

Date of Submission	30 April 2026
--------------------	---------------

IPL Project (281) Annual Report Form

Period of activity under report
from 1 January 2025 to 31 December 2025

1. **Project Number and Title:** Project IPL-281 Modeling landslide susceptibility and volumes using Geographic Information System and Unmanned Aerial Vehicle

2. **Main Project Fields:**

Select the suitable topics. If no suitable one, you may add new field.

(1) Technology Development

B. Hazard Mapping, Vulnerability and Risk Assessment: **Hazard and susceptibility mapping, landslide sediment volume assessment**

(2) Targeted Landslides: Mechanisms and Impacts

A. Catastrophic Landslides

(3) Capacity Building

B. Collating and Disseminating Information/ Knowledge

(4) Mitigation, Preparedness and Recovery

A. Preparedness

3. **Name of Project Leader** Dr. Gabriel Legorreta Paulín

Affiliation: Instituto de Geografía, Universidad Nacional Autónoma de México (UNAM). Associate Researcher "C".

Contact: Instituto de Geografía, UNAM. Circuito exterior s/n. Ciudad Universitaria. C.P. 04360, Del. Coyoacán, México, D.F.

Email: legorretag@hotmail.com and/or legorretag@geografia.unam.mx

Core members of the Project: Names/Affiliations: (4 individuals maximum)

Dr. Marcus I. Bursik / The State University of New York, University at Buffalo.

Dra. Lilia Arana Salinas / Universidad Autónoma de la Ciudad de México.

Dr. Fernando Aceves Quesada / Facultad de Ciencias, UNAM.

4. **Objectives** (5 lines maximum)

For the first year: (1) Prepare a landslide inventory map for the study area in GIS. For second year: (2)

Prepare a susceptibility map per landform and/or multiple logistic regression. For the 3 years: (3) Calculate the volume for selected landslides for one year in 2-time periods and the total volume for all landslides in the watershed and make the results available to the public through a website and delivered to local municipal authorities.

5. Study Area: Xopanac-Apitzato watershed on the eastern flank of Iztaccíhuatl volcano, within the State of Puebla, México

6. Project Duration: 3 years

7. Report

Progress in the project (30 lines maximum)

- 1) Background information was systematically compiled to provide context and to establish a generalized characterization of landslide processes within the watershed. This included geology, land use, climate, hydrology, and previously available landslide maps and reports. All datasets were georeferenced and integrated into a GIS environment using ArcMap. Landslide data were initially obtained from a pre-existing multi-temporal landslide inventory (Legorreta-Paulín et al., 2024) and complemented through remote sensing interpretation using Google Earth imagery (2001), as well as aerial photographs and orthophotos from 1993 and 1995 (scale 1:20,000).
- 2) Four fieldwork campaigns were conducted during 2025 (January 29; March 13–15; April 21–27; and September 3–7). These campaigns enabled the verification, completion, and updating of the landslide inventory, as well as the validation and refinement of mapped landforms. The first campaign also served to establish communication with local authorities in Santa María Nepoalco and to request permission for field activities, including future UAV (VANT) surveys. In addition, field activities contributed to capacity building through the training of two students (one undergraduate in Geomatics and one graduate student in Geography).
- 3) A total of 1,643 landslides were initially mapped; however, after the first phase of field verification, this number was refined to approximately 1,578 validated landslides. The landslide inventory is currently still under verification. Progress has been slightly delayed due to the migration of the inventory and its associated database from ArcGIS 10.7 to ArcGIS Pro. Fieldwork has also been partially constrained by local social conditions following a security incident in 2024, which has increased community sensitivity to external activities. Consequently, efforts have focused on strengthening communication with municipal authorities to ensure safe and conflict-free field operations.
- 4) Finally, the integration of field observations and desk-based analysis (GIS, remote sensing, and existing inventories) allowed the consolidation of a consistent landslide database and

geomorphological framework, which supported the preparation and completion of a scientific article on landslide inventory mapping, landform characterization, and susceptibility assessment in the Apitzato watershed.

1) **Planned future activities or statement of completion of the Project (15 lines maximum)**

The project has largely completed its initially planned activities, including the development of the landslide inventory and the susceptibility assessment based on landform units. Future work will focus on refining and strengthening the results obtained. Additional fieldwork campaigns will be conducted to re-verify and further validate the landslide inventory, with the aim of improving its accuracy and consistency. At the same time, new thematic variables (e.g., morphometric, environmental, and land-use factors) will be compiled and prepared in a GIS environment to support a landslide susceptibility analysis based on statistical approaches, particularly logistic regression models. This will allow a direct comparison between susceptibility results derived from landform-based and statistical methods. Furthermore, UAV (VANT) surveys will be carried out to obtain high-resolution orthophotos, digital surface models (DSM), and digital elevation models (DEM), as well as to measure landslide geometry (length, width, and depth) and estimate volumes for selected cases. These activities will contribute to improving the reliability of susceptibility assessment and to expanding the geomorphological understanding of landslide processes in the study area.

2) **Beneficiaries of Project for Science, Education and/or Society (15 lines maximum)**

The project provides benefits at multiple levels, including science, education, and society. At the local scale, municipal authorities and stakeholders benefit directly from the delivery of a final written report that includes the landslide inventory, susceptibility assessment per landform, and estimates of potential landslide volumes within the watershed, which can support risk management and land-use planning. At the academic level, the project contributes to scientific advancement through the publication of research articles and book chapters, facilitating the dissemination of methodology and results within the international landslide research community. In addition, the project supports education and capacity building through the involvement and training of undergraduate and graduate students. Finally, by making maps, datasets, and results available through the Institute of Geography's web platform, both specialized audiences and the general public will benefit from access to updated geospatial information, contributing to increased awareness and understanding of landslide hazards.

8. Results (15 line maximum, e.g. publications)

3) A total of 1,578 landslides were identified and validated within the Apitzato watershed and classified into six main types of gravitational processes. The inventory indicates that debris flows are the most frequent landslide type, whereas debris slides account for the largest proportion of the affected area. In parallel, thirteen geomorphological landform units were delineated and assessed, with

susceptibility ratings ranging from low to very high. The highest landslide densities are associated with moderate- and steep-gradient hillslopes, as well as with convergent landforms such as inner gorges and bedrock hollows. Overall, the watershed was classified as having very high landslide susceptibility. These results highlight the dominant influence of slope gradient, geomorphological setting, and hillslope–channel connectivity on landslide occurrence.

Note:

- 1) If you will change items 2-6 from the proposal, please write the revised content **in Red**.
- 2) Please fill and submit this form to ICL Network <icl-network@landslides.org>
- 3) Reporting year must be one or two years (Maximum).