Part 3 Questions & Answers Session A

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Sean McCartney (sean.mccartney@nasa.gov) or Robert Emberson (robert.a.emberson@nasa.gov).

Question 1: In the core concepts section, you noted that vegetation type and density influence landslide propensity and that extreme wind can knock down trees and mobilize sediment. In western North Carolina (USA), Hurricane Helene triggered slides and blew down thousands of trees, mainly at high elevations on steep slopes with shallow soils. How do you assess the risk of such factors combined, and how does this risk evolve over time, from months to years?
Answer 1: This is an excellent question, and one that NASA researchers are currently exploring using a range of SAR and optical data. The longer-lived effect of wind damage on landslide susceptibility remains poorly constrained at a global scale; some local case studies have explored these connections, including recently in Taiwan: https://www.nature.com/articles/s44304-025-00062-x.

Question 2: Will high-resolution Digital Elevation Models (DEMs) lead to better landslide estimates? Do we have open DEM data that is finer than 30m?
Answer 2: Higher-resolution data can lead to better estimates, but not always; if landslide inventories are not produced at a high resolution, then a higher-resolution DEM for a susceptibility model is unlikely to provide improved outcomes. Global, open data is typically available at 30m, but more local areas may have higher-resolution data; OpenTopography is an excellent resource that provides access to DEMs around the world.

Question 3: How do you ensure the completeness of a landslide inventory?
Answer 3: First, it is important to frame what you mean by complete. On a long enough timescale, landslides may occur on almost any hillslope, so we typically discuss completeness as relative to a specific timeframe. For a singular landslide triggering event such as an earthquake or rainfall, completeness is typically simpler to assess; simply ensuring cloud-free imagery is available is usually the main factor. Ground-based validation would be important to determine whether small landslides

have been missed. Overall, completeness can be defined relative to the area mapped and the considered timeframe.

Question 4: Can landslide susceptibility for an area be significantly affected by forest loss due to wildfires? Do you have any examples where this was observed?
Answer 4: Yes, this is a very significant factor in many settings. The United States Geological Survey (USGS) maintains a detailed set of analyses of post-fire areas and the potential for landslides and debris flows, which can be explored here: https://landslides.usgs.gov/hazards/postfire_debrisflow/.

Question 5: How can risk models be accessed and tested in a specific area of interest?
Answer 5: We do not maintain risk models, but instead have developed methodologies to construct generalized models. I would encourage you to reach out directly to discuss the specific area of interest.

Question 6: Have any of these analyses been "checked" with ground truth data, or have they only been developed with satellite images?
Answer 6: Several of our local scale projects, including work in Rio de Janeiro and Bangladesh, were tested and validated using field observations of landslides. Globally, it is important to note that the Global landslide catalog consists of landslides observed typically from ground-based assessment, improving the quality of our global susceptibility validation.

Question 7: Is the LHASA model open source? Is it possible to train the LHASA model on a country specific or area specific dataset?
Answer 7: Yes, the model is open source. You can find the code and information here: https://github.com/nasa/lhasa.
Training on more local inventories should be possible, and we encourage you to reach out directly to us for further information.

Question 8: In the LHASA2 model update, why has snow mass been excluded?
Answer 8: Ultimately, this is because we lack sufficient data on the timing of landslides in snow-affected regions to effectively calibrate the overall impact on the model. Further information regarding the timing of such landslides across a wide range of

landscape types would be necessary to ensure accurate calibration and use of snow-mass data.

Question 9: Is it possible to predict the intensity of a landslide? If yes, how?
Answer 9: Intensity of landslides depends on a number of factors, and it is critical to point out that size does not always equate to impact; small landslides can still be deadly. However, if size is of primary concern, estimating landslide volume using statistical methods has been demonstrated in recent studies (see part 2 of the training for more information), although generalizable physical models at a global scale remains challenging.

Question 10: Which is recommended for better landslide susceptibility assessments: considering all available (including all historical) landslide inventories, or considering more recent landslides for say the last 5-10 years?
Answer 10: Shallow landslides are typically revegetated on the order of decades, meaning that the landslides that can be observed at any given moment represent the extent of landsliding that may occur over that length of time. If a more long-term hazard analysis is what sought, multi-temporal landslide inventories may be helpful. Historical landslide inventories, including geomorphic analysis of pre-historic landslides, is certainly important in some studies include those that might determine the potential for large deep seated landslides, which may be rarer but cause significant damage to human communities.

Question 11: How does soil moisture influence the occurrence of shallow landslides at a local scale? How can InSAR technology revolutionize the integration of soil moisture data and landslide monitoring to develop a more effective hazard prediction model?
Answer 11: Soil moisture has a strong role in landslide occurrence. This is also included as a factor in models. The return rate of InSAR data tends to be slower, 7 days at best currently. As a result, the use of such data for direct prediction of landslide hazard may be limited given the need to characterize rapidly changing triggering conditions. However, SAR analysis of soil moisture may plan an important role in future if latency and return periods decrease.

Question 12: Can HAPS (High-Altitude Pseudo Satellites) provide real-time data of runout zones when a disaster is happening like Valencia DANA floods?

Answer 12: Although this is not something that has been tested by NASA researchers up to this point, this is an interesting question and certainly could form part of dynamic monitoring if such systems are available. Further testing would be needed.

Question 13: Can geological factors, such as the contact between two lava flows (e.g., weathered basalt and compact basalt), contribute to landslide occurrence? Additionally, can geospatial techniques help in identifying and mapping these lava flow boundaries for landslide susceptibility assessment?
Answer 13: Potential changes in mineral composition may strongly influence the susceptibility for landslides. In terms of geospatial techniques, hyperspectral data sets may help explore this, but optical data can possibly be used in settings where clear distinction is seen between different lava flow units. This will depend on spectral characteristics.

Question 14: Which NASA Earth System datasets or remote sensing techniques are most effective in detecting lithological discontinuities, such as lava flow boundaries, that may influence landslide susceptibility?
Answer 14: It will depend on the spectral characteristics of the area of interest. Hyperspectral data may be useful for this kind of analysis; we recommend reviewing ARSET resources on hyperspectral data.

Part 3 Questions & Answers Session B

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Sean McCartney (sean.mccartney@nasa.gov) or Robert Emberson (robert.a.emberson@nasa.gov).

Question 1: Is there a reference for the input parameter weight/effect plot?
Answer 1: Drawn from the following study:
https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020EF001666.

Question 2: Where can I download ORNL DAAC images containing global data for soil thickness and regolith?
Answer 2: Data is available here:
https://daac.ornl.gov/SOILS/guides/Global_Soil_Regolith_Sediment.html.

Question 3: Does the LHASA model consider historical seismicity for modeling? If not, is there any consideration for it as a permanent input?
Answer 3: This remains a topic of open research. Several studies have demonstrated that seismicity can influence landslide susceptibility for many years after a major earthquake (e.g., https://pubs.geoscienceworld.org/gsa/geology/article/43/10/883/131712/Transient-changes-of-landslide-rates-after) but this has not yet been incorporated into LHASA.

Question 4: In section 2, construction of susceptibility models, it was proposed to work on a pixel basis. Is it possible to apply a geoalgorithm that calculates the centroid of each pixel associated with the altitude to perform cross-sectional analysis of landslides? Is there a database of images associated with the altitude related to each pixel? Can you share sources if they exist?
Answer 4: You can derive the altitude of a pixel from the DEM, since the elevation model defines the height above a specific threshold. Note that Digital Elevation Models differ slightly from Digital Topography Models (DTMs) and Digital Surface Models (DSMs); DEMs and DSMs may include the height of the treetop canopy, whereas DTMs would estimate the elevation. At coarse resolution, this may be less relevant.

Question 5: What is your source of global landslide data, for example in the UK?
Answer 5: NASA Landslides team has a range of datasets available that they use. This started with the Global Landslide Catalog. The current iteration - the Cooperative Online Open Landslide Repository, or COOLR, can be found here: https://gpm.nasa.gov/landslides/data.html. This includes information from global sources. For more local information, we recommend reviewing information available from national geological survey resources.

Question 6: Are landslide hazards also considered at source areas, since communities or infrastructure may be built at the slope or above the landslide scar. Can this scar retrograde or destroy the community immediately?
Answer 6: Certainly. The hazard footprint of a landslide includes both the source and deposit area; the critical distinction is that deposits are not the area that is initially susceptible to a landslide failure.