tsunamis than previously believed. The method produces a reliable estimate of the destructive potential of a tsunami within minutes — typically, well before the tsunami reaches coastal areas.

The viability of the method was demonstrated in computational tests in which the method yielded accurate representations of three historical tsunamis for which well-documented ground-motion measurements were available. Development of a global tsunami-warning system utilizing an expanded network of coastal GPS stations was under consideration at the time of reporting the information for this article.

This work was done by Y. Tony Song of Caltech for NASA's Jet Propulsion Laboratory.

The software used in this innovation is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45940.

Stream Flow Prediction by Remote Sensing and Genetic Programming

A genetic programming model assimilates SAR images and geoenvironmental parameters to assess soil moisture at the watershed scale.

Stennis Space Center, Mississippi

A genetic programming (GP)-based, nonlinear modeling structure relates soil moisture with synthetic-aperture-radar (SAR) images to present representative soil moisture estimates at the watershed scale. Surface soil moisture measurement is difficult to obtain over a large area due to a variety of soil permeability values and soil textures. Point measurements can be used on a small-scale area, but it is impossible to acquire such information effectively in large-scale watersheds. This model exhibits the capacity to assimilate SAR images and relevant geoenvironmental parameters to measure soil moisture.

In the past, spaceborne radar imaging satellites used all-weather observation, but estimation methods of soil moisture based on active or passive satellite images remains uncertain. Estimation of soil moisture based on SAR measurement was made possible by developing linear regression models and nonlinear regression models in a single land use/land cover from several hundred square meters to several square kilometers, based on traditional statistical regression theory. This GP-based artificial intelligence mode uses an evolutionary computational approach to estimate soil moisture with a variety of land use/land cover patterns.

The function derived in the evolutionary computation links a series of crucial topographical and geographical features including slope, aspect, vegetation cover, and soil permeability with well-calibrated SAR data. Research findings indicate that this development and application of the GP model has proved useful for generating a highly nonlinear structure in regression regimes, which exhibit strong statistical correlations between the model estimates and the ground truth measurements (volumetric water content), based on unseen datasets.

Using this model, science missions would be capable of handling large-scale moisture estimation using spaceborne satellite images, and could generate multi-temporal soil moisture maps over seasons. The GP-model is ultimately extensible and interoperable for any river basin of interest, though the impact of landscape complexity needs to be studied further.

This work was done by Ni-Bin Chang of Texas A&M University for Stennis Space Center.

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