Review comments

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[Automated classification of seismic signals recorded on the Åknes rockslope, Western Norway, using a Convolutional Neural Network]

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The manuscript presents a deep-learning-based classification model to automatically detect the microseismic events occurred at slope. Precision in the occurrence time of microseismic catalogue would be helpful to explore the temporal link between microseismic activity and temperature variations. I think that the subject is relevant to publication in Earth Surface Dynamics. However, there are several places where I think a bit more explanation and major revision is needed. Detailed comments are listed below.

(1) Lines 92-98

Introduction of seismic monitoring needs to be enriched with the literature review.

Continuously seismic monitoring: Chang et al. (2021), Locating rock slope failures along highways and understanding their physical processes using seismic signals, *Earth Surf. Dynam.*, 9, 505-517. They presented the physical processes of surface mass-wasting events using a series of the spectrogram features, which were comprehensively supported by the video records, eyewitnesses and field investigation.

In this manuscript, on the validation, I think the authors either forgot to or did not accurately present the microseismic event validation. The authors do not have direct evidences to support detected events (47,561 after regional earthquakes, spikes and noise are removed) linked to the rockslope site.

Seismic precursors: Schöpa et al. (2018), Dynamics of the Askja caldera July 2014 landslide, Iceland, form seismic signal analysis: precursor, motion and aftermath, *Earth Surf. Dynam.*, 6, 467-485. They presented the precursory seismic signals, source mechanism of landsling, and location of afterslide sequence. A series of numerical modeling was conducted to have a better understanding in mechanism of generation of precursory seismic signals.

In the current manuscript, actually, there are a lot of statements that are not certainly supported by the results, which are often possible, but they are not open-discussed based on the referred references.

Seismic interferometry: Kang et al. (2021), Rigidity strengthening of landslide materials measured by seismic interferometry, *Remote Sens.*, 13, 2834. They investigated the temporal link between daily relative velocity changes and in-situ measurements of slope to understand the possible rigidity strengthening.

In this manuscript, a broadband seismometer was deployed in 2009, which is available for analysis of seismic interferometry. Then, tiny velocity variations can be extracted to provide additional information in understanding the physical processes of slopequakes. More discussion should be added in the manuscript.

(2) Line 107

For the detector of the short-time-average/long-time-average STA/LTA trigger, successful capturing of seismic events depends on proper settings of the trigger parameters: (a) the average values of the absolute amplitude of signal in two consecutive moving-time windows; (b) a pre-set value of the STA/LTA ratio. I cannot find aforementioned parameter settings in the manuscript.

(3) Lines 132-139

There are two methods for constraining S-wave velocity structure at slope scale:

(a) Rayleigh-wave ellipticity from polarization analysis of seismic ambient noise (e.g., H/V spectral ratio).

(b) Dispersion curve inferred from the seismic ambient noise cross/auto-correlation functions.

Thus, a combination of P-wave (seismic reflection profile) and S-wave velocity model is helpful to location source of detected signals. The velocity model is not always difficult to establish.

The second question is related to identification of seismic phases generated by the microseismic events. In fact, it is very difficult to distinguish the P- and S-wave due to the complexity of the source mechanism and the dominance of surface waves in the slopequake-generated seismic signal. However, analysis of three-component seismogram can help us to identify the types of seismic phase, such as the particle motion analysis.

A possible solution for aforementioned problems is the amplitude source location (ASL) method (Chang et al., 2021), which can estimate the source location by using the large bursts of seismic amplitude without a priori knowledge of velocity model and seismic phase. Such methods, the reader may want to find explored and clarified by the authors.

(4) Lines 141-146

At least, the preliminary location of microseismic event is required to support the manually labeling (slopequakes, tremor, rockfall) used in this study. Otherwise, you cannot study the seasonality pattern of microseismic activity, also resulting poor understanding their source mechanisms (origin of slopequake and tremor). Above questions are also existed in the previous study of Provost et al. (2018). You need have some advances compared to Provost et al. (2018).

(5) Lines 166-169

In fact, the motion behavior of rockfall is composed of falling, sliding, rolling, and bouncing, which are dominated by the slope angle except for the sliding. For example, as the slope angle is less than 45°, rock mass tends to roll.

(6) Lines 177-179, 294-296

All records are extracted by using the STA/LTA detector, thus, you cannot have the noise label. As the example of noise signal and spectrograms shown in Fig. A8, there are an obvious and emergent signals with a short duration (the time point from 2 to 4 seconds). I am sure that is not noise signal. And, that's the reason why the noise label can be easily classified as the source types of regional earthquake (32.3%) and tremor (10.8%) based on the current model (see Figure 5). I am completely not surprised to see above result.

(7) Lines 214-227

Actually, seismic features observed in this manuscript (such as signal duration, dominant frequency content; see Table 1) can be easily be automatized by machine-learning-based classification/picker/detector approaches.

(8) Lines 245-251

For a specific source (events associated with the slope or surrounding area; Figures A1-A8), there are the clear discrepancies in signal arrival-time, frequency content, and spectral amplitude, which would be useful to constraint the possible source location, further understanding the origin of source mechanisms of microseismic events. I suggest that only stacking the three-components seismograms for each station and building the single station-based training model to detect the seismic signal individually. In practical real-time application, once the number of triggered station reach a certain threshold (for example, larger than three station), location approach can be implemented.

(9) Line 250 "remove low-quality traces based on a user-defined threshold"
Provide a certain definition of a user-defined threshold used in this study.

(10) Figure 4
The overall flavor of argumentation is somehow "positive-example"-based, rather than generic and equally balanced. In several cases I can read a lot about the positive outcomes and do not read negative cases. One example is the statement in the section of "Near real-time implementation" and Figure 4.

(11) Line 309
The authors do not have direct evidence to support detected events in this study linked to the rockslope. Current manuscript did not convince me, even though I can feel the enthusiasm of the authors.

(12) Line 317-320
Please make a systematic comparison between detected catalogue in this study and dataset reported by Fischer et al. (2020). Such comparison, the reader may want to find explored and clarified by the authors.

(13) Figure 6
(a) Please add time-series of rainfall, groundwater level, and borehole displacement
(b) What's the range of magnitude of regional earthquake? Can the authors predict the peak ground-motion amplitude by using the empirical ground-motion prediction equation? If YES, you can see what's happened in relation between slopequake activity and ground shacking.

(14) Lines 325-329
Seasonality pattern can also be influenced by the detection capacity of network. Snow melting and precipitation can increase the noise level due to the rainfall water dropping to ground and high flow dynamics in river channel and gully at slope (water-generated seismic noise). Please provide more detail discussion about this question. Above statement also supports that the number of most of seismic sources show decreasing trend during the summer months (June to September).

(15) Lines 329-337

Can the authors estimate the changes of forces/pressures caused by the variations in water density? Then, how large magnitude of slopequake can be triggered due to aforementioned state changes?

(16) Line 358-361

This is an unfair estimation. The mean of maximum amplitudes is significantly depended on both of the frequency and distance of wave propagation. Thus, current maximum amplitude used in this study (Figure A14) can be directly used to represent the event size.

(17) Lines 388-397

If an additional broadband seismic station far away from the slope sit was included, it is very easy to identify the regional earthquake event or microseismic events on surrounding hillslope.

(18) Figure A7

What is an electronic spike? If it is due to the instrumentation problem (data logger), why spike signals can be observed at same time for all stations?