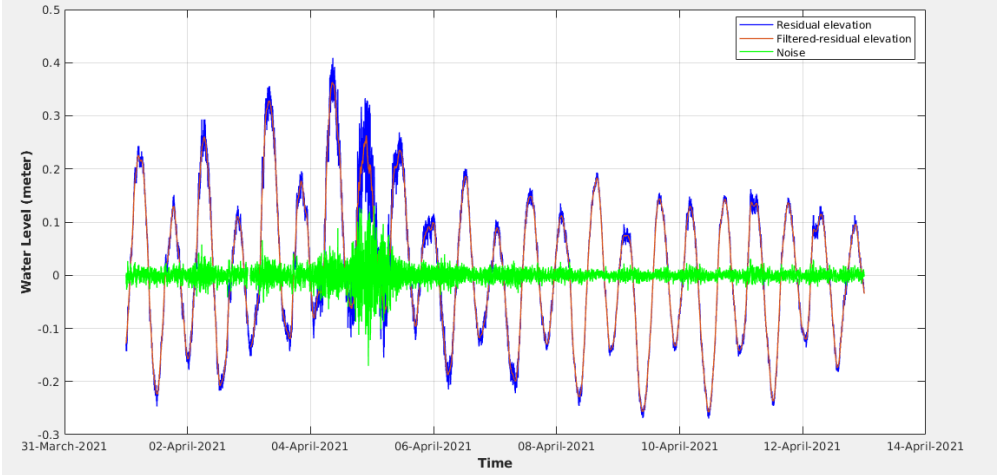
The comparison of the Recorded, Predicted, and Residual water elevation. The high-frequency noises detected between 4 - 6 April 2021. A further steps need to be taken to inspect the high-frequency noise.

Result of harmonic component elimination

- The harmonic component elimination resulted in the unexpected residual with low-frequency (tidal) component amplitude.
- The high-frequency noises is disappear or covered with tidal component amplitude.







Took further steps:

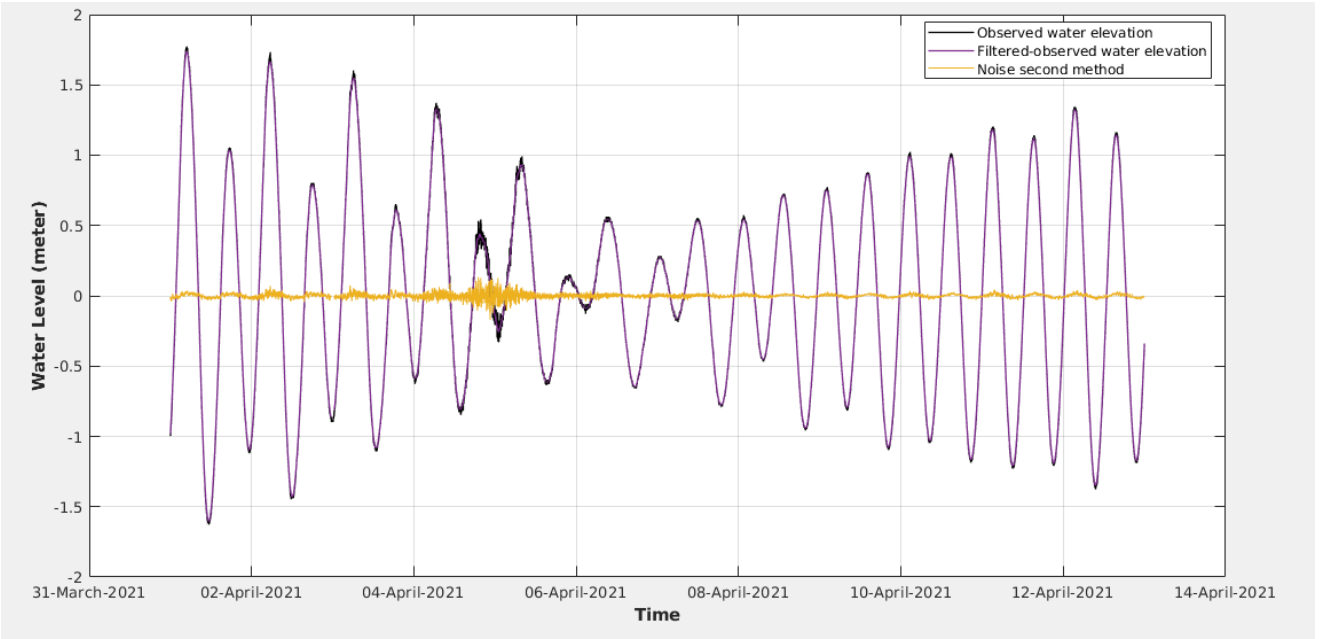
Moving average filter applied to eliminate the low frequency elevation.

Moving average with 60 data of window size is applied.

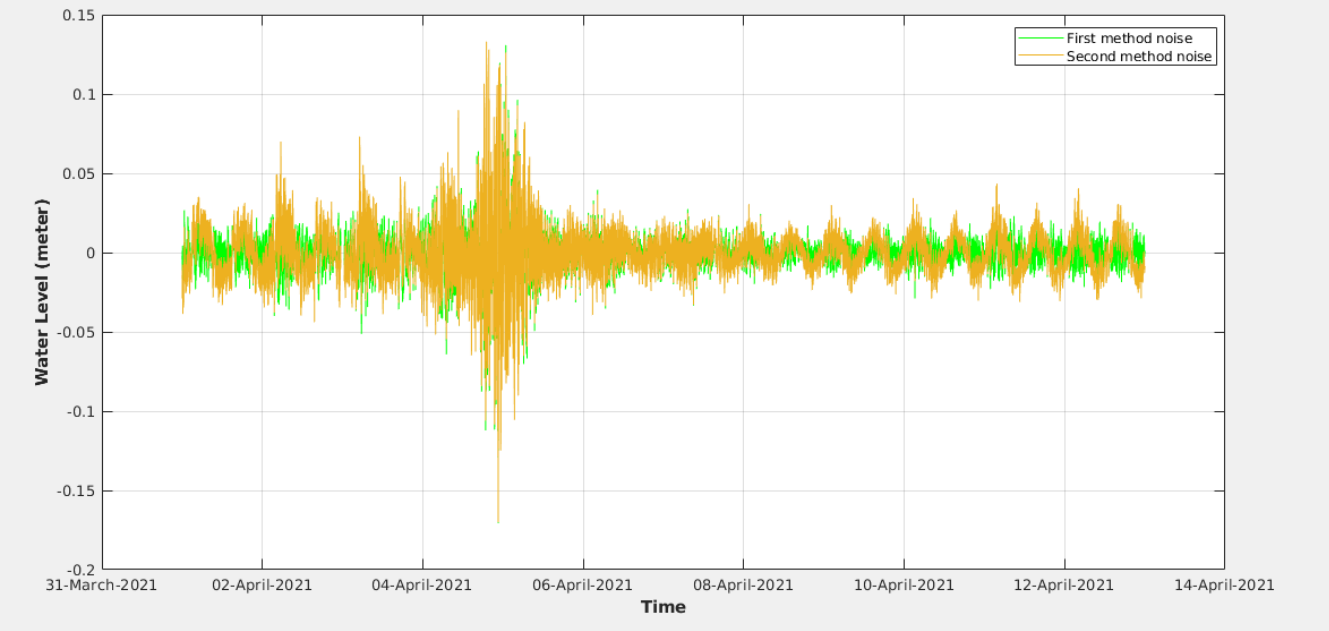
Big Deeper in Different Way

I think this is a promising result of moving average filter.

The moving average-filtered observed data eliminates low frequency elevation (tide) resulting in the noise.

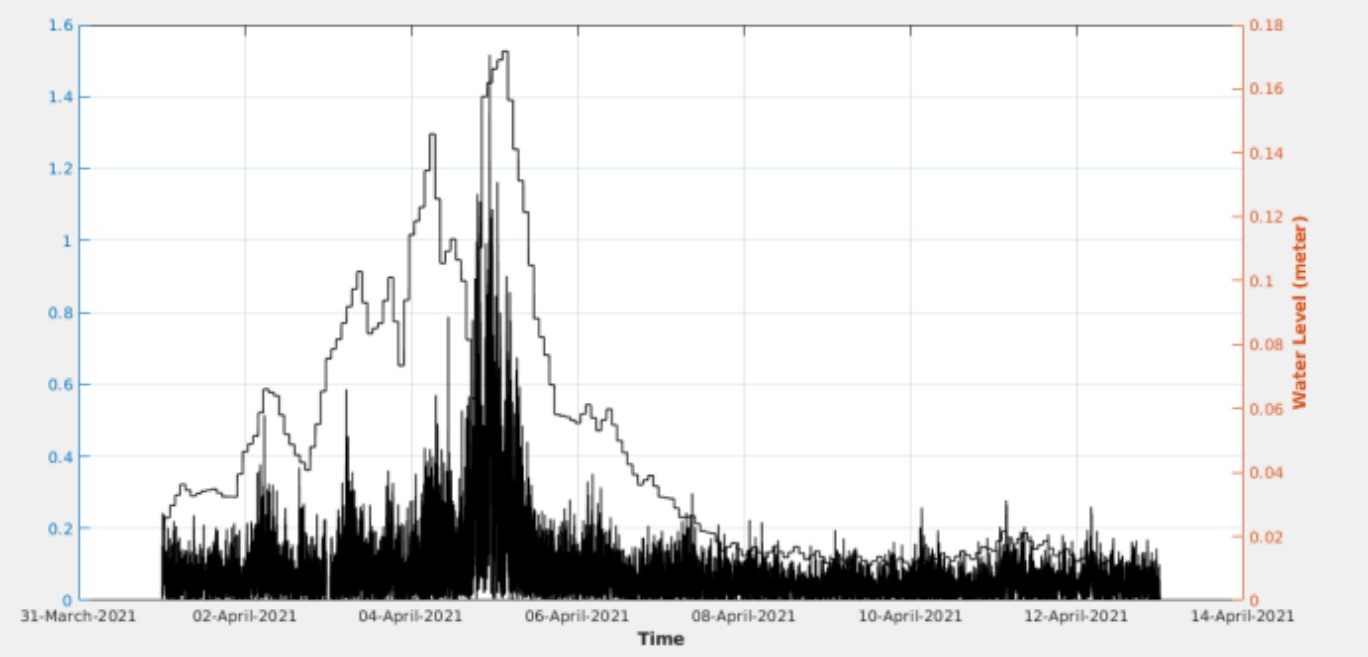


The Noises Comparison



The figure above shows a comparison of different method of gaining the noises from the sea level observation to extract information about the sea state or wave condition during the extreme event i.e. STC Seroja in Nusa Tenggara Timur, in the early of April. The first noise elimination method shows better promising filtering method to extract the noise from water level observation.

The Noises Comparison



I think this is a promising result of moving average filter. The figure above shows comparison between InaWave hindcast wave data with the results of noise, almost at the exact coordinate. There is huge gap of wave height between the left and right, but it is due to the location of the tide observation station in the closed harbour.

Conclusions

- Further data processing is necessary on the noises to represent the sea state conditions
- The record of incoming and outgoing ships/vessels is important to eliminate the ship/vessel wakes
- Further wave propagation models are necessary to gain the picture of how wave propagates from the open ocean or sea into closed basin and harbour
- Increasing the observation resolution may improve the information and gain more noises to extract sea state (wave) information

References

Madsen, K. S., J. L. Høyer, W. Fu, and C. Donlon (2015), Blending of satellite and tide gauge sea level observations and its assimilation in a storm surge model of the North Sea and Baltic Sea, J. Geophys. Res. Oceans, 120, 6405–6418, doi:10.1002/2015JC011070.

Pascual, A., M. Marcos, and D. Gomis (2008), Comparing the sea level response to pressure and wind forcing of two barotropic models: Validation with tide gauge and altimetry data, J. Geophys. Res., 113, C07011, doi:10.1029/2007JC004459.

Pawlowicz, R., Beardsley, B., & Lentz, S. (2002). Classical tidal harmonic analysis including error estimates in MATLAB using T_TIDE. Computers & Geosciences, 28(8), 929-937.