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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Application and prospect of high-resolution remote sensing and geo-information system in estimating earthquake casualties" *by* T. Feng et al.

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Overall quality of the discussion paper ("general comments"): This article aims at coming up with a new model to estimate earthquake-related human casualties primarily considering satellite imagery based assessment of building damage. Three past earthquake events are considered to evaluate feasibility and quality of the proposed model. Estimation results suggest an extremely high accuracy that, however, has not been fully retraceable for me in the course of this review. The introduction section in general gives a good entry point to the article, referring to prior related studies and setting it in a disaster context. However, basically the entire introduction focuses on the assessment of building characteristics (collapse) as main input for casualty estimations. In [7140,

line 29] there is brief reference to the importance of "knowing about survivor numbers in the scene". The introduction, however, fails to mention the essential aspect of knowing the spatial population distribution (population exposure) in the affected area and in particular at the time of the event! In particular occupancy information is considered crucial and in sophisticated models the need has been raised to integrate how many people are actually inside of a collapsing building. As references see e.g. Aubrecht et al. (2013) for an overview on spatial population exposure data; more specifically referring to the temporal aspect Porter et al. (2008) and Zuccaro & Cacace (2011) for info on integrating time-dependent occupancy information for EQ casualty assessment; as well as, referring to the high spatial resolution domain of the proposed study, Bhaduri et al. (2007) and Freire & Aubrecht (2012) for time-dependent high-res population distribution models that can serve as input. This criticism applies to the article in general, as the explained locational population factor is also basically ignored in the proposed model outlined in chapter 2 and illustrated in figure 1 (despite the obvious awareness of the importance of population aspects as described e.g. in 2.1.2) as well as in the 3 test applications for the Bam, Wenchuan, and Yushu EQs. Based on literature the paper decently refers to a way of classifying damage from high-res satellite imagery that is in its basics (but naturally less sophisticated) related to the field survey based EMS98 damage classification scheme. Overall, the building damage assessment presented in the paper is explained alright (not really novel though) and that way of assessment can indeed provide one important input for earthquake related casualty estimations in the post-event impact assessment phase. Without the actual population distribution and therefore exact exposure component, however, the presented method conceptually seems to fail to be comprehensive in the current setup. The assumption made in this study is that building occupancy is related to structural building characteristics ("the number of occupants has high correlation with the number of buildings"), the authors use relative class relations in that regard instead of object-related (to be in line with the building-level VHR damage analysis) geospatially allocated distribution and density values. This has so far not been supported in the literature as population-to-

building correlations are rather apparent with regard to the functional type of building (i.e. residential, commercial, industrial, etc.) and consequently with the time stamp, i.e. occupancy during day and night time. The setup of the additional adjustment factors is hard to follow in the current description. While the results suggest an almost perfect fit of the model, it is not really clear to me how the occupancy issue was solved. E.g., just stating that the (average) population density in that city is about 2 times larger than in some other towns seems a very crude assumption which surely cannot yield such accurate results on the local level. In fact, in the conclusion it is confirmed that "the casualty number was hard to estimate only by the damage grade of building. The attribution of damaged buildings and the distribution of occupants in affected areas were essential." Despite this statement, I haven't seen in the text that actual population distribution patterns were considered in the model. Without further explanation I cannot follow how it was eventually possible to estimate the numbers that accurately. Referenced literature: Aubrecht, C., D. Özceylan, K. Steinnocher, S. Freire (2013) Multi-level geospatial modeling of human exposure patterns and vulnerability indicators. Natural Hazards, 68(1), 147-163. Bhaduri, B., E. Bright, P. Coleman, M. Urban (2007) LandScan USA: a high-resolution geospatial and temporal modeling approach for population distribution and dynamics. GeoJournal, 69(1), 103-117. Freire, S. & C. Aubrecht (2012) Integrating population dynamics into mapping human exposure to seismic hazard. Natural Hazards and Earth System Sciences, 12(11), 3533-3543. Porter, K.A., K.S. Jaiswal, D.J. Wald, P.S. Earle, M. Hearne (2008) Fatality models for the U.S. Geological Survey's Prompt Assessment of Global Earthquakes for Response (PAGER) System. The 14th World Conference on Earthquake Engineering. Beijing, China, 8 pp. Zuccaro, G. & F. Cacace (2011) Seismic Casualty Evaluation: The Italian Model, an Application to the L'Aquila 2009 Event. In R. Spence, E. So, & C. Scawthorn, eds. Human Casualties in Earthquakes. Advances in Natural and Technological Hazards Research. Springer Netherlands, 171-184.

Individual scientific questions/issues ("specific comments"): Talking about the "prevention.. of earthquake" (7138, line 24) is scientifically not correct. The occurrence of an

earthquake cannot be prevented; just its impacts can be mitigated and minimized by proactive risk reduction and better coordinated response actions. Same statement is made again later on (7140, line 9). "Building damage is the main contributor to earthquake casualty except some countries, such as Japan" (7138, lines 25/26). What is the main contributor there then according to the authors? Considering state-of-the-art literature it is always supposed to be building collapse as number 1 contributor, at least in terms of the direct impact (i.e. not considering effects of cascading and chain events as well as indirect or secondary impacts such as fires, disease outbreaks, etc.). Please explain the statement. ". . . casualty estimation is the primary information to support the design of rescue plan" (7139, lines 11/12). I would say that this is not exactly true, at least not exclusively. Basically data derived from comprehensive 'risk' assessment is the primary information to support appropriate response actions. Casualty estimation is just one aspect of it (e.g. in addition to resource distribution planning, evacuation planning, etc.) and is also used as input for preventive action, e.g. structural retrofitting in modeled 'potential high casualty' areas in order to decrease buildings' structural vulnerability and consequently probability of collapse that leads to casualties. Regarding the workflow in figure 1: At this point in the text it is not yet clear why, if first the damage is assessed (DI) referring to a post-event situation, in a second step the buildings' material/structure is analyzed and integrated into the casualty "estimation". Later on it is described that different materials offer different survival chances, so the workflow does indeed make sense. Please add a sentence on that here already as otherwise a reader might be confused. In general the structural information can also be used to analyze structural vulnerabilities and therefore estimate collapse probabilities (very common procedure), i.e. thus not only including it after the actual damage assessment, but also beforehand may be beneficial. Also there is a bit of a contradiction regarding the 'casualty estimation' concept. I.e. earlier on in the introductory section the concept seems to refer to a pre-event situation assessment that then helps to support response actions. Now, in the model, actual post-event damage data is classified and implemented, so this is a different phase in disaster management. In fact, the first sentence

of 3.1 confirms that it is actually dealing with post-event analysis, so maybe that should just be clarified better at the beginning. Referring to a previous study, in section 2.1 it is referred to the number of people in a building and their potential escape speed and available evacuation time as well as to the 'usual number of people in a building' (there is no indication if e.g. on the latter data is available and has been integrated). Some of those parameters are seen in relation to the building structures, i.e. referring to the fact that better structures provide more time to react before potential collapse, but also that different structures collapse differently and potentially offer higher survival chances. A relationship is shown that sets buildings of different materials in relation to varying fatality numbers after collapse. The sub-chapter heading is a bit misleading as, despite indeed talking about building attributes, the main focus lies on the relation to fatality estimation and survival chances. It would be beneficial to rephrase the section heading.

Compact listing of purely technical corrections at the very end ("technical corrections": typing errors, etc.): Figure 1: In the text it is referred to 3 parts of the model when pointing to figure 1. This is not clearly reflected in the figure, please adapt. Figure 2: It may be better to refer to the x-axis as 'Rate of fatalities' as it is indeed about the actual death rate, independent of additional injuries as far as I understand from the text. Figure 3: Labels are very hard to read. There are a couple of typos throughout the text, please check and correct (e.g. Hati earthquak [Haiti earthquake]; in idea situation [in an ideal situation]; the high change of the pixel [height change], etc.). Despite not being badly written, a general check by a native English speaker would be preferable as in parts grammatical problems are apparent.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 1, 7137, 2013.