Nat. Hazards Earth Syst. Sci. Discuss., 3, C1814–C1817, 2015
www.nat-hazards-earth-syst-sci-discuss.net/3/C1814/2015/

Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Tsunami hazard potential for the equatorial southwestern Pacific atolls of Tokelau from scenario-based simulations" *by* A. R. Orpin et al.

A. R. Orpin et al.

alan.orpin@niwa.co.nz

Received and published: 25 September 2015

We welcome the insightful feedback from Anonymous Referee #2. Together with the two previous iterations of review comments, they make a meaningful contribution to the improvement of our manuscript. A number of important points are raised, to which we offer the following responses:

a) The potential for ambiguity between a risk and hazard assessment is a valid point, in particular since a true risk analysis was not undertaken or inferred. Where appropriate, we will provide more correct reference to a tsunami hazard assessment in the final

manuscript.

b) Maximum Wave Height (Hmax) refers to the elevation above a specified zero level (MSL or MHWS). The equivalent of wave amplitude is implied and is consistent with our treatment of other indicators of tsunami flooding, presented in the manuscript explicitly or as part of other calculations, such as runup or Hin. To reduce any ambiguity, the term "maximum wave amplitude" will be added when Hmax is first defined in the text. Some confusion is also possible because of the terminology used in Figure 4, which will be revised for the final manuscript.

c) Relevant model outputs to inform a civil advisory are addressed (in part) in Figures 7 and 9. These figures show the modelled maximum inundation distance (horizontal) and flood depth (vertically above land); effectively the form of the tsunami-wave on the emergent landmass. Many elements of our presentation of model outputs are consistent with the approaches developed for other tsunami studies (e.g. Tinti et al., 2011). The specificity of each case study requires tailor-made representations of results that best address the nature of the tsunami hazard. Similarly, our under-riding objective was to simplify the model outputs to highlight which parts of the atolls are likely to remain dry under a series of plausible scenarios. The areas of greatest interest on each atoll are the villages.

d) Flow depths and velocities would indeed be worthy additions to a future study that had the additional advantage of incorporating (yet to be acquired) high resolution topographic and bathymetric data. We note that the impacts for Tokelau using the flow depths outlined by Tinti et al. (2011, Figure 17 and Table 6) would likely be no flooding (and no damage) or only slight flooding, as the villages are not inundated in our scenarios. Hence, the addition of flow-related model outputs could be premature and unwarranted at this stage. However, should an analysis of selected seawalls and gabions – primarily erected to mitigate the regular threat of storm surges – be considered to assess their long term engineering integrity, tsunami flow velocities might add usefully to a more holistic analysis. For this to advance new and more accurate topographic maps would be needed.

e) The tsunami generation modelling in Gerris Flow Solver is discussed at length in Popinet et al. (2011, 2012), and the scenario-based tsunami hazard assessment employed in our study is also presented in the companion study by Lamarche et al. (NHESS, published online in April 2015).

f) Our key task was to explore, semi-quantitatively, whether tsunami posed a legitimate threat to Tokelau, and to identify those sources that presented the greatest potential hazard. Further detail and refinements around tsunami that did not present an immediate threat were not pursued further as they would not trigger an emergency response. To that end, the specific objective of linking a tsunami warning (Mw and earthquake-source location) and an estimated "safe" elevation above a specified tidal height is presented in Table 4. Implicit in the construction of Table 4, our civil advisory is, necessarily, simplistic and considers only five essential variables: (i) a great earthquake from Kuril; (ii) another distant great earthquake; (iii) a regional source; (iv) tidal height; and, (v) quadrant of the island. In short, what quadrants of the atoll remain dry, and those earthquake sources that present the greatest threat to that quadrant? A more detailed decision matrix or strategy was not requested by the Government of Tokelau, but should our study be repeated with new baseline data, a more complete decision matrix could be developed.

g) No surveyed vertical (tidal) datum exists for Tokelau, so our simulations at MSL and MHWS were created from assumed reference heights drawn from our interpretation of what limited geomorphological information exists. The lack of significant relief, simple form, small size and basic shoreline of the atolls proved to be advantageous in this regard. Additional simulations at presumed MHHS or MLLW elevations are unwarranted given these uncertainties. Furthermore, scenarios that were not "worst case" or potentially hazardous were of low relevance to the civil advisory as they are more likely to be a lesser threat that may not require an emergency response. Again, a future modelling effort could better explore a number of the nuances revealed in our provisional study.

h) The numerous specific editorial suggestions made by Anonymous Referee #2 are welcomed, many of which can be readily incorporated into the final version of the manuscript. We note that Figures 2, 3 and 10 do have legends, and our presentation style for the model outputs is consistent with earlier publications in NHESS by Popinet (2011, 2012). Whilst we have made significant efforts to improve the figures already through the manuscript review process, we acknowledge that different representations of our results could be of interest to the tsunami modelling community. Unfortunately, a more detailed set of model representations falls outside the scope and baseline data afforded by the present study.

We thank Anonymous Referee #2 for their interest, patience and insightful feedback.

References cited in this reply:

Lamarche, G., Popinet, S., Pelletier, B., Goff, J., Delaux, S., Mountjoy, J.J., and Bind, J.: Scenario-based numerical modelling and paleo-historic records of tsunami in Wallis and Futuna, Southwest Pacific, Nat. Hazards Earth Syst. Sci., 15, 1763–1784, 2015.

Popinet, S., Quadtree-adaptive tsunami modelling. Ocean Dynam. 61(9): 1261-1285, 2011.

Popinet, S., Adaptive modelling of long-distance wave propagation and fine-scale flooding during the Tohoku tsunami. Nat. Hazards Earth Syst. Sci. 12(4): 1213-1227, 2012.

Tinti, S., Tonini, R., Bressan, L., Armigliato, A., Gardi, A., Guillande, R., Valencia, N., and Scheer, S.: Handbook of tsunami hazard and damage scenarios: SCHEMA (Scenarios for Hazard-induced Emergencies Management), Project no. 030963, Specific Targeted Research Project, Space Priority, Joint Research Centre Scientific and Technical Reports. EUR 24691 EN, 2011, Luxembourg, 41 pp., ISBN 978-92-79-19062-9.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 4391, 2015.