

# ***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 #3**

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Title: Integrated risk assessment due to slope instabilities at the roadway network of Gipuzkoa, Basque Country

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## **General comments**

The paper presents a model of evaluation of multirisk in selected points of the route network of the roadway network of Gipuzkoa, Basque Country. The model tries to quantify risks in four scenarios pertaining to about 100 already detected point of risk. The trans-

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formation of the inhomogeneous and scarce data in a quantitative score is made up with criteria driven by the judgement and on the basis of the historical available data about instability on the roadway network. So the model is a heuristic one, currently not yet validate. The paper is well articulated and developed, but generates some perplexity. Specific comments First of all, the referee #3 agree with all the specific comments on the submitted paper from referees #1 and 2. One main concern is about the use of the velocity concept in several part of the text and particularly in the section about the low landslides. Although velocity is widely adopted in many landslide classification systems, it is well known (from Physics) that in a force system the velocity of a rigid body mass is not representative of its equilibrium or disequilibrium state, which is demanded to the first derivative or gradient of the velocity vs time. About the classification and risk management of the “slow landslides”, the main references to this kind of landslide are the monthly slope deformation (periodically measured in inclinometers) and the one year cumulate displacements. So the Authors indirectly and correctly use the terms that contribute to the velocity vs time gradient (the acceleration). Some points are not clear or instill some doubts: We start with the consideration that number and position of the available instruments in each site are well positioned and representative of the deformative field of the whole landslide body; are the deformation readings in the inclinometers constantly and regularly (which is the frequency) performed? Do the deformations of the inclinometer allow durability of the measures? Bigger movements are usually at the head, but do we analyze the correct one phenomenology, i.e. a shallow instead of a most dangerous and deeper incoming failure? Finally: measurements normally refer to a pre-peak failure stage: the post peak behaviour with the typical range of strength reduction (and then the hazard magnitude) is strongly controlled by the dominant lithology, which has been missed throughout the decisional points of the whole proposed model. Lithology and soil plasticity are common factors in many heuristic hazard models. Similar consideration should be extended to short term vs long term groundwater variations.

The model has been applied to a system spatially extended for about 10.000 sq kilo-

metres and developing several hundreds of kilometres (see fig.1), whose health and wellness rely on a limited number of instrumentations and on periodical inspections; it is characterized by several geological frames and by a well-developed surface hydrography. The local control apparatus is aged about 16 years and does not allow real time measurements in spite of its expensiveness. In other words, the monitoring system installed and which is the main source of data on which the proposed model works can be considered somewhat obsolete. Today the large areas can be controlled by means of active or passive PS INSAR techniques (measurement return time about 6 days); inclinometers can be flanked by optical or capacitive TDR and other kind of devices able of continuous and real-time response.

While the meticulous and complete care in the model deserves great appreciation, some perplexities already expressed, together with the considerations about the repeatability of the scenarios, significantly limit the usefulness of the model in future scenarios.

#### Technical corrections

In fig.6, Patterns of movement for landslides responsive and not responsive to rainfall, nowhere is reported a numerical scale (also indicative) of time.

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