

# ***Interactive comment on “Multi-temporal landslide activity investigation by spaceborne SAR interferometry: Polish Carpathians case study” by Kamila Pawluszek-Filipiak et al.***

**Anonymous Referee #1**

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The main scope of this work is to investigate the activity state of the landslides mapped in the ‘SOPÓ’ Database in the Małopolskie Municipality (Poland) area. The PSI approach is selected to measure displacements (Ferretti, et al. 2000) while the state of activity is obtained through a PSI-based matrix assessment (Cigna et al., 2013), and the potential damages to vulnerable elements using the method proposed in Mansour et al. (2011).

## General Comments:

Despite a potential interest in some of the results of the analysis, the overall quality of the paper is well below the acceptable standards.

The paper is difficult to read: the English language is not of good quality; quite a few sentences are confounding and, here and there, the technical language is not precise or appropriate. The written would need a deep review. Furthermore, more care should have been put in the submission because paragraph numbering and figures numbering are both wrong.

The applied methods are used apparently without any, or sufficient, contextualization to the local characteristics, so, the assumptions are not outlined properly, neither verified. How representative of the real displacement are the projections? How much does the DEM resolution impact in equations 1 and 2 and then on the final results? Is the minimum number of PSs landslide size-independent? landslide body part independent? No matter how PSs are clustered in the landslide body? Are the different velocity thresholds applied in the literature consistent with the local settings? The same for the expected damages.

Furthermore, I think that the conclusions are not supported by evidence because the 'field validation' does not seem to answer questions like the temporal relationship between damages and activity, but in particular, it is definitely biased by the analysis conducted only on one alleged class, and the analysis does not take enough seriously the impact of the assumptions and the meaning of getting different activity states according to the different used imagery. How to use 3 different (and uncombined) results?

Specific Comments:

Title

Is Multi-temporal related to investigation?

Abstract

5-10 "activity state verification of existing landslide inventory maps": it sounds like the state of activity of a map.

10-15

“overcome”: perhaps mitigate.

“allows to homogenize the results from diverse acquisition modes and to compare displacement velocities”: not always the displacements are along the steepest slope direction, this is an assumption.

15-20

‘intensity’: Is this a standard way to define the motion rate?

1 Introduction

20-25

‘cumulative’: in what sense?

‘LIM’: not all the inventories provide all the information.

‘past and current landslides’: what is the difference?

“Martha el al., 2010; Martha et al., 2012; Li et al., 2016”: a bit surprised, these works are usually cited in relation to the (very good) results obtained using OBIA. I suggest to develop more the concept about the type of landslides that are tackled here. Slow-moving landslides usually need a stereoscopic view for being properly mapped.

30-35

‘landslide detection’: actually in most of the cases is the detection of displacements... May I also suggest to verify the use of DInSAR and InSAR here and there?

‘limitations’: for example?

45-50

‘ambiguous’: is it referred to the wrapped phase?

‘it is challenging, if not impossible’: I suggest to rephrase the sentence and say when

it is impossible.

‘For example...’: I suggest to better introduce the cited works.

‘millimetre precision’: referred to?

50-55

‘these methods’: I think this is correct and better than the list in 30-35, I suggest to try & merge the two.

‘the state’: of?

60-65

‘for updating the landslide inventory’: about the polygons or activity?

65-70

‘specific thresholding.. are performed’: I suggest to better explain this concept.

70 – 75

‘applied’: ?

75-80

‘sensitivity to measure deformation over the study area’: a ‘collective’ sensitivity? Not sure I understand this sentence correctly.

‘difference in landslide activity updated’: again, not sure I understand properly: different updates according to the different measures? But the activity is one... I guess.

1 Materials and Methods

2.1 Study area and existing landslide database

90-95

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'around ... occurrence': there is a mix of 3 different concepts here: area affected by landslides, most active landslides, and frequency of landslide occurrence. Please, better sort out or connect all the pieces.

95-100

'seven times': what does it mean? 7 events? Seven maps?

100 – 105

'catastrophic landslide activity damaged': the term activity can generate confusion here, I suggest to change it.

### 2.1.1 Geological and hydrological settings of the study area

In my copy, the paragraph is repeated twice...

115 – 120

'100 to 350': degrees

### 2.1.2 Landslide types and distribution

Again, in my copy, this paragraph is repeated twice.

130-135:

'among': in?

'hydro-geological conditions such as rock stratification and precipitation': not sure I would label precipitation as a condition.

'Catastrophic landslide activity occurred in 2010': again, I suggest not to use here activity. I also suggest to better contextualize this sentence because these landslides cannot be monitored using DinSAR (and in most of the cases it does not make sense at all). Probably this sentence wants to introduce the following one but it should be better connected.

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## 2.1.2 Pre-existing landslide inventory map

150-155

‘the project’: or the results of the project?

2 Methods

2-1 Radar data and PSI processing

170-175

‘traditional’: just to make it sure. Is this referred to as bi-temporal analysis or single interferograms? Anyway, if this is to justify the choice of the method, I suggest to move it in the discussion, together with the considerations related to the penetrating capacity of the X band, here only the method should be described.

2.2 PS post-processing phase

2.2.1 PS suitability analysis

2.2.2 PS velocity projection along the steepest slope

230-235

‘Herrera et al. (2013)’: they say: ‘a minimum absolute value for  $\cos \beta = 0.3$  is fixed for this study area’. Are the Authors sure that the same value can be used in a different area?

2.2.3 Velocity thresholding for activity state estimation – PSI based matrix approach

240-245

‘Commonly, the average of LOS velocity estimates’: I don’t understand. Is it when more PSs are in a single landslide?

‘Therefore, for activity state estimation, we applied 5 mm/yr as the Vslope threshold’: I can’t follow the reasoning. Did the Authors obtained the distributions and verified that

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they were like in the citations?

Landslide intensity estimation

255-260

'landslides with sufficient information': when is the information sufficient? Is it only related to the PS availability?

3 Results

3.1 Landslide activity state and intensity map generation

270-275

'At least four PS points within a landslide body were set up as the threshold': the choice should be better justified. No matter what size, and other variables are? Is the distance among PSs taken into account? How were the different (at least 4) PS values combined to obtain Activity and Intensity maps?

290-295

'Therefore there are also landslides, which activity state has been updated based on historical or pre-existing data (SOPP database) if an insufficient number of PS were detected on the landslide object (compare also Fig. 5)': this step cannot be dumped this way... more details are needed.

3.2 Possible hazard assessment

General Comment: this is not a hazard assessment.

300-305

'Based on a literature review' conducted by the authors or by Mansour et al. (2011) (in which there is at least a try to characterize the vulnerable elements)?

305-310

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'possible damages caused by mass movements in the study area are presented for three diverse PSI processing results': so, how a decision-maker should read the maps? There are a few landslide areas that experience all the 3 classes, minor, moderate, and major damages. What should they expect?

### 3.3 Field validation

General comment: I can't understand how the list of the 'field verification' examples could verify the results. What I see in the figures are damages associated with some PSs, most of which with a velocity higher than 100mm /year. Shall I deduce the activity from the level of damage?

315-320

'confidence degree': what is it?

'measured displacements represent landslide dynamics': what does it mean? Landslide dynamic in the PS position? Or the entire landslide dynamic?

'reality assessment': ??

'moderate damage': why this choice? This for sure can create a bias in the investigation

'Activity states have been confirmed for 43 landslides': I guess the class, how did the expert confirmed the moderate class?

Landslide 'just-Tegoborze,' SOPO ID 23374

330 – 335

'Landslides tend to develop and increase activity over a large area.': the 23374 or in general?

Landslide 'Zbyszyce' SOPO ID 73253

Landslide 'Liie-Jelna' SOPO ID 73194

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‘When reactivated, this landslide covered about 80% of the landslide area’: what does it mean?

Landslide ‘Wola Kurowska’ SOPO ID 73254

Landslide ‘Bartkowa-Posadowa’ SOPO ID 72917

4 Discussion

405-410

‘landslide occurrence’: Landslide occurrence or landslide monitoring? This sentence is a bad mix of different concepts.

‘mostly connected’: I suggest to relax the concept: ‘can be largely connected...’

410 -415

‘it was demonstrated that increasing the temporal sampling rate’: I disagree, it was not formally demonstrated because the two series (12 and 6 days) don’t overlap.

415 – 420

‘the slope movement in a NE-SW direction represents only a small percentage of the real occurred displacements in LOS displacement rates...’: This means that it is not only a matter of PS density... I think this point should have been taken into account more, both in the activity evaluation and in the discussion.

420-425

‘homogenise landslide velocity’: This is a (perhaps reasonable) assumption that needs to be verified. It can’t come only from homogenization needs...

‘real displacement rate can be much higher..’: so how can a decision-maker trust and use this analysis?

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‘landslide activity states were evaluated by field’: actually only a class was ‘verified’, so the evaluation is incomplete. I am not an expert in damages, so I can’t say whether they were moderate or not.

‘It can also support mentioned by Kroch..’: I can’t understand

## Conclusions

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