Study identifies coastal black pine trees resistant to tsunamis and strong winds

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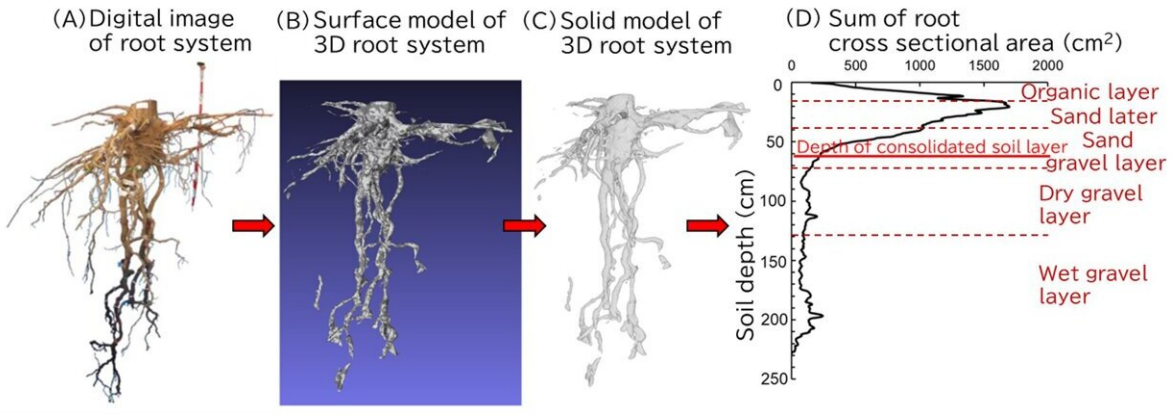
Pinus thunbergii trees planted in coastal forests in Japan are very resistant to tsunamis and strong winds because of their strong roots growing straight down and deep. Credit: Yasuhiro Hirano

Researchers in Japan have found that the taller the Japanese black pine trees (Pinus thunbergii) along the coast, the deeper their roots go into the ground. Trees with deeper roots are more resistant to damage from tsunamis and strong winds. Their findings suggest that the resilience of coastal P. thunbergii trees may be improved by inducing deep root growth, specifically in short trees. The study was published in the *Journal of Forest Research*.

Many P. thunbergii trees have been planted in coastal forests in Japan because they are salt-tolerant and can grow in sandy soils lacking nutrients. P. thunbergii trees are very resistant to tsunamis, strong winds, and blowing sand because their strong roots grow straight down and deep. Such trees should offer protection to houses and fields from natural disasters.

During the Great East Japan Earthquake in 2011, P. thunbergii trees along the coast played an important role in suppressing wave forces and debris carried by tsunamis. However, several P. thunbergii trees with roots that did not grow deep enough were severely damaged and washed away.

"If we can estimate how deep the roots of the trees have grown without digging them up, we can easily understand which trees are less resistant to disasters," said Professor Yasuhiro Hirano of Nagoya University, the first author of the study. "So, our team tried to clarify whether the characteristics of the above-ground parts of P. thunbergii trees and the characteristics of the soil around them help to estimate their maximum root depth."



The surface model (B) and the solid model (C) of the 3D root system created from digital images (A) allow for the sum of the root cross-sectional area (D). Credit: Yasuhiro Hirano

The research team of Hirano, Associate Professor Toko Tanikawa, and their colleagues first dug up the roots of P. thunbergii trees on the coast of Aichi Prefecture, Japan, to measure the maximum depth of the roots and analyze the characteristics of the above-ground part of the trees and the soil around them.

To study the root system structures, 700 digital photographs of each tree, from all angles, were taken on-site right after excavation, eliminating the need to transport samples to the lab.

In the laboratory, the researchers analyzed the relationship between the maximum depth of roots measured in the field and the characteristics of the above-ground part of the trees and the soil around them. They found that as P. thunbergii trees grew taller, their roots grew deeper. This relationship was also consistent with the results of previous studies on 43 P. thunbergii trees harvested in Japan.

The researchers also created three-dimensional structures of the root system based on the digital photographs they took in the field. "We created not only surface models but also solid models of the root system, which allowed us to continuously estimate the sum of the root cross-sectional area at any depth in the depth direction," Hirano said.

Their findings suggest that shorter P. thunbergii trees are more likely to fall because their roots have not grown deep enough to hold them up in strong winds or extremely large waves.

"A high water table near the coast and hard soil are thought to prevent roots from growing deep," Hirano said. "So, if, for example, we help improve drainage for the high groundwater or soften the soil specifically at short P. thunbergii trees, we may improve the disaster mitigation capacity of P. thunbergii coastal forests."

More information: Yasuhiro Hirano et al, Intraspecific variation in root system structure in a Pinus thunbergii stand grown in a gravelly spit coast, *Journal of Forest Research* (2024). DOI: 10.1080/13416979.2024.2431756

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