INUNDATION LIMITS OF THE 2011 TOHOKU-OKI TSUNAMI AND INLAND LIMITS OF THE TSUNAMI DEPOSITS

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We investigated the preservation and disappearance of tsunami deposits that formed by in the 2011 Tohoku-Oki tsunami along the Misawa coast, Aomori Prefecture, northern Japan. The 2011 tsunami height at the coast was 5 to 10 m above the mean sea level and the inundation distance is 200-500m.

Nakamura et al. (2012) observed inland limits of both tsunami inundation and tsunami deposits distribution at 13 profiles along the Misawa coast in April 2011, less than one month after the tsunami. They also described the thickness, facies, and structure of the sandy tsunami deposits. In September 2016, we revisited all the sites studied by Nakamura et al. (2012) and found that the deposits were still preserved at 68 sites (50% of all sites). The deposits were well preserved especially in the undamaged coastal forest, where the deposits have been covered with newly developed soil after the tsunami and their thicknesses are not changed significantly. Meanwhile, at the seaside forest where the trees were knocked over or heavily damaged by the tsunami, they were removed during the reconstruction process and new planting has started, and there the 2011 tsunami deposits have disappeared. At most of the sites near the inundation limit within residential areas, the deposits were undetectable in 2016, because of human activity and weathering by rain and wind. Weathering has progressed even in the process of deposits being buried by new soil formation.

We examined 13 profiles, and each profile is 230 to 550 m long and has 3 to 22 excavation sites (in total 137). Our results are summarized in Fig. 1. We found preservation state of the tsunami deposit increased from the coast to the forest and suddenly decreased in the residential area. This is because of reconstruction near the coast and high preservation potential in the forest. Note that more than half of thin deposits (less than 2 cm) were detectable in 2016.

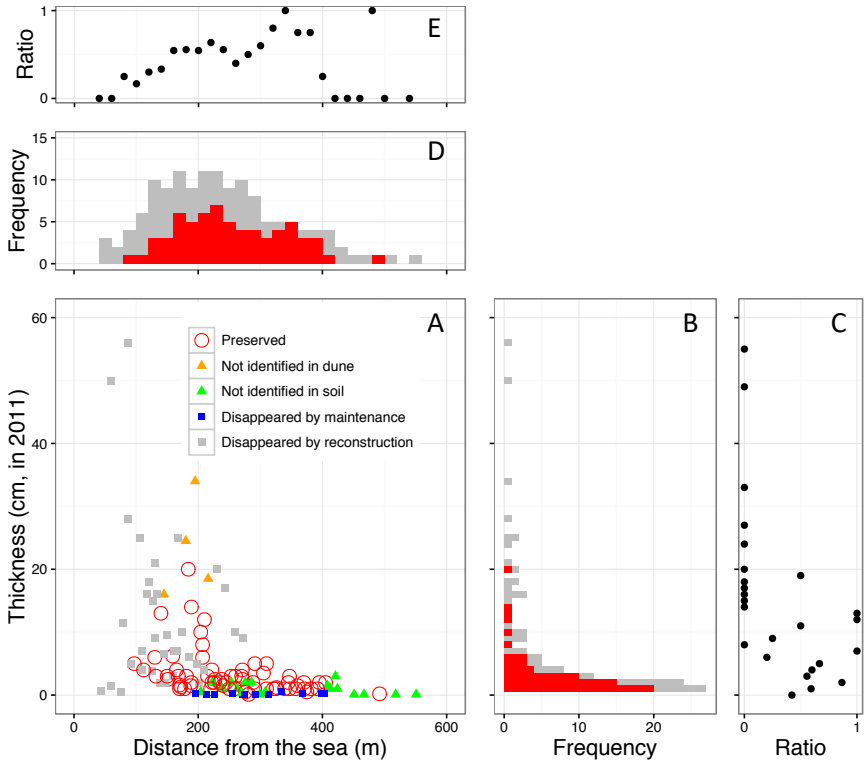

Fig. 1. Preservation and disappearance of the deposits as related to their original thickness and distance from the sea that as obtained in 2011 by Nakamura et al., 2012 (A). In histograms (B & D), gray bars are for all counts and reds are for those preserved. Preservation state is also shown (C & E). The vertical axis is the ratio to the all of the preserved.

In 2011, Nakamura et al. (2012) traced the tsunami deposits up to the tsunami inundation limits for 4 profiles of the 13 profiles. However, in 2016, the deposits near the boundary for these 4 profiles were not detectable even though 3 of them were in the forest and not expected to have been disturbed by human activity. It may be because the thin and fine deposits were blown away by wind while on the ground surface

or scattered in the soil during plants growth. Of the other 9 profiles, there were only 3 of them for which we could trace the deposits in 2016 up to the 2011 boundary. Fig. 2 shows inundation limits of the tsunami, deposition limits in 2011 and those in 2016 for each profile. On average, the inland limit for tracing the deposits reduced 15% in distance (Fig. 2-A) and 23% in height (Fig. 2-B). This information could be useful for evaluating tsunami inundation based on deposit distribution for historical or prehistorical events.

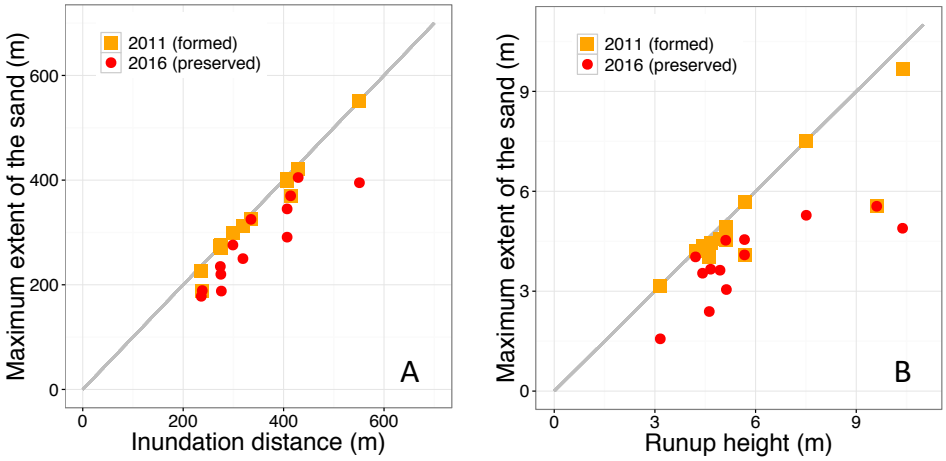

Fig. 2. Inundation limits of the 2011 tsunami, inland limits of the deposit distribution observed in 2011(■) and those in 2016 (●) for each profile. A is for the inundation distance and B is for the runup height.

Inland thinning and inland fining are thought to be common trends in sandy tsunami deposit. They are observed in both formed and preserved tsunami deposits in Misawa (Fig. 3). For the deposit along the Sunamori profile, the mean grain size of the deposits tend to decrease with the distance from the sea, but relatively coarse sand were found near the tsunami inundation limit. On the other hand, this feature was not observed along the Hosoya profile, where the deposits along the inland half of the profile were disappeared.

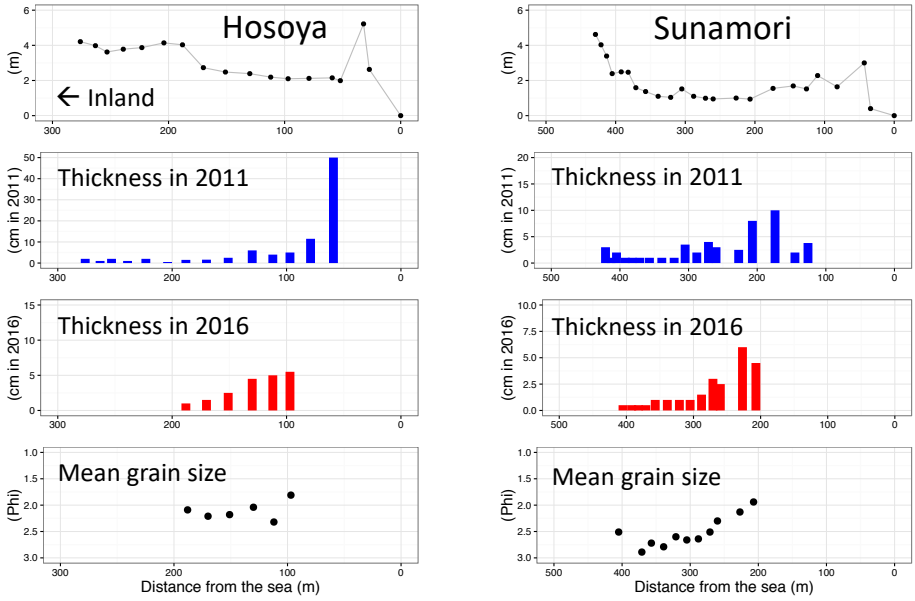

Fig. 3. Topography from the beach to the 2011 tsunami inundation limit, thickness of the tsunami deposit in 2011, those in 2016 and mean grain size of the deposit for two profiles Hosoya (left) and Sunamori (right). Intend thinning and inland fining trends are clearly observed by the remaining tsunami deposits.

References

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