International Journal of New Technology and Research (IJNTR)
ISSN:2454-4116, Volume-3, Issue-10, October 2017 Pages 01-03

Determination of the Potential of Meteotsunami in the West Coast of Sri Lanka

K.W. Indika, M. Ranagalage, E.M.S.Wijerathne, S.S.L. Hettiarachchi

***Abstract*— Meteotsunami are tsunami-like waves of meteorological origin than of seismic origin. This study is done as the first determination of Meteotsunami around the Sri Lankan coast. Sea level data were used from permanent tide gauge stations establish Colombo, Trincomalee, Kirinda interconnected to the global sea level monitoring network establish by the inter-governmental oceanographic commission. Using high frequency readings, specific events were identified and further analyzed to remove tidal constituents and to obtain residual sea level variations. Residual sea level height was fast filtered and high frequency detected to identify Tsunami waves as same as seismic tsunami waves. The atmospheric pressure gradient was 1008-1011milibar hours while the wind speed increase from 14.21 to 31.90 mph in during same period. The amplitude of isolated meteotsunami event was higher than four time of residual's STD (σ). Meteotsunami event was identified during low tide with wave height > 0.3 m.**

***Index Terms*— Meteotsunami, Tsunami, Atmospheric, Resonance, Sea level.**

I. Introduction

Meteotsunami is one of ocean based natural disaster similar to seismic tsunami waves. These waves are destructive, long shallow, surface wave [1]. Meteotsunami waves are originated due to sudden variation of meteorological conditions in the sea. The migrations of inter-tropical convergence zone, equatorial planetary waves that propagate in all directions, within atmosphere and oceans, interaction of these waves with land mass (e.g. maritime continent) and ocean boundaries, and air-sea interactions associated with such disturbances [10]. Main meteorological factor for Meteotsunami is moving pressure disturbances in atmosphere while seismic tsunami waves are generate due to earth quacks [2]. Meteotsunami are much less energetic than seismic tsunamis while seismic tsunamis can have globally destructive effects [3].

The Oscillation covers the amplitude range of water level from a few 10 cm to a few meters, and the period from a few minutes to a couple of hours. Bothe amplitude and the period are highly variable depending on the geometry of the water body and the triggering mechanisms [4]. Meteorological disturbances such as squalls, tornadoes, thunderstorms, frontal passages and atmospheric gravity waves are other causes to produce these longer-period surface waves either locally or remotely with main forcing propagation mechanisms are an abrupt change in sea surface atmospheric pressure and associated wind gusts [5]. Typically a sharp pressure jump in atmosphere with a 1 hPa during a few minutes of period followed by a series of wave [6]. Redar image analysis indicated Meteotsunami were associated primarily with convective storm structures, with a considerable contribution from frontal storms as well [7].

Usually Meteotsunami waves are not much higher than Seismic tsunami waves. The wave length of Meteotsunami is greater than depth [3]. Meteorological tsunamis are propagating shallow water waves which exhibit many similarities to seismic tsunamis but are generated by a moving atmospheric disturbance [8]. They have similar wave periods, same spatial scales, and similar physical properties and affect the coast in a comparably destructive way. Developing up to catastrophic meteo-tsunami wave is normally observed only in a limited member of specific bays and inlets [8]. Those waves are consisted geospatial and temporal properties [9]. The meteorological tsunamis wave generate by a moving atmospheric pressure disturbance (jump).The main three courses are meteorological disturbances, resonance effect between the speed of the meteorological disturbances and deep water wave speed and amplifying quality of harbors, bay or inlets.

There are a few characteristics of harbors and bays that will lead to amplification of Meteotsunami waves. "Bottle-like" bays exhibit a quick change in bottom elevation. In "V-shaped" harbours, waves are funnelled in towards shore and energy density increases. When the "Q - Factor" >> 1, waves are amplified. The Q-factor is defined as follows. $Q \sim L/l$, L is harbor length, l is harbors width. The objective this study determination of potential to occurring Meteotsunami in the west coast of the Sri Lanka. For the study computed sea level changers with disturb atmospheric system and variation of related meteorological parameters.

II. Material and Methods

Sea level data (in research quality) were obtained from Global Sea Level Observing System (GLOSS) conducted by the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) of the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC) This study done using the data collected by the national aquatic resources research appraised using tide gauge data gathered by the National Aquatic Recourses Research & Development Agency (NARA), Sri Lanka. The meteorological readings were used under the bilateral project conducted between university of Notre dame, United States and NARA. Further atmospheric readings were collected from the meteorological department of Sri Lanka. The abnormal sea level chenged observed during disterb wheather system.

K.W. Indika, National Aquatics Resources Research and Development Agency, Sri Lanka
M. Ranagalage, Rajarata University of Sri Lanka
E.M.S.Wijerathne, University of Western Austalia
S.S.L. Hettiarachchi, University of Moratuwa, Sri Lanaka

III. Results

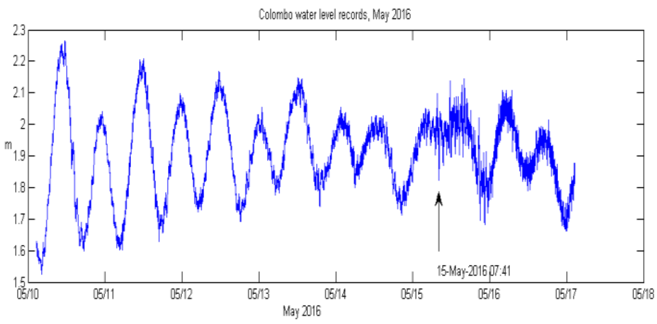

Figure 1: Initial of identification of Meteotsunami

Figure 1 shows the general occilation of water level including astronomical impact and meterological impact without removing any constituents.

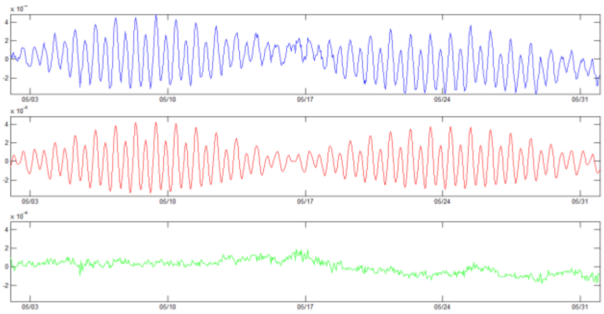

Figure 2: Time series of Colombo sea level record for May 2015, showing the filtering procedure used to isolate the Meteotsunami.

A) Blue- Observed water level time series.
B) Red - The Residual time series obtained, (Observed records-Tidal Component)
C) Green - The tidal component time series from the harmonic analysis

Time series of sea level record collected from sea level measuring stations and were used to filter and isolation of meteotsunami. The T_TIDE harmonic analysis function of time series analysis in MATLAB' software was used the tidal constituents.The time series of Colombo sea level record for 15th May 2016 showed isolated of the Meteotsunami after removing tidal component and filtering. Residual values were past filtered using MATHLAB function. After, those fast filtered values were fasts smoothed filtering function to identify Meteotsunami events.

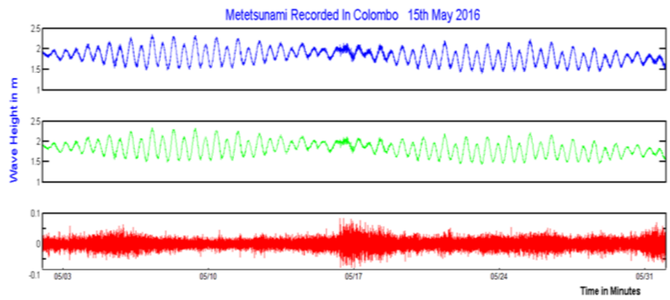

Figure 3: The filtering procedure to isolate the meteotsunami using time series of Colombo sea level record for May 2015, showing.

(A) Blue - The observed water level time series May 2016
(B) Green - Low pass filtered time series,
(C) Red - Time series with period < six hours to identify tsunami waves.

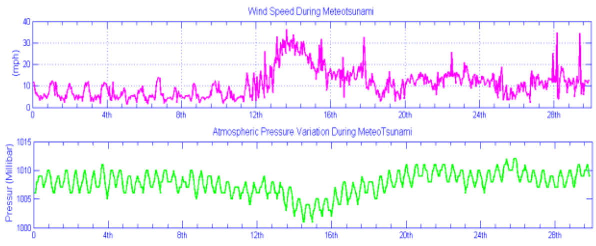

Figure 4: Time series of meteorological Observations

(A) Pink - line is time series of Wind Speed (upper)
(B) Green - line Atmospheric pressure (Lower)

Mererologycal observations was computed using automated meteorology station establish at Baruwala regional canter of NARA. Blue line shows the sudden increase of wind speed while the green line shows the pressure decrease.

IV. Discussion

This event recorded in 2016 May 15, during the low tide. The considerable maximum peak recorded at 07.41 UTC. The aptitude of the Meteotsunami wave is very low due to low tidal range. The identified event further analyzed to conform whether Meteotsunami or not by the several step of isolation using mathematical analysis. The moving pressure jump and strong wind in a same period were recorded during the abnormal sea level changing in the west coast of Sri Lanka. According to the initial investigation around the Sri Lankan costal tide gauge measurement was found small scale meteotsunami evens from the east coast. The observed result shows the potential of the occurrence meteotsunami events around the country with impact of global climate change. The amplitude of recorded Meteotsunami in east coast is low than west coast. The historical investigations were not recorded for the proper understand.in the Sri Lanka coast. The process of determination of metetsunami is very difficult and specific. The identification this events depend on the high frequency coastal hydrological observation and atmospheric observations. Further these studies required to extend to determination the relationship with synoptic scale events in the northern Indian region.

V. Conclusion

The recorded maximum amplitude of Meteotsunami was >35 cm. The event was recorded in the permanent tide measuring station in Colombo, Sri Lanka during the low tide period. The recorded meteotsunami event was occurred during disturbed climate system in the Bay of Bengal (BOB). The atmospheric pressure gradient was 7 mbar (1000 to 1003 milibar) while the wind speed was (35 mph) 03 mph to 38 mph (miles per hours) during 6 hours of time interval. The wind direction also changed in 3500 degree in North during the same period with the property of disturbs atmospheric system. The scientifically unclassified event which gave destructive experience to the fisheries community during the disturbed weather system must be Meteotsunami.

References

[1]. Pattiaratchi, C. B, Wijeratne E.M.S. (2014). Manuscript for Natural Hazards, Observations of meteorological tsunamis along the south-west Australian coast.

[2]. Pattiaratchi C. B, and. Wijeratne, E. M. S. (2015) Are Meteotsunami an underrated hazard?, 1,2, School of Civil, Environmental and Mining Engineering, The UWA, Oceans

[3]. Monserrat, S., Vilibi, C, and Rabinovich A. B., (2006). Meteotsunamis: atmosphere-ically induced destructive ocean waves in the tsunami frequency band.

[4]. Vilibić, I, Sepic, J., Rabinovich, A. (2016). Modern Approaches in Meteotsunami Research and Early Warning, DOI: 0.3389/fmars.2016.00057

[5]. Huang, N.E., Shih, H.H., Shen, Z, Long, S.R. L. Fan, K.L. (1999). The age of large amplitude coastal Seiches on the Caribiean Coast of Puero Rico.

[6]. Monserrat, S., Vilibi, I, Rabinovich, A. B. (2006). Meteotsunamis: atmospherically induced destructive ocean waves in the tsunami frequency band. Natural Hazards and Earth System Science, Copernicus Publications on behalf of the European Geosciences Union, 2006, 6 (6), pp.1035- 1051.

[7]. Ilona Nudelman, I., Roger K. Smith, R.K. and Reeder. M.J, (2010). Climatology of pressure jumps around the Gulf of Carpentaria. Australian Meteorological and Oceanographic Journal, 60, 91-101

[8]. Bechle1, A.J., Kristovich, D.A.R. and Wu, C.H., (2015) Meteo-tsunami occur-ences and causes in Lake Michigan

[9]. Vilibicl, I, Sepicl, J, Rabinovich, A.B. and Monserrat, S (2016). Modern approaches in Meteotsunami reaserach and early warning. Frontiersin Marine Scinces, https://doi.org/10.3389/fmars.2016.00057

[10]. Branscombe, A. (2014). Sea Level Spike can harm beaches worse than hurricane, Nat. Hazards Earth Syst. Sci., 6, 1035–1051, doi: 10.5194/nhess-6-1035-2006.

[11]. Fernando, H. (2006). Intraseasonal Dynamics of Equatorial Atmosphere and Oceans. Retrieved on 2017.09.06 from http://www.safl.umn.edu/tba-27