TSUNAMI HAZARDS: ASSESSMENT OF EXPOSURE OF SRI LANKA – CASE STUDY IN UNAWATUNA, SRI LANKA

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A series of ocean waves with exceptionally long wavelengths resulting from an impulsive disturbance that displaces water is defined as a Tsunami. These catastrophic waves can be a result of volcanic eruptions, landslides, the explosion of cosmic objects, and most prominently, seafloor earthquakes. In recent history, the Indian Ocean Tsunami event of December 2004 invoked colossal destruction in coastal regions of Sri Lanka where nearly 35000 lives were lost. This demonstrated not only the vulnerability of people, infrastructure, processes, commodities, information, and services, but also the need for an early warning system to limit the number of fatalities and injuries caused by tsunamis in coastal regions of Sri Lanka.

Generally, far-field tsunami waves provide a time window of a few hours through which, the authorities could gain clearance to issue early warnings and start evacuation protocols before waves strike the coastline in case of a tsunami event. Therefore, an accurate projection of the exposure can highly benefit the process of incorporating this lag-time effectively to issue early warnings. Galle district suffered with the second highest deaths from 2004 Tsunami and Unawatuna has a significantly high population density (1200/sq.km) along with extensive tourist attraction throught the year. However, recent research has not specifically focussed Unawatuna coastaline, except for the general studies done along whole the Southern coast. Hence, this research outlines the exposure assessment for the southern coastline in Unawatuna, Sri Lanka extending from Watering Point (Bonawistawa) up to Dalawella.

Community Modelling Interface for Tsunamis (ComMIT) model was utilized for the modelling of tsunami waves with moment magnitude (Mw) of 7.6 -9.3, originating along the Sunda arc near Indonesia and Makran fault off the coast of Pakistan. Bathymetry data retrieved from DEM Global Mosaic dataset that was developed by National Centres for Environmental Information (NCEI) was utilised for developing the model. The developed model was run for 2004 December Tsunami event and the results showed significant similarity to both historical event modelling and existing observation data. Hence, model was then run for the identified tsunami generation scenarios to obtain maximum wave heights at 50m depth.

The maximum wave heights at 1m depth in 4 selected locations were calculated, combining the model run results and the Green's Law to identify the tsunami exposure levels of the coastal stretch. It was revealed by the study that the coastline between Bonawistawa and Dalawella is severely exposed to tsunamis generated by earthquakes of 9.2 Mw and 9.3 Mw. It was also revealed that the coastline is highly exposed at Bonawistawa and Dalawella while moderately exposed at Yaddehimulla and Unawatuna Central, to earthquakes of 9.1 Mw. There is negligible exposure to for magnitude 8.4 along the shore, and none for magnitudes 8.2 or lower. This hierarchy of exposure will be key in the planning of evacuation and early warning systems.

Keywords: Tsunamis; Inundation modelling; ComMIT; Early warning; Numerical modelling

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Target Area

Coastline from Watering Point (6° 1.044' N , 80° 14.114' E) to Dalawella (6° 0.166' N, 80° 15.447' E)

Earthquake Magnitudes

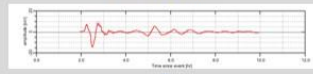
7.6	7.8	8.0	8.2	8.4	8.6
8.8	9.0	9.1	9.2	9.3	

Observation locations

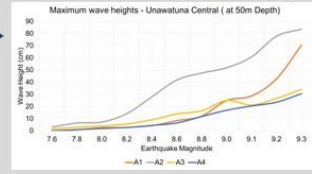
Bonawistawa	Yaddehimulla
Unawatuna Central	Dalawella

- Segmentation of unit sources
- Fault parameter calculation
- Forming unit source combinations
- Bathymetry data extraction
- Numerical Model run with ComMIT
- Model Validation

Model Results

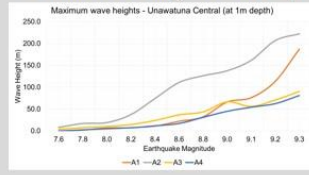


Maximum Wave heights at 50m Depth



Wave transformation (Green's Law)

Maximum Wave heights at 1m Depth



Maximum Wave Height at 1m depth (cm)	Exposure Level	Damage Expected
0-50	None	None
50-100	Low	Very Small damage
100-200	Medium	Coastal and Ship damages
>200	High	Damage and Loss of life

Exposure Assessment

Earthquake Magnitude	Location			
	Bonawistawa - Watering Point	Yaddehimulla	Unawatuna Central	Dalawella
7.6	None	None	None	None
7.8	None	None	None	None
8.0	None	None	None	None
8.2	None	None	None	None
8.4	Low	Low	Low	Low
8.6	Medium	Medium	Medium	Medium
8.8	Medium	Medium	Medium	Medium
9.0	Medium	Medium	Medium	Medium
9.1	High	Medium	Medium	High
9.2	High	High	High	High
9.3	High	High	High	High

Conclusion

- Overall high exposure from magnitudes of 9.2 and 9.3
- Highest wave – Yaddehimulla (2.46m)
- Highest exposure through A2 zone in Sunda Trench

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