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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "A comparison of a two-dimensional depth averaged flow model and a three-dimensional RANS model for predicting tsunami inundation and fluid forces" *by* Xinsheng Qin et al.

Anonymous Referee #1

Received and published: 27 June 2018

Summary of the Manuscript:

The authors present comparisons of simulations for tsunami inundation that incorporate the built environment of a physical model of Seaside, Oregon. The comparison has been made between a two-dimensional depth-integrated model namely GeoClaw and a three-dimensional model called OpenFOAM. Initially, the models were validated through a dam break experiment that compared the water level, velocity profile and forces on a single square column by a bore. Without the column, the OpenFOAM model was able to reproduce the water level fairly accurately whereas GeoClaw slightly over-

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estimates the initial bore height followed by an underestimation as the bore progresses. Moreover, the vertical velocity profile captured by OpenFOAM was predicted well except at the bottom whereas the GeoClaw only gives constant velocity over depth which was determined to be overpredicted. With the column included OpenFOAM model captured well horizontal forces on a square column whereas the drag coefficient had to be decreased from 2.0 to 1.76 for the force prediction to match the measurement closely.

According to the authors, simulating tsunami inundation for a physical model of Seaside, Oregon which incorporated the built environment using the two models had their challenges especially in the case of the 3D model OpenFOAM. OpenFOAM is shown to be very computer intensive compared with GeoClaw. Both models were able to predict the flow well compared with the experimental model, however, OpenFOAM provided more details of the flow especially near the impact. Thus, according to the authors, the three-dimensional model solves this challenge better than the two dimensional one. The 2D model however, underestimates the forces as the model underestimates the flow velocity in the complex flow.

Overall Assessment:

Overall, I think the study makes a beneficial contribution in understanding the flow characteristics and forces acting in a complex constructed environment through the use of two and three dimensional models. The conclusion of the study can assist civil engineers in improving upon the designing of coastal structures in tsunami inundation zones as the 3D model gives a better representation of the forces. I would like to recommend this manuscript provided the author addresses the following comments.

Comments:

Page 1 - 5: I would suggest if the Introduction can be tailored to a broader audience and be more concise in terms of purpose, application and scope of the paper. Most of the existing introduction can then go under a section on Previous Work. Also the authors

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could include examples (in possibly a separate section) of existing coastal structures in tsunami inundation areas that have utilised 2D or 3D modelling studies to determine forces on structures. You might want to cite:

Ingraffea, Nathan & Libby, Mark, 2015. Design of a Tsunami Vertical Evacuation Refuge Structure in Westport, Washington. Structures Congress 2015, pp.1530–1537.

González, Frank, Randy LeVeque, and Loyce Adams. "Tsunami Hazard Assessment of the Ocosta School Site in Westport, WA." (2013).

Page 1, Line 10: The line should read, “However, it is not clear whether these equations . . .”

Page 3, Line 24: Has not the increased computing power affected both tsunami runup process and wave impact on an individual structure.

Page 8, Line 17: space after i,

Page 9, Line 33-34: the line should read, “. . ., causing the measurement to oscillate dramatically.”

Page 13, Line 13: the momentum flux in equation 20 is in parenthesis so replace denominator by parenthesis

Page 15, Line 1: delete in the experiment. The sentence already makes it clear that the sampling rate is for the experiment.

Page 15, Line 7: Define CSZ here i.e. Cascadia Subduction Zone.

Page 28 - 30: The conclusion may be strengthened by suggestions for the practitioner as to when might it be useful to utilise three-dimensional model studies rather than two dimensional studies in designing coastal structures within tsunami inundation areas and whether the increased computational power is really necessary or not. This point may be connected to looking back on what may have been done differently when determining forces to design for example the Tsunami Vertical Evacuation Refuge Structure

in Westport.

Figure 3. Add legend, remove grid, add one label for time and velocity along x and y axis respectively so you can then remove Abscissa: time (s) a. Ordinates: velocity (m/s) from the caption.

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