LANDSLIDE AREAS IN MORTON COUNTY, NORTH DAKOTA

Fred J. Anderson, Levi D. Moxness
Christopher A. Maike, and Edward C. Murphy

2021

LANDSLIDES IN MORTON COUNTY

Landslides are masses of rocks and sediment that have tumbled or slid down a slope under their own weight. These geologic hazards can destroy buildings, roads, railroad tracks, pipelines, transmission lines, and other types of infrastructure. Landslides are generally characterized in the field by steep, near-vertical slopes (the scarp) that are upslope from a mound of displaced rock (the body). The body of the slide may be relatively intact, or it may be severely fragmented. Recent or relatively new landslides are generally characterized by a fresh (well-exposed rock) scarp and a sparsely vegetated body. Older slides are typically more difficult to identify in the field because the topography of the scarps and bodies may be smoother and more subdued due to weathering. They may also be covered with vegetation and mature trees obscuring the underlying topography. Landslides are most readily identifiable from LiDAR data, supplemented with aerial imagery.

Landslides in Morton County were mapped from LiDAR data collected from October 2015 to November 2016 along with NAIP digital imagery from August 2016 and a complete set of historical aerial photographs that were flown in May 1964 at a scale of 1:20,000. It is unfortunate that these photographs were taken when leaves were on the trees because groves of leaf-bearing trees tend to obscure landslides, especially small ones. On the other hand, leaves can sometimes make it easier to identify these features. Trees and bushes are often aligned within very distinct parallel-, transverse-, and/or semi-circular-depressions that generally occur within the body of the landslide. The use of LiDAR elevation data allows us to see through most of the areas previously obscured by vegetation in the historical imagery and aerial photography and greatly increases our ability to identify additional landslide areas.

Slopes fail for various reasons including the steepness or angle of the slope, rock type, bedding, and moisture content of the rocks. Most landslides in western North Dakota are rotational slumps that have a well-defined head and toe. Typically, the part of the slope that breaks apart slides down the slope as a single unit and the beds tilt back in the direction of the slope. The failed mass of rock is, however, almost never a cohesive unit; tension cracks generally cause the failed material to splinter into smaller portions. Successive landslides may occur at the same location. Over time, the accumulated material from multiple, adjacent landslides can cover an area that is several thousand feet wide and several miles long.

The geology of Morton County consists dominantly of sedimentary bedrock of the Fort Union Group which contains marine mudstones and sandstones of the Cannonball Formation, along with terrestrial deposits of the Bullion Creek and Sentinel Butte Formations, consisting of sandstones, siltstones, claystones, mudstones, and lignite. Most landslides in Morton County (76%) occur in the Cannonball (38%), Bullion Creek (17%), and Sentinel Butte Formations (22%) within the major hydrologic corridors in the County.

Most of these slides cover less than 10 acres (fig. 1) but, a few landslide complexes are up to 100 acres or more in size. Landslides are concentrated along drainages, ravines, and coulees, and within areas of high local topographic relief along the major hydrologic corridors like the Heart River. All, or portions, of the head of a ravine typically fail, presumably because headward erosion causes these areas to undergo some of the fastest rates of erosion.

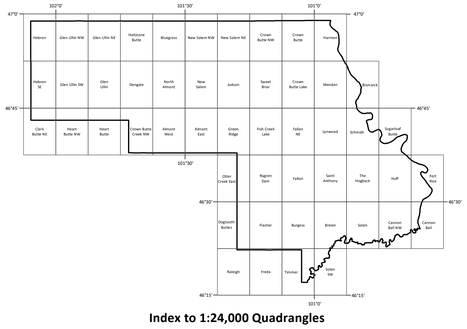
Numerous historical abandoned coal mines occur in Morton County. These small coal mines, commonly referred to as wagon mines, are scattered mainly across western portions of the county and drainages east of Lynwood. These features are mapped as Qml where mine workings or sinkholes from the collapse of underground voids are visible on the surface, but uncollapsed mine voids may occur in the subsurface beyond the boundaries of the mapped areas. Also included are locations with no obvious surface modification, but a mine is known to have occurred in the area according to records compiled by the North Dakota Public Service Commission. It can be difficult to determine whether small surface irregularities along drainage slopes are old mines or slumps, further complicated as abandoned mines are susceptible to slope failure. Thus some areas mapped as landslides may include the collapse of abandoned mine headwalls.

Small landslides, 10 acres or less in size, are common throughout the rugged topography of western North Dakota. Many of these, as well as larger landslides, are typically obscured by slopewash or colluvium. Layers or blankets of slopewash typically cover the lower portion of a slope and extend horizontally from the base of a slope. Thick, smooth layers of slopewash often completely obscure the broken, jumbled beds of landslide material. In some areas, smaller landslides, or landslides that are very old and have been inactive for a long period of time, are only visible if slopewash is thin or absent, or the beds are sufficiently jumbled to create subtle irregularities at the surface.

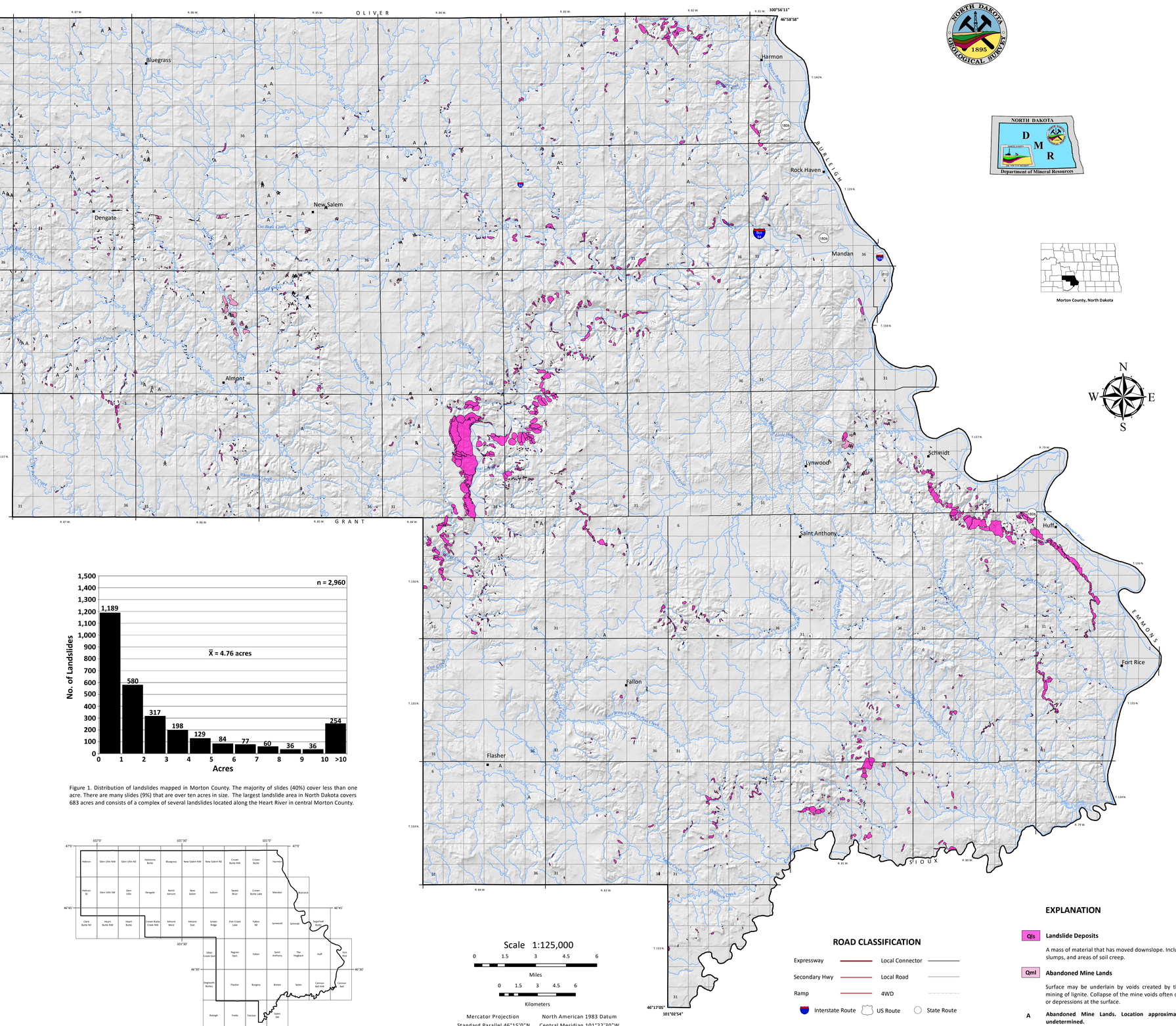
A total of 2,960 landslide areas, along with 163 former AMLs, were identified in Morton County. Several of these slides are complexes, consisting of multiple landslides that formed from a dozen or more individual events. Therefore, the number of individual landslides in this county is much higher. Collectively, these landslide areas cover 23.4 square miles (14,951 acres) or approximately 1.2 % of the county. Most of the landslides occur within the Heart and southern side of the Missouri River Valleys. One of the largest slides in North Dakota is the Green Ridge landslide complex, an extremely large lateral spread slump feature, that occurs along the Heart River 11 miles east of Almont and 12 miles north of Flasher covering 3.8 square miles (2,432 acres). The Big Muddy Creek Valley also contains a large number of landslides.

An area with a large number of landslides suggests that the local slopes may be predisposed to future slides in the area. Even when landslides are not identified in these types of settings, these areas often remain vulnerable to slope failure and should be evaluated prior to the development of any civil works or energy infrastructure projects and, when possible, be avoided.

Figure 1. Distribution of landslides mapped in Morton County. The majority of slides (40%) cover less than one acre. There are many slides (9%) that are over ten acres in size. The largest landslide area in North Dakota covers 683 acres and consists of a complex of several landslides located along the Heart River in central Morton County.



Index to 1:24,000 Quadrangles



Scale 1:125,000

0 1.5 3 4.5 6
Miles
0 1.5 3 4.5 6
Kilometers

Mercator Projection
Standard Parallel 46°15'0"N
North American 1983 Datum
Central Meridian 101°22'30"W

ROAD CLASSIFICATION

- Expressway
- Secondary Hwy
- Ramp
- Local Connector
- Local Road
- 4WD
- Interstate Route
- US Route
- State Route
- River
- Railroad

EXPLANATION

Qls **Landslide Deposits**

A mass of material that has moved downslope. Includes earth flows, slumps, and areas of soil creep.

Qml **Abandoned Mine Lands**

Surface may be underlain by voids created by the underground mining of lignite. Collapse of the mine voids often creates sinkholes or depressions at the surface.

A **Abandoned Mine Lands. Location approximate and extent undetermined.**

Abandoned Mine Lands (AML) location data maintained by the North Dakota Public Service Commission's Abandoned Mine Lands Program.

Cartographic Compilation: Navin Thapa