

Evaluation of Bathymetric Changes due to Tsunami at Kirinda Harbor, Sri Lanka

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Introduction: Kirinda fisher harbor is located in southern coast of Sri Lanka. Since 1985 when it was constructed, it has the problem of keeping the harbor entrance open due to the unusual sediment transport pattern. Several studies were carried out to identify this scenario at Kirinda fishery harbor and some modifications also were introduced. Extending of the Main Break Water (BW), introducing secondary BW at the north side and a groyne at southern side were the major modifications which had done to reduce the sand intrusion into the harbor. Unfortunately these solutions were also not enough to solve this sedimentation problem. Up to 2004 tsunami event, the siltation problem at the mouth was remained same. Once tsunami waves hit the Kirinda coast, there was a remarkable bathymetric change in the harbor area including the washout of sediment at the harbor entrance. However, the currently siltation problem at the harbor mouth is back to the same situation as before the tsunami (Figure 1).



Figure 1: Kirinda fishery harbor-2009(Google Earth)

Aim and Objectives: The aim of the research is to evaluate the bathymetric changes due to tsunami, and its recovery process with the action of normal wind waves at Kirinda fishery harbor.

Methodology: Four bathymetric data sets (2004Nov, 2005Feb, 2005Nov and 2006Feb) obtained from JICA were imported to the ArcGIS software and digital database were created for each bathymetry with the 2.5m rectangular grids' resolution. Significant changes were clearly observed and four different transects (Figure 2) were selected in order to identify the changes in more detail in the harbor area. Furthermore, transformed wave data from three past wave recoding locations (Galle, Hambantota and Kudawella) to Kirinda 15m depth (Gunaratne et al., 2010) were analyzed and used for this study to elucidate the variation of the bathymetry.

Review of the bathymetric changes: 2004Nov bathymetry reveals that the complete blockage of the harbor mouth due to the siltation and huge sand accumulation along the BW-A (main) as well as between the BW-B and BW-C. However, by 2005 February, harbor entrance was totally eroded and some accumulation could

be seen in north of the BW-C (Goto et al., in press). The 2005Nov bathymetry shows the redeveloping of the siltation at the mouth, while eroding the accumulated sand above the BW-C (Goto et al., in press). Finally, all the activities of harbor were disturbed by 2006 February, as the result of completely close of harbor mouth.

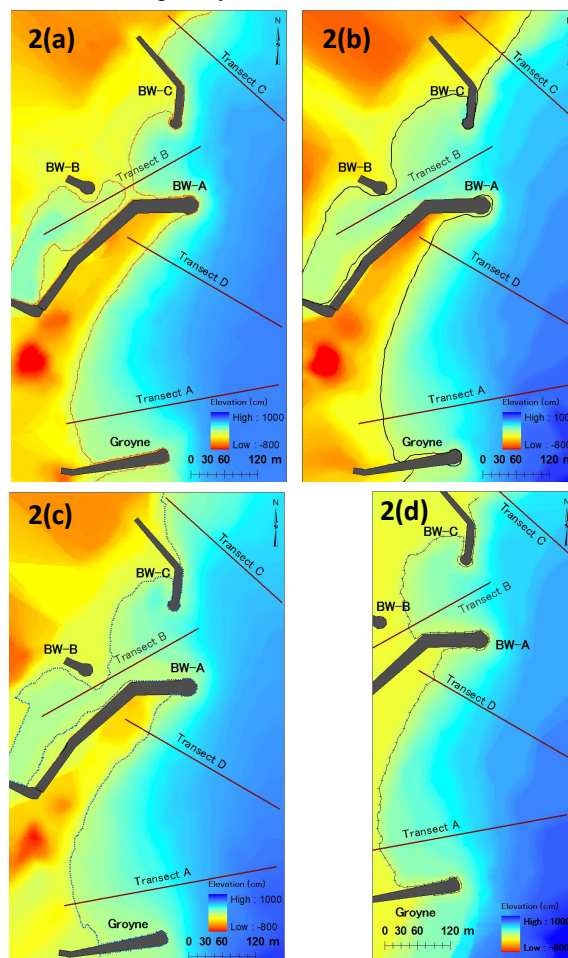


Figure 2: Bathymetry Data (2a: 2004Nov, 2b: 2005Feb, 2c: 2005Nov and 2d: 2006Feb)

External forces affect to the changes: It is a well-known fact that the tsunami has done remarkable change in Kirinda bathymetry by hitting the coast. The maximum tsunami wave height at Kirinda was about 9 m (Goto et al., in press). Other than the period of 2004Nov-2005Feb, main causes for the bathymetry change is the effect of wind waves in Kirinda. In the months of May-September south west monsoon waves are the most significant, whilst north east monsoon waves are dominant in December-February. Table 1 shows the wave statistics with the average significant wave height (H_s), peak wave period (T_p), and dominant wave direction (DWD) in four seasons of South West (SW), North East (NE), and Inter Monsoon (IM) 1 (March-April) and 2 (October-November) at Kirinda at 15 m depth. The wave statistics reveal that, all

over the year, swell wave direction is remaining the same value of 185°N; only the sea wave direction is changed with the seasons (Table 1).

Table 1: Wave Statistics at Kirinda 15m Depth

SEASON	SEA			SWELL		
	Hs/(m)	Tp/(s)	DWD/(°N)	Hs/(m)	Tp/(s)	DWD/(°N)
SW	1.00	4.91	235	1.30	12.45	185
IM1	0.69	5.58	115	1.00	11.75	185
NE	0.68	5.07	120	0.68	11.97	185
IM2	0.67	5.73	175	0.94	12.15	185

Discussion: The 2004 tsunami was able to wash the sand deposition at the harbor mouth as well as the sand which was along the BW-A. Furthermore, it could be seen that high deposition near the BW-C (Figure 3a), while some deposition in nearshore area as well (Goto et al., in press). During the south west monsoon season, nearshore bathymetry (4m to 7m below mean sea level) was getting somewhat deeper, indicating the significant erosion near the BW-C. However, the surrounding area at the harbor entrance was swallowed in the same period. There could be some influence by inter monsoon as well, since this period is covered March- November (Figure 2b). In NE monsoon period (Figure 3c), bathymetry change became as an opposite of that in SW monsoon in 2005 (Figure 3b).

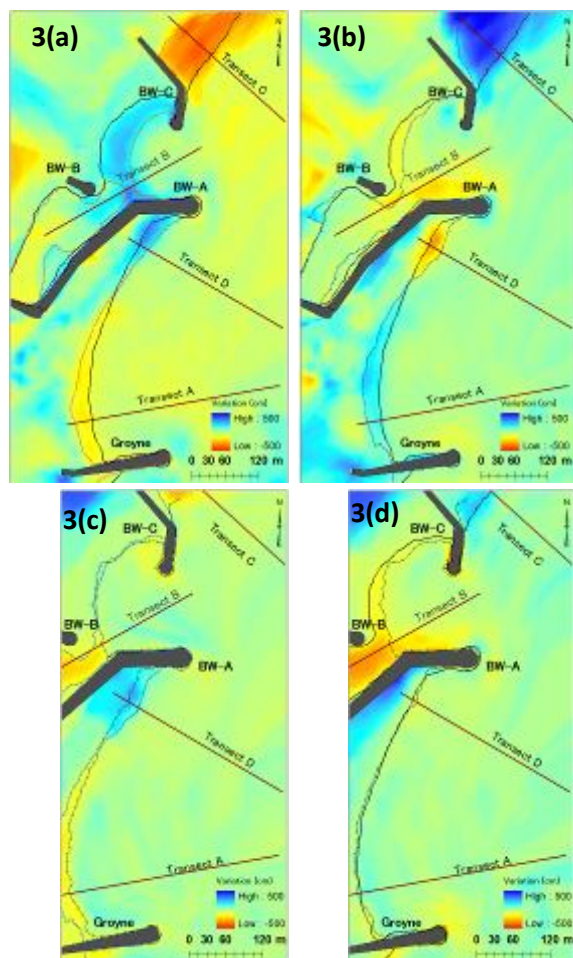


Figure 3: Bathymetry variation (3a: 2004Nov-2005Feb, 3b: 2005Feb-2005Nov, 3c: 2005Nov-2006Feb and 3d: 2005Feb-2006Feb)

However, in the harbor month still could be seen the increase of the sand deposition (Figure 3c). Influence of the normal waves is indicated by Figure 3d which shows the changes from 2005Feb-2006Feb. One year after 2005Feb, shore line back to the same position in between BW-A and the groyne. During this one year period, net deposition has occurred in the harbor whereas net erosion has occurred near the BW-C and, along the BW-A.

Conclusion: Tsunami has changed the Kirinda existing bathymetry instantly by eroding the harbor entrance and depositing the sediments in the harbor as well as the nearshore area. North sides of the BW-C and the groyne were eroded by south west monsoon waves while north east monsoon has created the accretion in the same area. Siltation at the harbor entrance has occurred in all over the year in more or less amount due to the normal wind waves. At the southern part of the harbor, shore lines were coincided in 2005 February and 2006 February, even though the shoreline has under gone some variation during the monsoon periods (Figure 3d). Normal wind waves were unable to recover the pre-tsunami condition even more than one year after the tsunami in some locations in nearshore area (Figure 4).

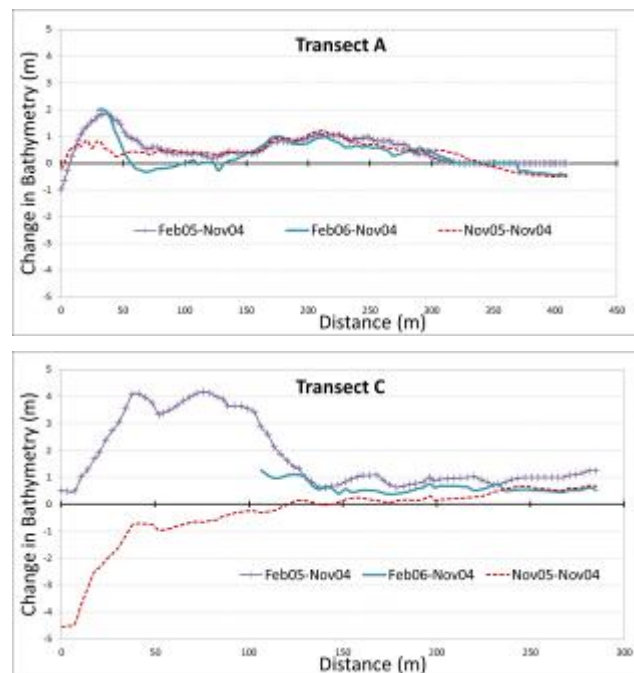


Figure 4: Variation along Transect A and C at 2 months, 1 year and 1 $\frac{1}{4}$ years after the tsunami

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References:

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