Developing and Testing a Geomorphic Mapping Protocol in Mount Rainier National Park, USA

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Introduction

The grand landscapes and river systems of Mount Rainier National Park (MORA) are influenced by its glaciovolcanic geology and the temperate climate of the Pacific Northwest. Mapping geomorphic changes is a crucial step to understanding, interacting with, and preserving the pristine environments of MORA. Geologic hazards and large-scale hydrologic events are common within park boundaries, putting infrastructure and cultural and historical sites at risk of permanent damage. To assist in the efforts of the MORA Geology Group, I designed a functional protocol for mapping geomorphic landforms that influence threats to park infrastructure and assets.

With this protocol, geoscientists of varying skill levels will be able to produce repeatable geomorphic landform inventories at locations of interest within MORA. These standardized methods are designed so that final map products are consistent regardless of who conducts the mapping. The protocol will allow the Geology Group to provide stakeholders such as resource managers, maintenance crews, and the public with valuable information regarding the ongoing evolution of the landscapes they oversee. I tested the new protocol along a portion of Nisqually-Paradise Road, compiling an inventory along the road segment that the Geology Group considers to be most at risk (Cutter et al., 2019). Hazards from both hillslope and fluvial processes threaten the road between Milepost 5 and Milepost 6. This study is intended to provide insight for developing mitigation strategies.

Methodology

Protocol References:

- Designated geomorphic features custom to the unique environment of MORA from "Geomorphic mapping and taxonomy of fluvial landforms" (Wheaton et al., 2015) and the "Protocol for Landslide Inventory Mapping From LiDAR Data in Washington State" (Slaughter et al., 2017).

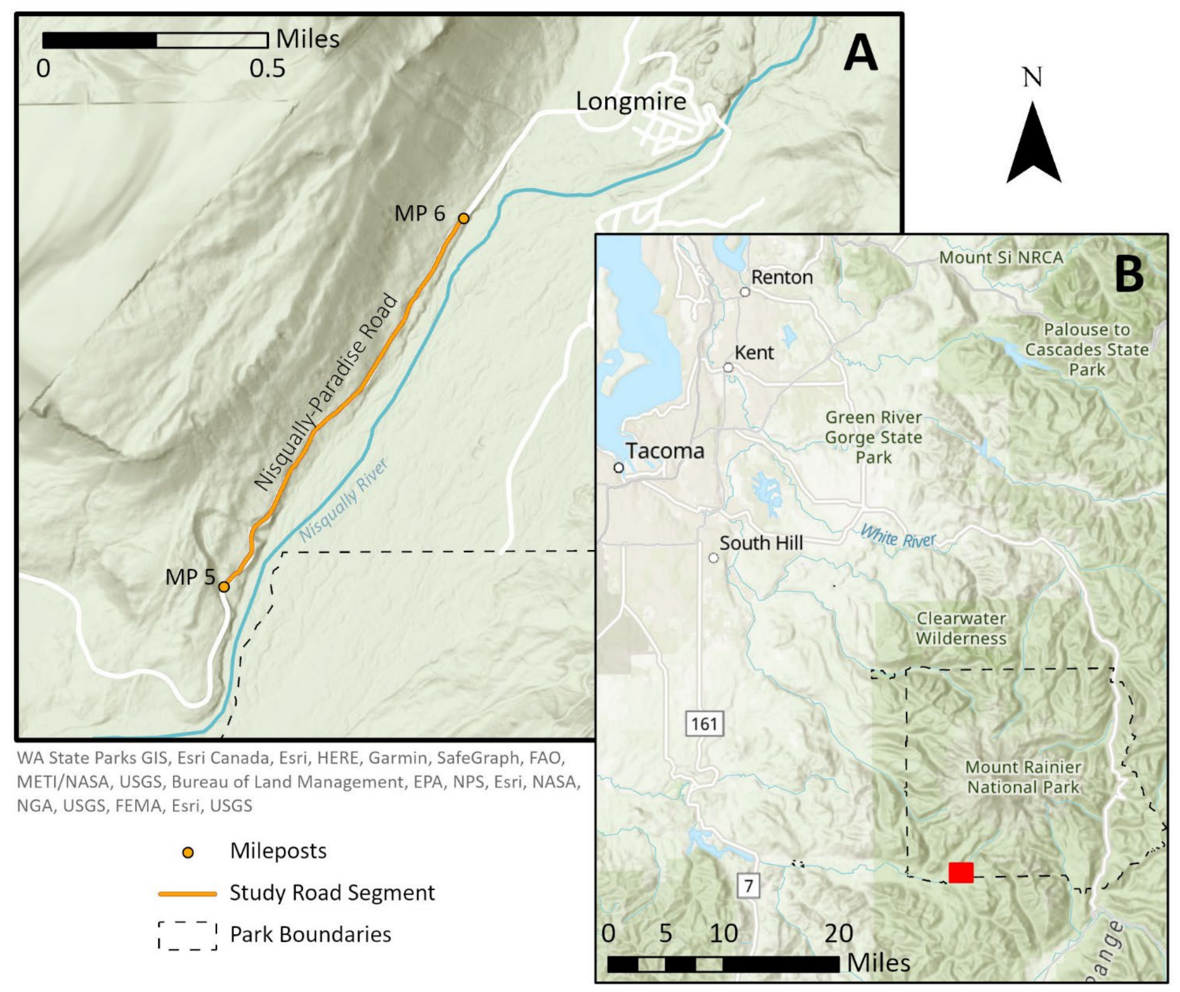
ArcGIS Pro:

- Defined site boundaries with a watershed delineation.
- Assigned key attribute domains to further describe each mapped feature.
- Mapped landform features using the Lewis County 2009 Digital Surface Model (DSM) LiDAR (Mann et al., 2010) and Maxar basemap aerial imagery.

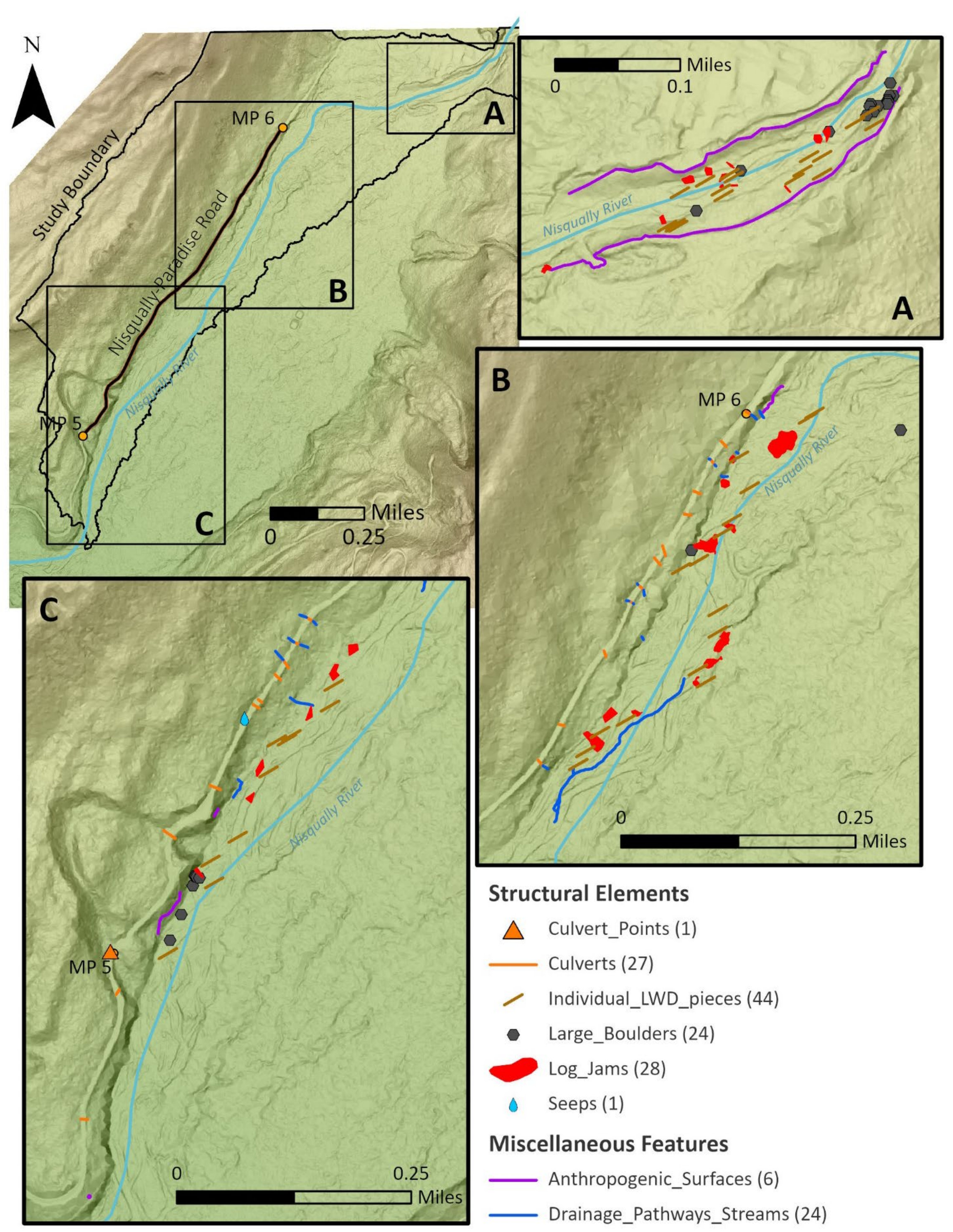
ArcGIS Online/Field Maps:

- In-field mapping with a mobile tablet and an Emlid Reach RS2 backpack-mounted GNSS receiver.

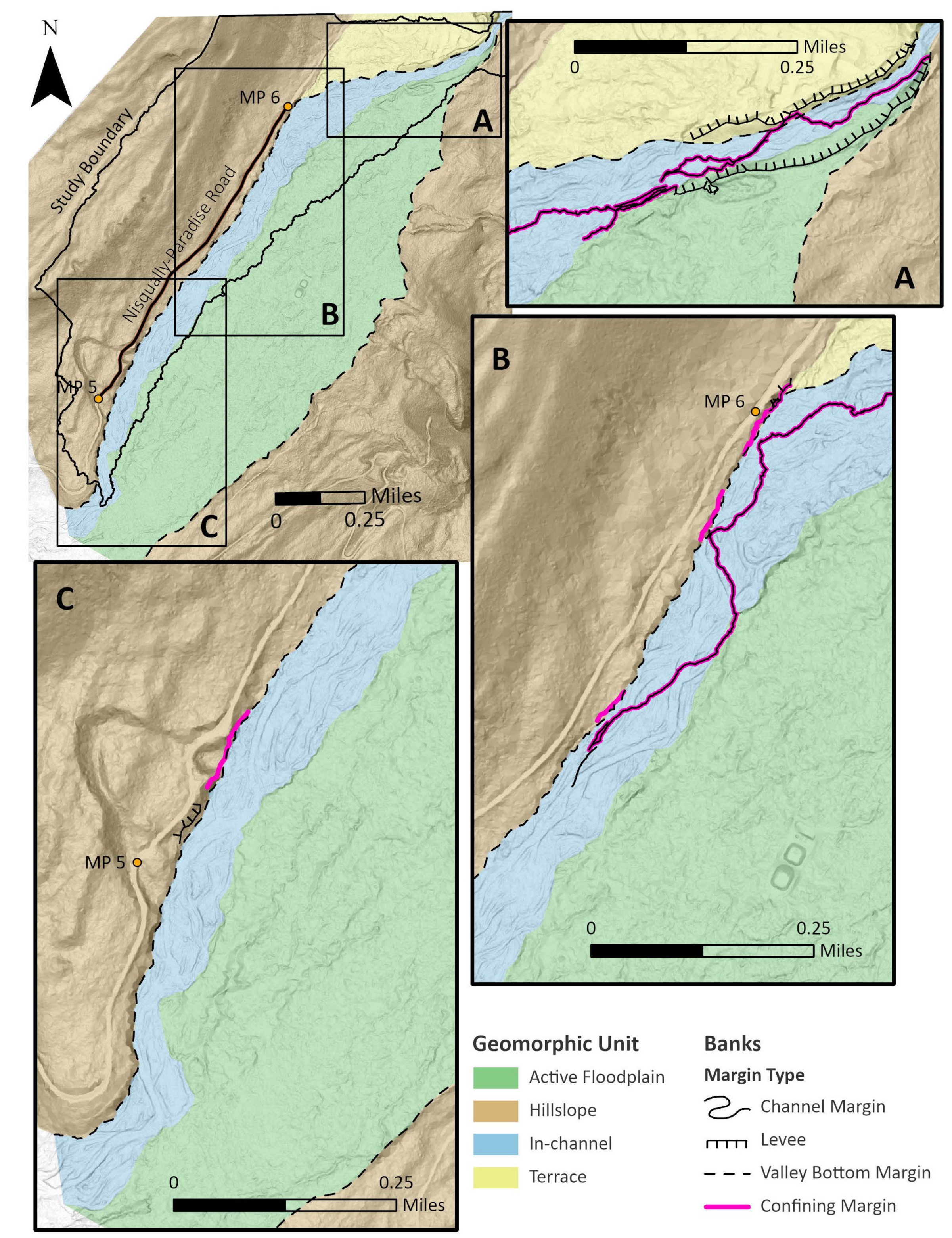
Mapped Features



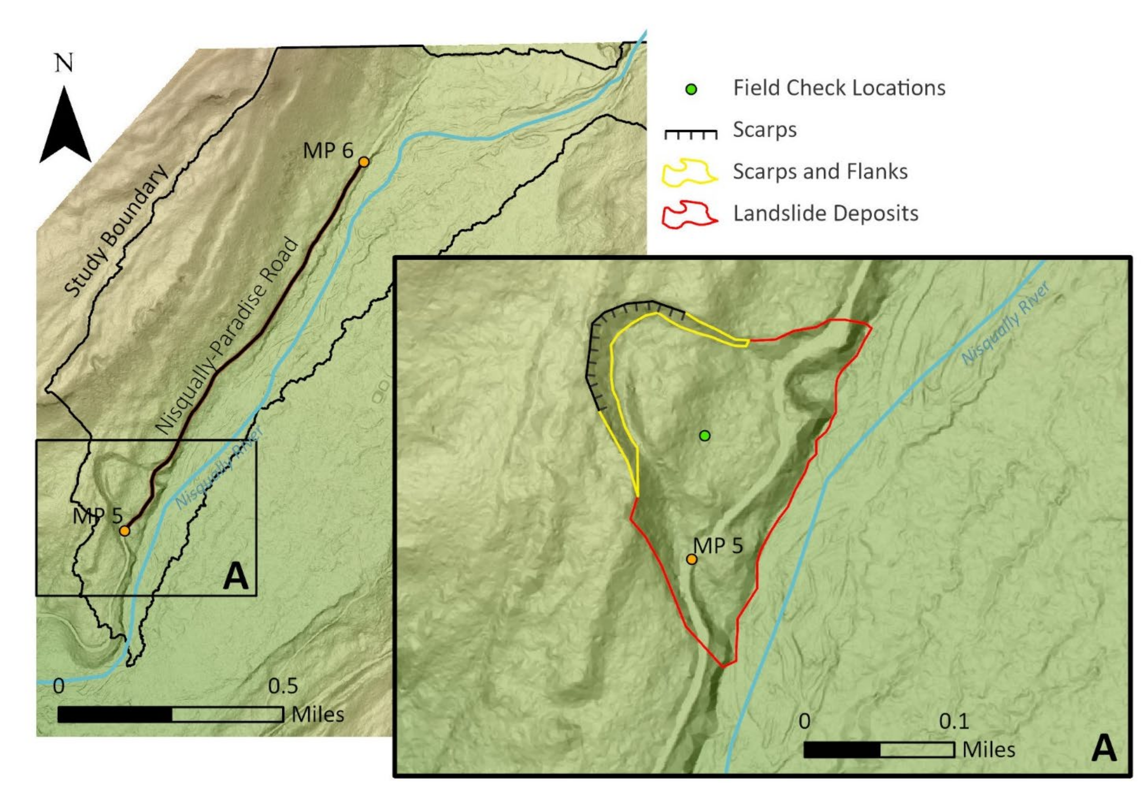
(A) Location map of the Nisqually River valley at Longmire, WA. (B) Index map of study area relative to major geographic locations.



Inventory map of structural elements and miscellaneous feature classes identified within the study site with total feature counts in the parentheticals.



Inventory map of Geomorphic_Unit and Banks features classified by stage heights and types.



Inventory map showing the Landslide_Deposits feature layers mapped within the study site using the WGS protocol.

Key Findings

- Protocol in 'Beta' phase, but testing suggests it works.
- The protocol inventory is a result of methods testing. It's incomplete and varies in accuracy.
- Remote mapping and analysis based off outdated LiDAR.
- Study designed for GPS accuracy within 3 feet, but, in general, receiver accuracies can vary.

Benefits

- Accessible, relatively affordable, and standardized.
- Monitor changes on different timescales.
- Efficient data management through the 'cloud.'

Limitations

- Relies on good GPS conditions and updated LiDAR.
- Field mapping can be inefficient/dangerous.
- Glacial rivers are dynamic and changes can occur daily.

References

Cutter, S.B.K., Bersson, J.J., Kenyon, T. R., Jost, R.P., and Beason, S.R., 2019, The Nisqually River: Risk Assessment and recommendations for future actions.: 27 p.

Mann, P.A., and Hyatt, M., 2010, 2008-2009 Lewis County LiDAR Project: LiDAR Remote Sensing Data Collection: Lewis County Study Area, Washington, http://pugetsoundlidar.ess.washington.edu/lidardata/restricted/projects/2009lewis.html (accessed May 2021).

Slaughter, S.L., Burns, W.J., Mickelson, K.A., Jacobacci, K.E., Biel, A., Contreras, T.A., 2017, Protocol for Landslide Inventory Mapping From LiDAR Data in Washington State: Washington Geological Survey: Bulletin 82, 35 p.

Wheaton, J.M., Fryirs, K.A., Brierley, G., Bangen, S.G., Bouwes, N., and O'Brien, G., 2015, Geomorphic mapping and taxonomy of fluvial landforms: Geomorphology (Amsterdam, Netherlands), v. 248, p. 273–295, doi: https://doi.org/10.1016/j.geomorph.2015.07.010

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