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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Reconstruction of flow conditions from 2004 Indian Ocean tsunami deposits at the Phra Thong island using a deep neural network inverse model" *by* Rimali Mitra et al.

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Dear authors, thanks for the opportunity to review your work on Reconstruction of flow conditions from 2004 Indian Ocean tsunami deposits at the Phra Thong island using a deep neural network inverse model.

I deeply appreciated your effort and I consider that this manuscript has potential to be accepted for publication at NHESS after some major revisions. I detailed them on over 100 comments on the annotated version attached.

I find the aim of the manuscript really interesting and at the forefront of tsunami geoscience. To couple forward and inverse modelling to reconstruct tsunami flow characteristics is essential for the scientific community to be able to provide accurate reconstructions of past events that can be passed to coastal planners and civil protection authorities to better plan adaptation, mitigation and emergency plans.

The numerical modelling you applied has recently proved to be reliable (Mitra e al., 2020, JGR). Therefore, I was expecting some major steps forward in this study case instead of just another small incremental exercise. The Science is there but English must be revised extensively and above all there must be a clear clarification on how and what exactly field data was used to validate the model. I believe you used Fujino et al. (2010) data but sometimes when reading the manuscript one feels puzzled to confirm that you did use it and which values have you used it. For instance, thickness, grain-size curve, etc. Therefore, I cannot agree with the title proposed because it was not well-establish that the regressive model used geological data. Sometimes the reader feels, the models fed and validated each other and no solid, extensive and accurate field data was used. I assumed that this might just be a language and writing problem. Even if it is that, you need to address it. Sometimes the text is confusing and one wonders what you trying to transmit. For example, when you state the model was validated by "observed" flow depths in several locations along the studied profile...in fact, you are saying that the model agrees well with previous modelling exercises for flow depth establishment. The meaning of both sentences in totally different regarding field validation and this is crucial for this manuscript.

There are many other aspects I raised on the annotated version and I suggest you analyse them critically. I might have misunderstood some wording (which means that you need to make it clear) or I might have perceived things correctly (which means you need to change the structure and scope of the manuscript). One example, is sediment concentration. How can you validate flow sediment concentration from the deposit? Only if you look at grain-size curve, spatial distribution and packing (inner

architectural arrangement) of the deposit. You never mention this along the manuscript which means that I am puzzled how you reconstruct sediment concentration on the inverse model. It is easy to understand how you do it with the forward model but departing from sediments (without mentioning the characteristics above) is baffling.

Having said this, the manuscript has lots of potential and after a detailed revision might be accepted for publication on NHESS. I acknowledge the authors effort and hope they take my comments constructively. I believe most of my comments here and especially on the annotated version will improve your manuscript. Kind regards Pedro JM Costa

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Reconstruction of flow conditions from 2004 Indian Ocean tsunami deposits at the Phra Thong island using a deep neural network inverse model

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Abstract. The 2004 Indian Ocean tsunami caused major topographic changes that resulted in significant economic losses and a large number of fatalities in the coastal areas. The estimation of tsunami flow conditions using inverse models has become a fundamental aspect of disaster mitigation and management. Here, in relation to the 2004 Indian Ocean tsunami, a case study involving the Phra Thong island in Thailand was conducted using inverse modeling that incorporates a deep neural network (DNN). The inverse analysis reconstructed the values of flow conditions such as maximum inundation length, flow velocity and maximum flow depth, sediment concentration from the post-tsunami survey around Phra Thong island. The quantification of uncertainty was also reported using the jackknife method. Using other models applied to areas in and around Phra Thong island, the predicted flow conditions were compared with the reported observed values and simulated results. The estimated depositional characteristics such as volume per unit area and grain-size distribution, were in line with the measured values from the field survey. These qualitative and quantitative comparisons demonstrated that the DNN inverse model is a potential tool for estimating the characteristics of modern tsunamis.

1 Introduction

On December 26, 2004, a Mw 9.1 earthquake triggered a devastating tsunami that affected the coastal areas and cities adjacent to the Indian Ocean, which resulted in extensive socio-economic damage and numerous fatalities in several countries including Thailand, Indonesia, Srilanka, India, Myanmar (Rossetto et al., 2007; Satake et al., 2006; Sinadinovski, 2006; Philibosian et al., 2017; Satake, 2014; Pari et al., 2008). In Thailand, 8300 people lost their lives, with 70 lives and a village of households were lost on the Phra Thong island in Phang-Nga province (Satake et al., 2006; Masaya et al., 2019). The total damage was estimated to amount to around USD 508 million, which equates to 2.2% of GDP which while the number of deaths was 4225, with the injured and missing cases and the cost reconstructing properties much lower than the overall damage value (Jayasuriya and McCawley, 2010; Suppasri et al., 2012).

An awareness of tsunami disaster prevention is the most essential criterion to reduce socioeconomic losses suffered by countries lying along the coastlines, such as Thailand, Japan, Indonesia, India and Srilanka etc (Lin et al., 2012). However, it

Fig. 1.