Inverse modeling of Tsunami deposit using Deep Learning Neural Network

*Rimali Mitra[1], Hajime Naruse[1]

1. Kyoto University, Graduate School of Science

Tsunami is one of the most catastrophic disasters along coastal zones, and tsunami deposits are layers of sediment formed by hydrodynamic activities of tsunami. These event deposits provide clues to estimate the recurrence intervals and relative magnitude of prehistoric tsunamis that serve as a tool for future tsunami hazard evaluation. Towards the quantitative assessment of hydraulic conditions of tsunamis from deposits, this study applies the inverse model using deep learning neural network (DNN) for tsunami deposit. In order to conduct machine learning of DNN, forward model calculation was repeated at random initial flow conditions (e.g. maximum inundation height, flow velocity, concentration, etc.) to produce artificial training data sets which represent depositional characteristics such as thickness and grain-size distribution. The model serves as the modified version of previously proposed FITTNUSS model, which incorporates nonuniform and unsteady transport of suspended sediment and also turbulent mixing. Then, DNN was trained for establishing the inverse model on the basis of artificial data sets. SGD (Stochastic gradient descent) is used as an optimizer for this DNN model. Tests using artificial data sets successfully indicated that the established DNN can reconstruct the original flow conditions from the characteristics of deposits. Finally, the model was applied to natural data sets taken from the 2011 Tohoku-Oki Tsunami deposit. The deep learning neural network showed promising result for natural data sets. Comparing to existing inverse models, deep learning neural network enables the inversion to employ a forward model that requires higher computational costs, and to avoid a local optimum. The further applicability and validation of this method will be checked with other parameters, and natural data set from different field visits in future endeavour.

Keywords: Tsunami Deposits, Inverse Modeling, Machine Learning

