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Pump Up (or Down) the Volume with Color Infrared Imagery and Surface Consistent Scaling

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Summary

Surface consistent scaling is a significant step in seismic processing for onshore oil and gas exploration. Amplitudes of received and transmitted signals can be affected by the coupling of sources and receivers to various ground types and conditions. Using a combination of color infrared imagery and LiDAR, we investigate the connection between classified ground conditions and surface consistent scalers.

Location

In 2018 Explor acquired a ground-breaking seismic survey in the Alberta oil sands region. Figure 1 shows the area of interest without location information for proprietary reasons. While extensive geographic information was harnessed in this area for analysis, focus will be placed on the three data types and their derived products for analysis. The first data type is the imagery, both high resolution and color infrared (CIR) as shown in Figure 1. Second data type is the LiDAR who's derived canopy height model is shown in Figure 2. The third data to be investigated are both the source and receiver surface consistent scalers (Figure 3).

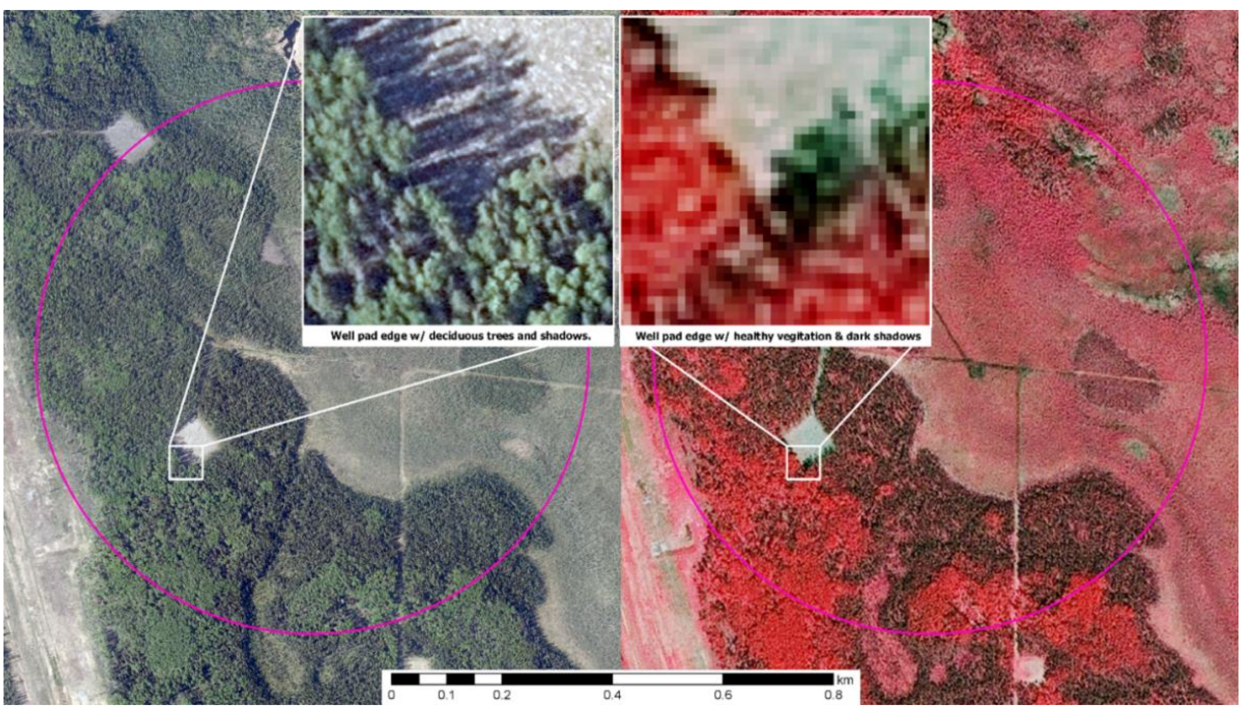

Figure 1. High resolution imagery (left) and color infrared (CIR) imagery right of the survey area. Inset images show resolution differences between the two sets of imagery used.

High Resolution Imagery

The high-resolution imagery used in this study was drone acquired in the summer 2017 with 30x30 centimeter resolution (Figure 1, left). The imagery provides a good means to manually distinguish between vegetation types such as deciduous and coniferous trees, grasslands and bushes, and open ground and roads. The inset image on the left of Figure 1 shows the “fluffy” look of deciduous trees, and their shadows being cast on the open ground of a well pad. Understanding these characteristics is important for manual classification of CIR imagery.

Color Infrared

The color infra-red (CIR) imagery used in this study was acquired April 2016 with 1.5x1.5-meter resolution (Figure 1, right). CIR imagery consists of three reflection electromagnetic wave (EM) bands; Near Infrared (NIR) (0.760-0.890 mm), Red (0.626-0.695 mm) and Green (0.530-0.590 mm). CIR color bands are good at penetrating cloud cover for vegetation determination ((ALTAVIAN, 2016) flood plain identification (Karlin, 2016), and assessing soil moisture (Minnesota Comprehensive Wetland Assessment, Monitoring and Mapping Strategy Steering Committee , 2016). The juxtaposition of high-resolution imagery and CIR in Figure 1 allows for better identification and classification of vegetation type, shadows and open water.

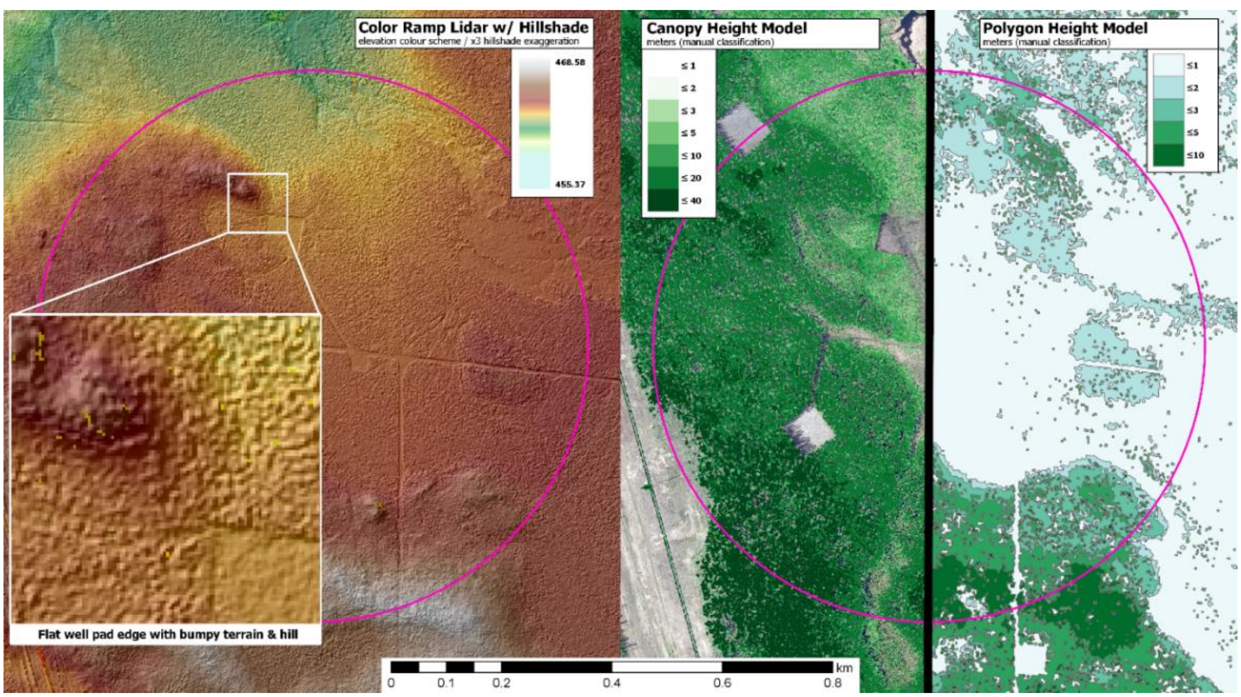

Figure 2. Color ramp representation of LiDAR (left) and classified canopy height model with polygon height model (right). The color ramp representation is semitransparent overlaid on the LiDAR derived hillshade with 3 times height exaggeration for effect.

LiDAR

The LiDAR used in this analysis, delivered as bare earth (BE) and full feature (FF), was acquire in the summer of 2017 with a resolution of 1x1 meters (Figure 2). As shown by the characterized BE LiDAR in Figure 2 (left) the area of interest is flat with only 13-meter elevation change. The FF LiDAR was used to generate two canopy height models shown on the right of Figure 2. The canopy height models were used to condition the supervised CIR imagery prior to classification.

Surface Consistent Scaling

Surface consistent scaling is performed at each source and receiver location to correct amplitude variations in recorded signals which can be affected by ground coupling. The goal is to calculate a single scalar for each shot and receiver that will account for these effects (M. Turhan & Koehler, 1981). The Kriging geostatistical representations of both the first pass receiver (left) and source (right) surface consistent scalars is shown in Figure 3.

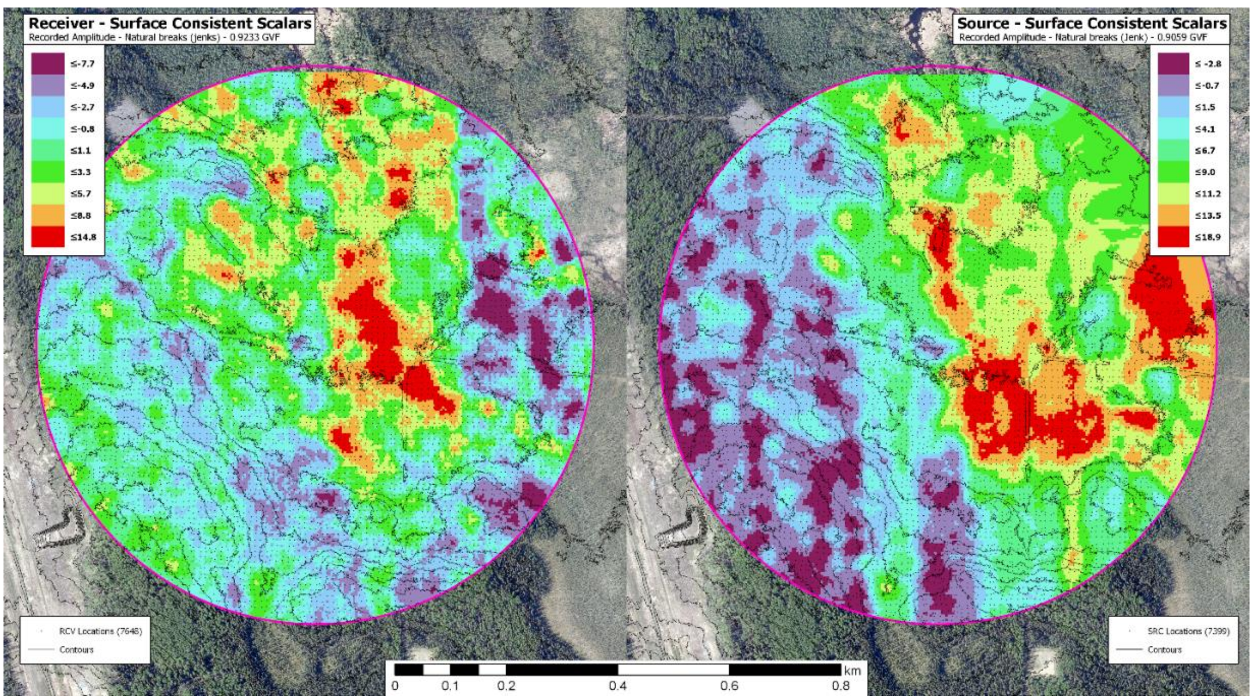

Figure 3. Kriging raster representation of Receiver Surface Consistent Scalars (left) and Source Surface Consistent Scalars (right).

CIR Classification

Image classification of the CIR imagery is a function of the reflectance and absorption of the color bands from vegetation, water and land within the imagery area. Different plants types (grass, deciduous and coniferous trees) as well as open ground, water and human made structures have discreet band reflectance which can be classified within a CIR image.

Classification of the color infrared imagery was complete in two separate work flows. The first work flow used unsupervised object-based classification. This method relies on computational statistical analysis taking into consideration color and shape characteristics within the imagery for classification. (Figure 4, left).

The second method for image classification was supervised object-based analysis. A predefined schema of tree types (deciduous and coniferous), land types (grass lands, barren, scrubland

and herbaceous), water and shadow were used as digitizing aids in this computational statistical analysis. The digitization of the schema was conditioned with the canopy height model as generated through LiDAR classification with results shown on right in Figure 4.

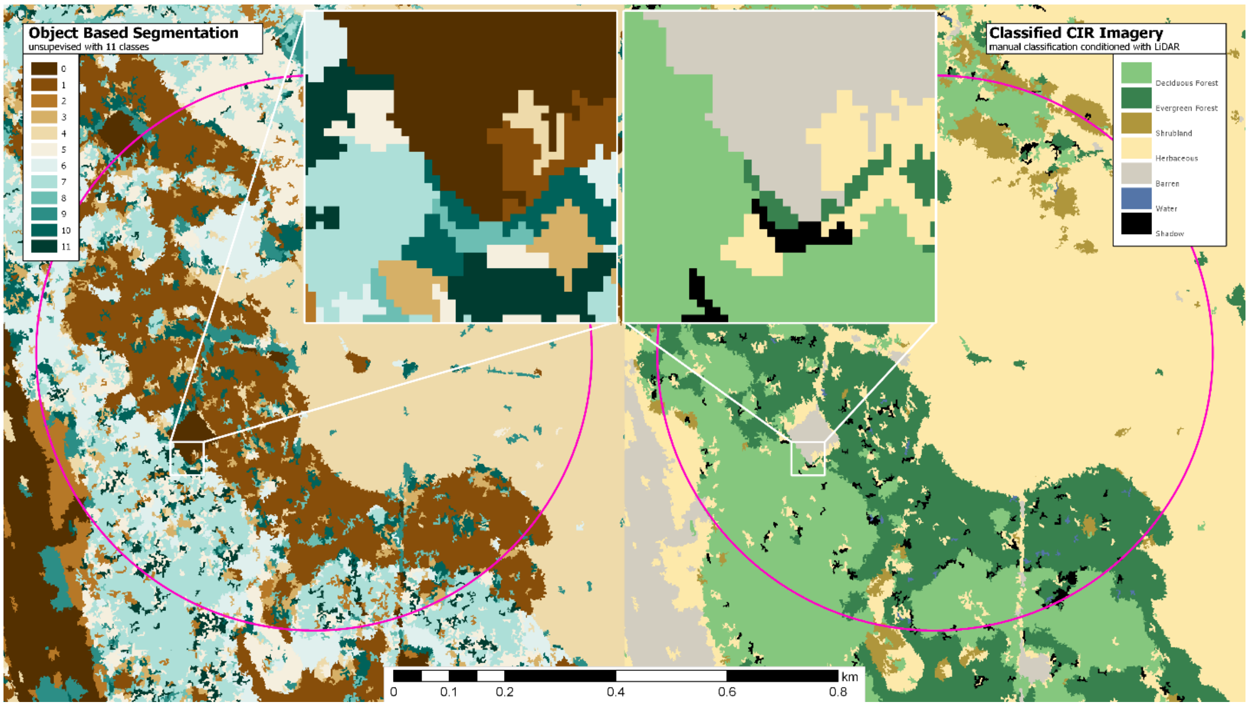

Figure 4. Unsupervised Object based Segmentation (left) and Manually Classified CIR imagery (right).

Results and Discussion

Results and statistical analysis of the receiver and source surface consistent scalars with respect to both the supervisor and unsupervised classified CIR imagery will be discussed at GeoConvention 2019.

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