Mapping in the 21st Century

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Previous GeoNews articles have focused on technologies such as LiDAR (Light Detection and Ranging) and drones (Maike, 2016; Anderson and Maike, 2017; Maike, 2017, 2018). These are exceptional tools that enable scientists to collect, analyze, and implement data from various sources, some previously inaccessible, in unprecedented detail. The North Dakota Geological Survey (NDGS) has used LiDAR extensively for geologic hazard mapping, paleontological investigations, and surface landform identification for sand and gravel studies. LiDAR allows geologists to see characteristics of landslides that are not easily observed on aerial imagery. The processing of the data removes trees and vegetation allowing geologists to see the bare surface. The addition of a drone to the survey has allowed for unique perspectives of geologic hazards not previously seen. The combination of drones and LiDAR allows geologists to make more accurate maps than ever before.

These technologies still have their shortcomings. Among its many uses, LiDAR is a great tool for making digital elevation models (DEMs) of Earth's surface, identifying geologic hazards, and modeling surface hydrology; however, it is a snapshot at a specific instance in time. For example, if a landslide was to occur in 2018 and the last LiDAR data available was from 2012, we are relying on semi-current aerial imagery and older LiDAR. There are multitudes of landslides in North Dakota that are hard to recognize because they are obscured by vegetation, this is when LiDAR becomes a huge advantage. A drone-mounted LiDAR system would be a major advancement for sub meter monitoring of landslide movement and continued monitoring. The NDGS has been using the statewide LiDAR to assist in establishing a landslide inventory throughout the state (https://www.dmr.nd.gov/ndgs/landslides/). This is critical for consultants and developers to take into account for construction practices.

Currently, the NDGS is using a Phantom 4 Pro drone (see background photo) to acquire imagery and video. This drone is the perfect combination of affordability and image quality. It has allowed for the acquisition of high quality images of landslides, reclamation sites, paleontological sites, and reconnaissance for our rare earth elements and sand proppant studies. The technology has enabled geologists to reduce time spent hiking up buttes and has provided a new imagery source to enhance the interpretations made by geologists. The shortcomings of drones in the field have been cold temperatures and high winds. Cold temperatures can cause voltage to drop on a drone's batteries, reducing flight time, and even result in the drone falling from the sky. Recently, DJI, a large drone manufacturer, announced the release of the Matrice-200 Series (fig. 1), a drone capable of operating in sub-zero temperatures, remain stable in high winds, and have an increased flight time (up to 38 minutes in the air). The DJI Matrice-200 Series would be revolutionary in obtaining data for the North Dakota Unmanned Aircraft System (UAS) industry. It would allow for more sites to be visited through the winter months as well as during the many windy days that we encounter.

Most LiDAR systems for drones cost between $50,000 and $100,000. However, Velodyne LiDAR® has developed a LiDAR system that costs just $8,000. This is a game changer for scientists on a limited budget eager to collect LiDAR themselves. The Velodyne Puck™ (fig. 2) features impressive specifications along

Figure 1. DJI Matrice-200 Series Drone (DJI, 2018b).

Figure 2. Velodyne Puck™ LiDAR Sensor (Velodyne, 2018).

Background photo: Geological Survey drone (DJI Phantom 4 Pro Drone).

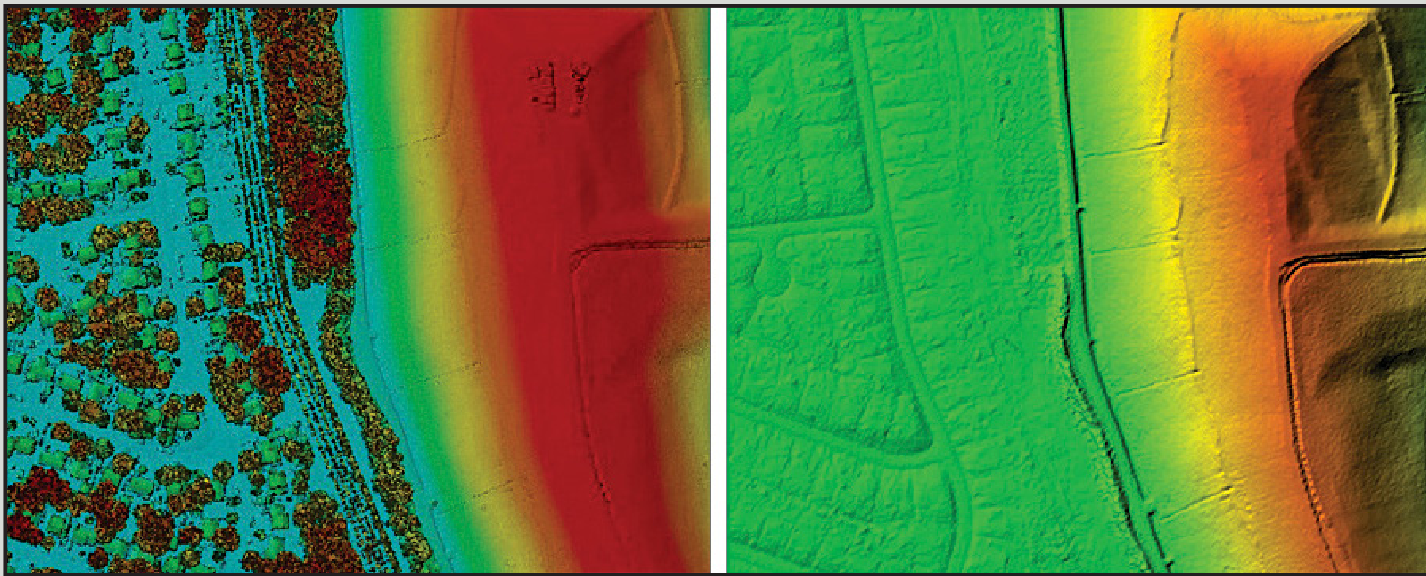

Figure 3. A side by side comparison of point clouds and a digital elevation model (DEM). Left: XYZ point cloud. Right: DEM of bare earth surface. Notice that vegetation was filtered out of the data for a bare earth model (ESRI, 2014).

with a compact size. The unit contains 16 lasers (16 channels) collecting data 360° around the sensor at a rate of about 300,000 points per second and data is being collected at a rate of approximately 1mb/second. The system permits the end user to visualize the data as it is being collected. The resource agencies would greatly benefit from the Velodyne Puck™'s dual capability to collect point clouds (xyz data) and create DEMs from the data quickly and affordably (fig. 3). This mobile LiDAR system would make it possible to more closely monitor potential geologic hazards, a proactive strategy that is critical for effective hazard mitigation, especially in areas where public safety may be at risk.

The technology industry is fast-paced, ever-changing and keeps producing products that enhance the lives of consumers. As drone technology continues to improve, it has great potential to assist geologists in their work (fig. 4). The NDGS is committed to keeping up with technological changes and to integrate it as part of their programs and mapping endeavors. The advancements in technology will enable state surveys to meet the demands for the maps that industry dictates.

Figure 4. NDGS Drone near North Dakota Department of Transportation inclinometer on Old Highway 10 west of Mandan.

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