

Response to the Comments of Professor Taubenböck

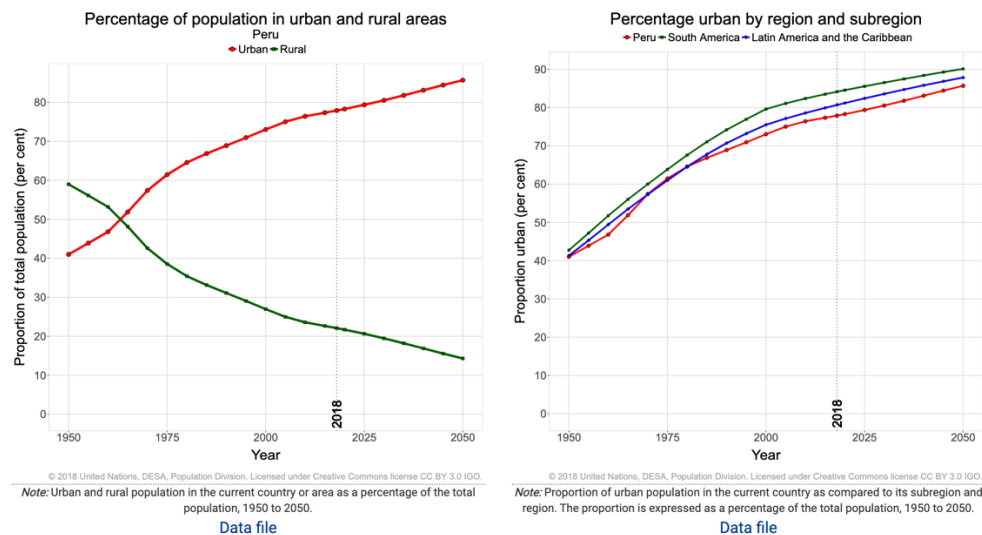
It is a great honor that professor Taubenböck, an authority on the subject, revised our manuscript. His comments were very educational. We sincerely acknowledge him for the time spent reviewing this manuscript. The following contains our response to each comment. Each response contains a reply and reports the changes in the manuscript. In this document, we refer to the manuscript that was revised by professor Taubenböck as the *original* manuscript, and the manuscript that contains the modifications, based on the reviewer's comments, is referred as the *updated* manuscript.

Comment:

“The first sentence of the introduction could be supported by a citation, e.g. from the United Nations world urbanization prospects.”

Reply:

We thank the reviewer for sharing the information. Indeed, the data from World Urbanization Prospects supports our statement. In addition to the report World Urbanization Prospects The 2018 revision. The website platform provides personalized graphs:



Change in manuscript:

Line 9:

Urban sprawl in Latin America has been influenced by the people migration from rural areas to the cities, which have produced high-density urban areas (United Nations, 2019). Informal settlement refers to the organization of people in search of housing who occupy unused land and perform collective actions to self-resolve their urban and social organization issues (Kapstein

Comment:

“Line 9: must it be the “organization of people” or could it be just one person as well”

Reply:

We have double checked other definitions, apart from Kapstein and Aranda, and all of them refers to people, not just one person.

Change in manuscript:

No changes.

Comment:

“Line 11: I would rather write instead of “consisted mainly of informal settlements” something like “was mainly driven by informal urban expansion”.”

Reply:

Following the reviewer’s comment, we have updated the sentence accordingly

Change in manuscript:

Line 11:

10 who occupy unused land and perform collective actions to self-resolve their urban and social organization issues (Kapstein and Aranda, 2014). [The urban growth in the capital city of Peru during the 20th century was mainly driven by informal urban expansion](#), which was motivated by the government policy of allowing people with low socioeconomic status to occupy unused

Comment:

“Line 16: Your statement “Frequently, informal settlements occupy unsafe zones against natural hazards.” was even proven in a scientific study recently by Müller et al., titled Misperceptions of predominant slum locations?”

Reply:

We acknowledge the reviewer for sharing relevant literature. We have included in the introduction the work of Müller et al. on the use of slope to assess exposure to landslides of morphological slums and formal settlements.

Change in manuscript:

Line 17:

15 have kept increasing countrywide. According to the Ministry of Housing, Construction and Sanitation (2021), 93% of the urban growth in Peru between 2001 and 2018 consisted of informal settlements. Frequently, informal settlements occupy unsafe zones against natural hazards. [For instance, Müller et al. \(2020\) showed that slum residents are more likely to settle in areas exposed to landslides than formal residents.](#) For instance, during the Niño Costero phenomenon in 2017, 63800 houses were destroyed

Comment:

“Line 20 – maybe it would make sense, to mention here additionally a study on urban growth based on EO-data?”

Reply:

Following the reviewer's comment, we included the work of Shi et al. (2019): Urbanization in China from the end of 1980s until 2010 – spatial dynamics and patterns of growth using EO-data

Change in manuscript:

Line 21:

20	Remote sensing data have been used to extract information from urban and rural areas, such as land cover classification (Geiß et al., 2020), urban growth (Shi et al., 2019), and detection of damaged buildings (Moya et al., 2021). Regarding infor-
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Comment:

“Line 23 – that studies in the “informal settlements” domain are still relatively scarce has been documented well by the review of Kuffer in 2016. I suggest to cite her study here.”

Reply:

Once again, we sincerely thank the reviewer for sharing important literature. We included the work of Kuffer et al. 2016 in the updated manuscript.

Change in manuscript:

Line 24:

	consider the temporal effects is reported in Kraff et al. (2020). However, remote sensing studies to identify spontaneous informal settlements consisting of makeshift shelters are scarce (Kuffer et al., 2016). The relevance of this task is the geolocation of
25	such settlements to perform prompt prevention actions, such a relocation when the settlements are located in vulnerable areas.

Comment:

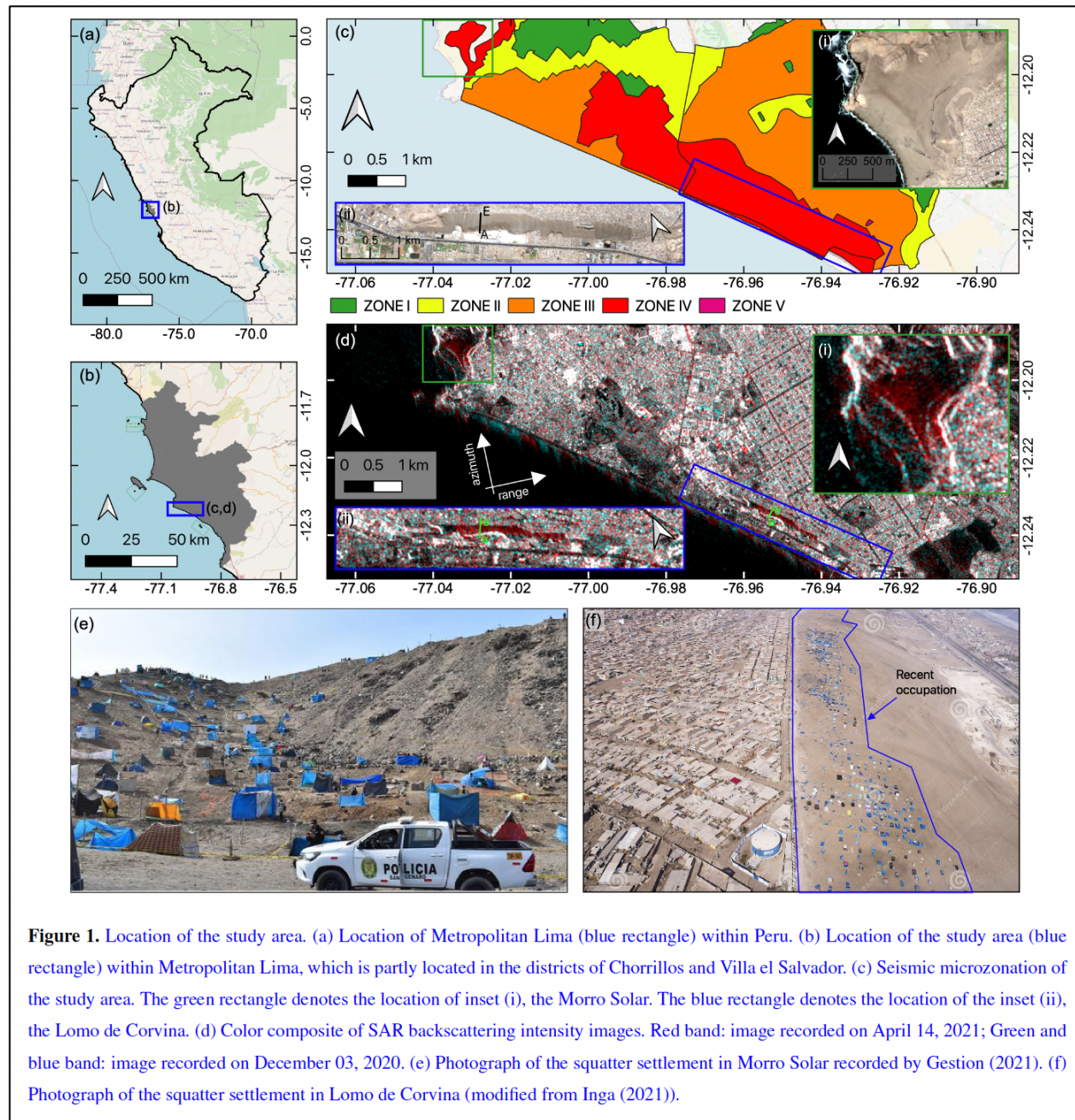
“Figure 1: In my opinion, image 1c (iii) is of high relevance, and needs to be larger. I wonder if figures 1a and 1b are necessary at all?”

Reply:

We agree with the reviewer. Figure 1c (iii) has been enlarged and moved to Figure 1e. We have also included another photo of Lomo de Corvina as Figure 1f. Regarding Figures 1a and 1b, it was a request from the editorial team.

Change in manuscript:

Page 3:



Comment:

“Line 57 onwards: “It is worth mentioning that the collapse of the light makeshifts built during the recent invasions may not have represented an effective danger condition to the inhabitants. However, non-engineering masonry houses could have been constructed in the short term if the inhabitants were not removed.” – these sentences sound too much as if there has been done something good for the people, which might be true from the perspective of natural hazards, but not from their perspective of the need for shelter. A differentiated classification should be made here.”

Reply:

The reviewer is absolutely right. The referred sentence, and the whole manuscript, does not address the more relevant issue: the need for residence. We have clarified in the updated version of the manuscript.

Change in manuscript:

Line 61:

60 waves along the slope (Gonzales et al., 2019). It is worth mentioning that the collapse of the light makeshifts built during the recent invasions may not have represented an effective danger condition to the inhabitants. However, non-engineering masonry houses could have been constructed in the short term if the inhabitants were not removed. *Note however that the solely action of removing shelters will exacerbate the need for residence.*

Comment:

“Line 80 onwards – is there any chance to provide a quantitative accuracy assessment?”

Reply:

I am afraid we were not able to perform field surveys on the occupied areas. We were recommended no to go to the occupied areas as there was friction between the local authorities and the people who occupied the areas. Fortunately, videos recorded from a UAV at the occupied areas in Lomo de Corvina were recently published in the internet:

- <https://www.dreamstime.com/lima-peru-zone-known-as-lomo-de-cervina-people-illegal-invasion-land-poor-people-illegal-land-dealer-lima-lima-peru-april-video217521408>
- <https://www.dreamstime.com/lima-peru-zone-known-as-lomo-de-cervina-people-illegal-invasion-land-poor-people-illegal-land-dealer-lima-lima-peru-april-video217520606>
- <https://www.dreamstime.com/lima-peru-zone-known-as-lomo-de-cervina-people-illegal-invasion-land-poor-people-illegal-land-dealer-lima-lima-peru-april-video217520563>
- <https://www.dreamstime.com/lima-peru-zone-known-as-lomo-de-cervina-people-illegal-invasion-land-poor-people-illegal-land-dealer-lima-lima-peru-april-video217520465>
- <https://www.dreamstime.com/lima-peru-zone-known-as-lomo-de-cervina-people-illegal-invasion-land-poor-people-illegal-land-dealer-lima-lima-peru-april-video217520257>
- <https://www.dreamstime.com/lima-peru-zone-known-as-lomo-de-cervina-people-illegal-invasion-land-poor-people-illegal-land-dealer-lima-lima-peru-april-video217518049>
- <https://www.dreamstime.com/lima-peru-zone-known-as-lomo-de-cervina-people-illegal-invasion-land-poor-people-illegal-land-dealer-lima-lima-peru-april-video217517546>
- <https://www.dreamstime.com/lima-peru-zone-known-as-lomo-de-cervina-people-illegal-invasion-land-poor-people-illegal-land-dealer-lima-lima-peru-april-video217516965>
- <https://www.dreamstime.com/lima-peru-zone-known-as-lomo-de-cervina-people-illegal-invasion-land-poor-people-illegal-land-dealer-lima-lima-peru-april-video217516619>
- <https://www.dreamstime.com/lima-peru-zone-known-as-lomo-de-cervina-people-illegal-invasion-land-poor-people-illegal-land-dealer-lima-lima-peru-april-video217515700>
- <https://www.dreamstime.com/lima-peru-april-th-aerial-media-over-pan-american-highway-one-most-important-america-crossing-south-to-north-video217513019>
- <https://www.dreamstime.com/lima-peru-zone-known-as-lomo-de-cervina-people-illegal-invasion-land-poor-people-illegal-land-dealer-lima-lima-peru-april-video217512728>

by georeferencing some images extracted from the videos, and with the aid of a high-resolution optical images, we manually draw the extent of the occupied areas at the Lomo de Corvina (See Figure R1a). Then we shifted the polygon to fit the occupied area in the SAR image, we use as reference the boundary between the existing urban area and the recently occupied area (See Figure R1b).

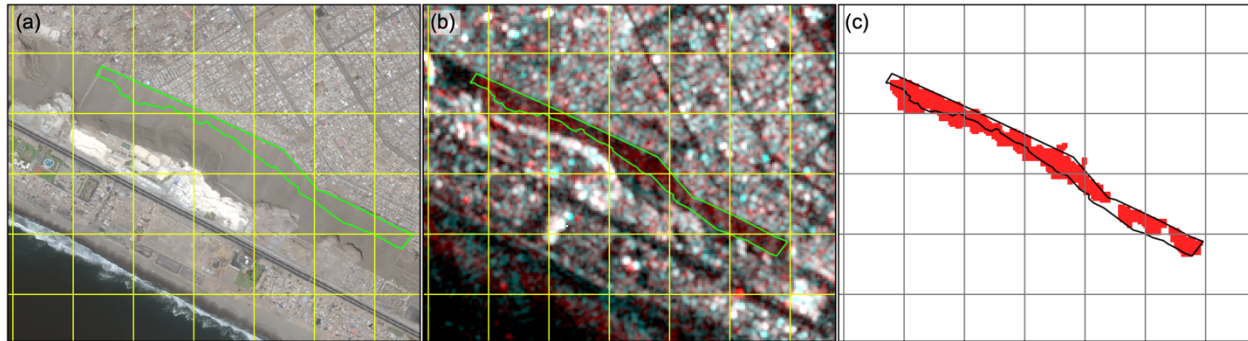


Figure R6. Extent of the occupied area in Lomo de Corvina

Figure R6c shows the estimated occupied areas from SAR imagery and that from visual inspection (VI). 84% of VI-based area were identified in the SAR-based results; on the other hand, 67% of the SAR-based results belong to the VI-based area.

Change in manuscript:

Line 97:

95 thresholding, the morphological operators *closing* and *opening* were applied using a kernel size of 3×3 . Then, pixel-clusters were identified and those with size lower than 200 pixels were filtered out. Figure 3 depicts the extent of the invaded areas in Morro Solar and Lomo de Corvina. The black polygon shown in Figure 3b denotes the extension of the occupied area estimated from visual inspection of images recorded by an unmanned aerial vehicle (UAV). Our results from SAR images identified 84% of the area identified by visual inspection. Furthermore, only 67% of the area identified from SAR images is contained within
100 the black polygon. We believe that the main reason of the discrepancies between the information from SAR images and visual inspection lies in the complex geometric distortions in the SAR images.

Comment:

“Line 89 “to perform a proper relocation” sounds cynical to me. It should be discussed in a more holistic sense – yes, relocation might be good due to the exposed areas towards natural hazards, but from a social, economic or personal perspective, relocation might be catastrophic, too. So, please discuss this.”

Reply:

The reviewer is right. This manuscript covers only the natural hazards aspect of informal settlements. We understand that against the problem of informal urban growth our work is limited. Unfortunately, we are not qualified to perform a social/economic analysis of the informal settlements. In fact, our motivation is that our work will be useful to the politicians/decision-makers that have to consider the full aspects of the problem.

Change in manuscript:

Line 120:

120	within few days. However, through a potential integration of other satellite constellations, a near-real time monitoring system can be achieved. It is worth mentioning that this study focused only on the natural hazard aspects of informal urban growth, which might be a narrow view of the problem. We believe, however, this study will be valuable for the authorities that must have a general view on the issue of informal urban growth.
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