Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2018-234-RC1, 2018

Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Integrated risk assessment due to slope instabilities at the roadway network of Gipuzkoa, Basque Country" *by* O. Mavrouli et al.

Anonymous Referee #1

Received and published: 16 October 2018

The objective of this manuscript concerns the risk assessment characterizing a roadway network affected by different hazards in Spain. For this, a "hybrid" quali-quantitative method mainly expressed in monetary terms has been proposed (as a multiple of a cost unit amounting to 1,000 EUR). The failure probability is evaluated with reference to four types of geotechnical hazards (rockfalls, anchored wall failures, slow landslides, and sea wall failures), whereas the related risk level is based on an economic criterion expressed as the average annual repair cost, at the considered section. The annual final risk is given by the product of probability/frequency occurrences of events, in assigned magnitude classes, per the monetary value of the elements at risk.

Even though the work is interesting, there are some questions which I would like to highlight.

I don't understand why the Authors put together the rockfalls (natural hazard) with the failures of man-made structures such as anchored walls, road platforms and sea walls. It is clear that these failures can be caused by natural causes linked to the slope movements but, in such a case, I would have expected the analysis of failures of passive retaining structures (barriers, fences, etc.), due to rockfalls.

Another big concern is for using heuristic methods in order to calculate the annual P/F occurrence for addressing the lack of adequate data. It seems to me that sometimes they are based on not adequately justified or tested expert judgments. This is particularly true for rockfalls and slow landslides types, where these approaches are used in order to overcome the lack of complete rockfall and landslide catalogues. In this respect, the Authors extend the frequency/magnitude relationships, calculated for sites with adequate data, to slopes with similar geostructural characteristics, scars, heights and block sizes (see on page 9, line 14).

With reference to rockfalls, the scoring assignment for the frequency index (IF) calculation involves five frequency indicators both qualitatively and quantitatively defined. In my opinion, this is a hybrid approach linking qualitative terms to quantitative data. With reference to the Differential Erosion indicator please, clarify what is the used figure for the score 2 (No, Yes, and...?) Then, the scores are summed up to calculate IF (see eq. 2), and a relationship between IF and the rockfall frequency, for enabling the assessment of thresholds, has been established. For this purpose, a calibration has been performed. I thought it would be interesting if the Authors would speak to us the calibration procedure and results.

Also with reference to the correction factors (Fr) assigned to different protection measures (see Table 6 – please, check the correct numbering of all tables and figures; the figure 4 is several times duplicated!), it seems to me that this was done to ensure too

high safety standards. I understand that, lacking in literature adequate tested values, the Authors adopted precautionary data but (e.g. see the tunnel case) assuming a range of values between 4 and 2, for magnitude classes A-D it seems to me too high!

Similar considerations must be done for the failure of retaining structures, where the HI factor is only based on subjective evaluations and expert judgments. Hybrid data (qualitative and quantitative in nature) is also reported in Table 7. What means sound rock or mixture? For instance, is it adequate the use of the Schmidt hammer or pocket penetrometer for their characterization? As the Authors are a well-known team working in the field of the hazard and risk assessment, I think that they must be very wary of suggesting not well-tested approaches because they have big authority in this very poorly explored research field.

Concerning the slow movements affecting the roads, might the slight/moderate damage on the road be due to shallow subsidence of the subgrade? (as it appears to me by some photos). Since the inclinometers are very often affected by installation problem, or malfunctioning causing lack of data have you been performing a reliability analysis?

For the failure of sea walls, I think that in an oversimplified way the procedure for the PIP index calculation is evaluated. As it is well know, the undercutting by waves is very important in causing the sea-cliff retreat or wall failure (mainly for toppling). Waves erode the cliff toe, undercutting and over steepening it. This destabilizes the overlying slope, causing it to collapse. Also with reference to the sea walls, the main failure mechanism is linked to erosion by waves. Consequently, the main factors affecting this failure process are the real dynamic pressure exerted by the water at the wall toe, the mechanical strength of concretes and design characteristics. As these quantities are very difficult to assess, generally the research approach uses aerial or satellite photos, topographic survey comparisons, LIDAR techniques, etc. Also the on-shore wave characteristics and meteorological observations in time and space are needed. With reference to eq. 7, and according to my opinion, the protection mass index (Mp) already should incorporate the correction factor (Fc) for the protection structure. What

do you think? I suggest that you remove this hazard from the text.

In conclusion, the suggested approach must be considered as a first attempt that cannot be extended to areas with different geotechnical and geomechanical characteristics, respect to the studied ones. The study confirms that a reliable quantitative risk analysis involving man-made structures can be performed using reliable and numerous data only. Otherwise and for wide areas, only heuristic approaches based on expert judgments can be used. But the question we have to ask is whether it is worth using complex procedures which incorporate not yet well-tested ratings.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2018-234, 2018.