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# TRACES OF THE TOHOKU REGION GREAT TSUNAMI BEHIND A COASTAL FOREST

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In the coastal area of Miyagi prefecture, pine trees have been planted to form a coastal forest since ancient times. Because this coastal forest demonstrated a barrier effect against the 1960 Chile Tsunami, afforestation has been promoted as a component of tsunami disaster prevention measures. However, due to the Tohoku Regional Pacific Offshore Tsunami that occurred in 2011, most of these trees were uprooted and swept away. This study uses aerial photographs taken immediately after the earthquake disaster to clarify the characteristic distribution of pine trees which became driftwood by GIS analysis and estimate the run up characteristics of the tsunami.

***Key Words :*** *tsunami, Tohoku Region Tsunami, coastal forest, driftwood, pine tree, tsunami run up*

## 1. INTRODUCTION

The coastal forest was expected to have a barrier effect against a tsunami. In fact, it has been reported that coastal forests in Miyagi prefecture of Japan acted effectively against tsunamis that occurred in the past. [1)] Conversely, it was indicated that if the height of the tsunami exceeds 8 m, the disaster prevention effect of the coastal forest will be lost. The 3.11-Tohoku region great tsunami that occurred in 2011 exceeded 5 m in the coastal area of the Sendai Plain, located in Miyagi prefecture, and most of the coastal forests that existed on the coast were knocked down or drifted after being uprooted.

In this study, based on the aerial photographs taken immediately after the tsunami by Google Earth, the distribution characteristics of pine trees scattered on land were clarified by GIS analysis, and the run up characteristics of the tsunami were estimated.

## 2. ANALYTICAL RESULTS AND DISCUSSIONS

Figure 1 shows the location of the coastal area of Sendai City, Miyagi prefecture, as the field of analysis (all of the aerial photographs used in this study are based on Google Earth). Figure 2 shows the tsunami inundated area (within the area indicated by the red solid line). Photo 1 shows a comparison of the coastal forest zone before and after the tsunami disaster. Most of the coastal forests expected to have a certain degree of barrier effect against the tsunami were swept away as seen in the photographs. The positions of the root of the outflowed pine trees and the axial directions of the tree trunks were read from the aerial photographs using GIS. An example of the analysis is shown in Photo 2 (right).

Photo 2 (left) is the state of driftwood that was taken directly at the site. The total number judged and read utilizing driftwood characteristics of pine trees swept away by the tsunami from the aerial photographs in the field reached 21,054. Their distribution is shown in Figure 3.

In Figure 3, the area is divided into 100 m square lattices and the number of driftwood in each lattice is displayed as the number density. The number density is color coded in six stages as shown in the figure legend.

The vectors in the figure show the averages of the direction of scattered pine trees within each lattice, and only the direction, not size, of the vector has meaning. Although the number density shows an overall complicated distribution, the high density zones are distributed in streaks behind the land side where width of the forest was comparatively wide previous to the tsunami (the positions indicated by ① and ③).

It is judged that the axial directions of the pine trees are roughly along the directions of the streaks and the strength of the flow accompanying the tsunami was distributed in the coastal direction. In the figure, the right side (whitish part) of the region noted by ② shows the place where a densely populated area of the housing exists, and the streaks of the high density area are surrounded around and extend to behind the wake field of the area.

Distribution along the river exceeds a 5 km distance from the coastline to inland direction. In addition, in the area between the river and ①, the vector rotates as a whole, indicating the formation mark of the circulation flow.

## 3. CONCLUSIONS

Based on the aerial photographs released by Google Earth, GIS analysis of the distribution of pine trees swept away by the 3.11-tsunami revealed that the total number of driftwood reached 21,054. The distribution shows some streaked high density areas behind both the vegetation zone with large width and the downstream of the housing density area before the tsunami. Reflecting the distribution of number density, the flow strengths accompanying the run-up tsunami were distributed along the coastal line. Driftwood due to tsunami propagation along the river ranged to 5 km inland from the coastal line.

## REFERENCES

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**Figure 1** Location of the study area.

**Photo 1** State of the coastal forest before and after the tsunami.

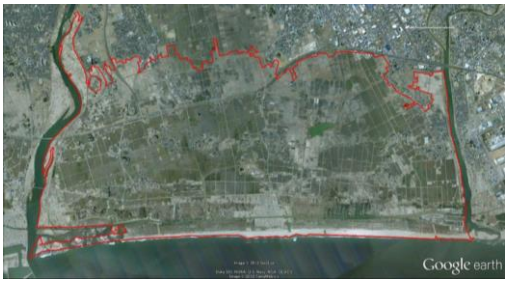


**Figure 2** Inundation area of the tsunami.

**Photo 2** A driftwood, and vectors showing the directions of the trees swept away by the tsunami.

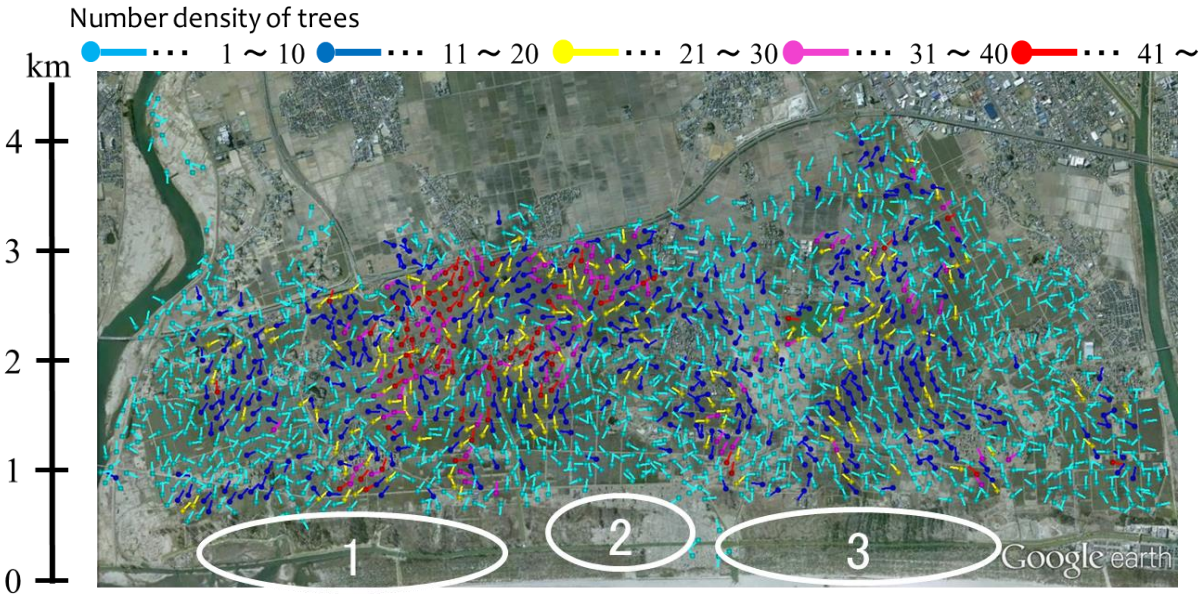


**Figure 3** Distribution of the number densities and the vectors averaged in each 100 m lattice. The direction of the vector shows the averaged axial direction of trunk of the trees.