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Generating tsunami risk knowledge at community level as a base for planning and implementation of risk reduction strategies

Stephanie Wegscheider (1), Joachim Post (1), Matthias Mück (1), Kai Zosseder (1), Abdul Muhari (2), Herryal Z. Anwar (3), Niklas Gebert (4), Günter Strunz (1), and Torsten Riedlinger (1)

(1) German Aerospace Center (DLR), Germany (stephanie.wegscheider@dlr.de), (2) Ministry of Marine Affairs (DKP), Indonesia, (3) Indonesian Institute of Sciences (LIPI), Indonesia, (4) United Nations University, Institute for Environment and Human Security (UNU-EHS), Germany

More than 4 million Indonesians live in tsunami-prone areas on the southern and western coasts of Sumatra, Java and Bali. Depending on the location of the tsunamigenic earthquake, in many cases the time to reach a tsunami-safe area is as short as 15 or 20 minutes. To increase the chances of a successful evacuation a comprehensive and thorough planning and preparation is necessary. For this purpose, detailed knowledge on potential hazard impact and safe areas, exposed elements such as people, critical facilities and lifelines, deficiencies in response capabilities and evacuation routes is crucial.

The major aims of this paper are (i) to assess and quantify people's response capabilities and (ii) to identify high risk areas which have a high need of action to improve the response capabilities and thus to reduce the risk.

The major factor influencing people's ability to evacuate successfully is the factor time. The estimated time of arrival of a tsunami at the coast which determines the overall available time for evacuation after triggering of a tsunami can be derived by analyzing modeled tsunami scenarios for a respective area. But in most cases, this available time frame is diminished by other time components including the time until natural or technical warning signs are received and the time until reaction follows a warning (understanding a warning and decision to take appropriate action). For the time to receive a warning we assume that the early warning centre is able to fulfil the Indonesian presidential decree to issue a warning within 5 minutes. Reaction time is difficult to quantify as here human intrinsic factors as educational level, believe, tsunami knowledge and experience play a role. Although we are aware of the great importance of this factor and the importance to minimize the reaction time, it is not considered in this paper.

Quantifying the needed evacuation time is based on a GIS approach. This approach is relatively simple and enables local authorities to implement it at low technical complexity and relatively low cost and time needs. Basic principle is to define the best evacuation route from a given point to the nearest safe area. Here the fastest path from that point to the shelter location has to be found. Thereby the impact of land cover, slope, population density, population age and gender distribution are taken into account as literature studies prove these factors as highly important. Knowing the fastest path and the distance to the nearest safe area together with a spatially distributed pattern of evacuation speed delivers the time needed from each location to a shelter.

A shelter location can either be a horizontal area or an evacuation building (vertical evacuation). For both kinds of evacuation target points, one limiting factor can be again time: are the people able to reach the target point within the available time? Especially for evacuation buildings, there is a second possibly limiting factor, namely capacity. In the majority of cases in all of the three study areas where this approach was applied to, capacity was the critical factor instead of time. Consequently, for planning purposes it is essential to know which area can be served by an evacuation building and which areas have to be assigned to a different evacuation target point due to exhausted capacity of the nearest one. The coverage of a building is also derived on basis of a GIS approach using the beforehand derived available and needed evacuation times and detailed population distribution data.

Evacuation time and derived evacuable areas are then used to identify high risk areas. In combination with detailed population distribution data, hazard probability and hazard intensity, it is possible to identify areas with high risk

and large deficiencies in response capabilities. Often enough, human response capabilities can be increased by thorough disaster planning and thus, the results of this paper provide valuable information for planning authorities to decrease the risk.

This paper presents results exemplarily for the study area Kuta, Bali where we tested this approach and where it is also in progress to be implemented by local authorities.