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Interactive comment on "Prediction of rainfall induced landslide movements by artificial neural networks" *by* Janko Logar et al.

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Similarly to the first two reviewers the 3rd reviewer recognizes the relevance of the presented work and gives some useful comments. Here is our response:

The introduction with literature review will be shortened and references that are not in close connection with the topic of the paper will be omitted. We will try to make figure captions more instructive. The flow chart of the proposed methodology will be added to the paper. We will also provide an objective measure for the quality of predicted landslide movements.

The scope of the paper is:

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- to confirm that ANN can be used as decision support tool to assist authorities such as civil protection in difficult decisions on evacuation or road closure due to expected landslide movements when heavy rainfall is expected. This was demonstrated on two landslide case histories of very different nature (fast moving earthflow and very slow landslide). It was shown that expected landslide movements can be predicted by ANN if a long enough history of measured displacements and rainfall as a triggering factor is available.

- to encourage the research community in the field of application of artificial intelligence to the landslide phenomena, not to focus only on the selection of new and better ANN algorithms but also to organize the input data for training and testing ANNs in different ways.

The literature review has shown that a significant amount of research is devoted to the use of different types of artificial neural networks for the prediction of landslide movements. We have tried to model the movements of Macesnik landslide also by using radial basis function neural network with good success. Nevertheless, we wanted to show that the presentation of input-output data to ANN may be equally or even more important than the selection of the type of ANN. In this way we had worked with many different input-output data sets for both landslides until we found the presented input-output configuration for each case history. They were different for each of presented cases as stated in the paper.

The reviewer suggests to compare our results with the results of other existing methods. There are some methods (see e.g. B. Thiebes et al, 2014, LS-Rapid code by K. Sassa et al, 2010) but they all need a good ground model, which in most cases of rainfall induced landslides doesn't exist. This is precisely the scope of our research: many landslides are monitored by geodetic methods and for rainfall induced landslides the precipitations are also normally available. The measured landslide movements are consequences of all ground data, morphology, rainfall and other factors. Taking

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into account that ground conditions don't change much with time, rainfall and displacements are the only interdependent variables. ANN's are able to establish the missing functional relation.

It is true that the movements are different in different sections of the Macesnik earthflow. This is the consequence of different cross-sectional areas in each specific section. Width and depth of cross-section varies along the earthflow while the continuity of masses must be preserved. Therefore, the rate of movements must be different along the earthflow. We have made predictions of earthflow movements by ANN in different sections. In the paper, only the results for one section are shown, the results for other sections are similar.

The authors don't claim that the proposed methodology of short term predictions of rainfall induced landslide movements will always yield perfect results. As mentioned also by the reviewer, if other factors than precipitations have important influence on the landslide movements, this factors should be included in ANN input-output parameters and their values should be measured. Nevertheless, we believe that in many cases of landslides, a procedure similar to ours will perform satisfactory and can serve as decision support tool.

The statement "training data should include obvious and/or theoretically justified input sets" refers e.g. to the description on Page 6, lines 16-20: "If there is no rain and no previous movements (all input data equal to 0) the expected rate of movement is also 0Âń. An obvious, although not measured input-output data pair was added to the training data set, which improved the predictions.

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