Ontario

Digital Raster Acquisition Project Eastern Ontario (DRAPE) 2014 Digital Surface Model and Digital Terrain Model

User Guide

Provincial Mapping Unit
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Ministry of Natural Resources and Forestry

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Additional Information

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Executive Summary

Key Words

Digital Raster Acquisition Project Eastern Ontario, Digital Elevation Model, Digital Surface Model, Digital Terrain Model, Elevation, Orthoimagery, Orthophoto, Imagery and Aerial Photography.

Abstract

The DRAPE 2014 DSM and DTM are 2 metre raster elevation products that were generated from the DRAPE 2014 Classified LAS. These products were generated in-house by Mapping and Geomatics Services Section (MGSS) staff in a continuing effort to improve surface and ground elevation products.

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List of Acronyms

CGVD: Canadian Geodetic Vertical Datum

DEM: Digital Elevation Model

DRAPE: Digital Raster Acquisition Project Eastern Ontario

DSM: Digital Surface Model

DTM: Digital Terrain Model

IfSAR: Interferometric Synthetic Aperture Radar

LiDAR: Light Detection and Ranging

LIO: Land Information Ontario

MNRF: Ministry of Natural Resources and Forestry

MGSS: Mapping and Geomatics Services Section

NAD: North American Datum

NVA: Non-Vegetated Accuracy

PMU: Provincial Mapping Unit

RMSEz: Root Mean Square Error in Z

TIN: Triangular Irregular Networks

UTM: Universal Transverse Mercator

VVA: Vegetated Vertical Accuracy

List of Definitions

Mass Points

Mass points are irregularly spaced points, each with x/y location coordinates and z-values, typically (but not always) used to form a TIN. When generated manually, mass points are ideally chosen to depict the most significant variations in the slope or aspect of TIN triangles. However, when generated automatically, e.g., by LiDAR or IfSAR scanner, mass point spacing and patterns depend upon the characteristics of the technologies used to acquire the data.

Digital Elevation Model (DEM)

DEM is a generic term for digital topographic and/or bathymetric data that is comprised of x/y coordinates and z-values to represent an elevation surface.

The term ‘DTM’ and ‘DSM’ should be used over the term ‘DEM’ to more specifically reference ‘bare-earth’ or ‘surface elevation’ model products when possible.

The term ‘DEM’ is to be used as a broader term when referencing a generic elevation data product. The Provincial DEM is an example of a generic elevation product given that it has been constructed using a combination of both ‘DTM’ and ‘DSM’ elevation datasets to achieve Provincial coverage.

Digital Terrain Model (DTM)

The bare earth surface (lowest surface, last reflective surface, or LiDAR last-return) represents the surface of the "bare-earth" terrain, after removal of vegetation and constructed features.

Photogrammetry has traditionally generated DTMs when elevations are generated by manual compilation techniques. Unless specified to the contrary, the bare-earth surface includes the top surface of water bodies, rather than the submerged surface of underwater terrain.

Similar to a DSM, a DTM can be structured either as a vector dataset (comprised of mass points and optionally 3D breaklines) to model bare-earth elevations or a raster dataset that is interpolated from the vector elevation data to model bare-earth terrain elevations.

Using modern elevation point cloud classification algorithms and file formats, such as LAS, a DTM can represent a mass point dataset that has been classified for ‘bare-earth’ terrain elevations.

Digital Surface Model (DSM)

A DSM is the highest reflective surface of ground features captured by the sensor. This surface may also be referred to as the first reflective surface or LIDAR first-return. The DSM may include treetops, rooftops, and tops of towers, telephone poles, and other natural or manmade features; or it may include the ground surface if there is no vegetative ground cover. Photogrammetry, IFSAR, LIDAR and sonar can all provide this type of surface, yet characteristics such as accuracy and degree of detail (ability to resolve desired surface features) may vary significantly across technologies and even within the same technology. With sonar, the DSM may include sunken vessels and other artifacts, whereas the bathymetric surface reflects the natural underwater terrain. Similarly, with photogrammetry, LIDAR, and IFSAR the reflective surface may include any artifact present when the sensor mapped the area, including passing cars and trucks and similar features not normally considered to be part of a digital terrain model.

Similar to a DTM, a DSM can be structured either as a vector dataset (comprised of mass points and optionally 3D breaklines) to model surface elevations or a raster dataset that is interpolated from the vector elevation data to model surface elevations.

Using modern elevation point cloud classification algorithms and file formats, such as LAS, a DSM can represent a mass point dataset that has been classified for ‘surface’ elevation features.

1. Product Description

1.1 Acquisition

DRAPE 2014 digital imagery was collected for areas in Eastern Ontario between April 28th and June 7th 2014 in leaf off conditions. It was a collaborative funding partnership that involved municipalities, Conservation Authorities, the Province of Ontario, selected Federal Departments as well as private sector organizations. In total, there were more than 60 funding partners involved in DRAPE.

1.2 Geographic Extent

The DRAPE 2014 DSM and DTM products contain approximately 37,226 tiles (1km x 1km) each (see Figure 1). The DSM and DTM products encompass an area of approximately 37,290 square kilometers.

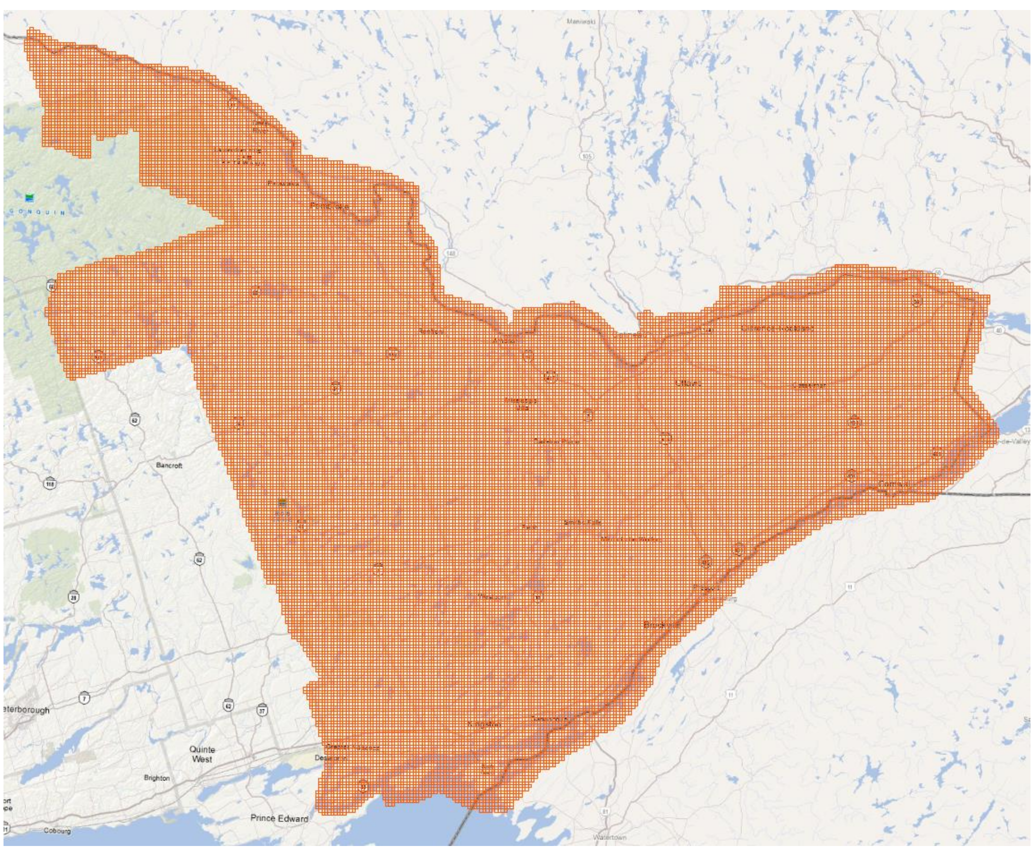

Figure 1: DRAPE 2014 DSM and DTM Tiles

1.3 Reference System

1.3.1 Horizontal Reference System

The horizontal coordinate system of the DSM and DTM are Universal Transverse Mercator (UTM) zone 18. The horizontal datum is North American Datum of 1983 (NAD83CSRS).

The horizontal unit of measure (coordinate system axis units) for all raster grid cells is metres (m).

1.3.2 Vertical Reference System

The vertical coordinate system is based on the Canadian Geodetic Vertical Datum 1928 (CGVD28) of the Geodetic Survey Division, and is measured in metres above mean sea level. For more information please see the Geodetic Survey Division of Natural Resources Canada (http://webapp.geod.nrcan.gc.ca/geod/).

The vertical unit of measure (coordinate system axis units) for all raster grid cells is metres (m). One single vertical elevation value represents each raster grid cell.

1.4 Vertical Accuracy Assessment

An assessment has been conducted to evaluate the vertical accuracy of SCOOP 2013 Digital Surface Model (DSM) and SCOOP 2013 Digital Terrain Model (DTM). To date, there has not been an assessment done specific to the DRAPE but the SCOOP and DRAPE products share many similarities. The results of the SCOOP assessments including the data can be downloaded on the metadata record of either of the SCOOP products.

1.5 Spatial Resolution

The grid spacing is based on Universal Transverse Mercator (UTM) projection with a raster cell resolution of 2 metres. This projection and resolution will match the DEM product. The rasters will be snapped together and share a common origin and resolution.

2. Product Details

The DRAPE 2014 Classified LAS was created using two products; DRAPE 2014 Raw LAS and DRAPE 2014 DEM. The Raw LAS was generated by the imagery contractor from the stereo photography using XPro SGM. The DEM was created using a proprietary ‘steam rolling’ algorithm to reduce raised surface features in the Raw LAS dataset. It is important to note that DEM does not represent a full ‘bare-earth elevation surface since it was created for the sole purpose of orthorectification of the imagery. While the ‘steam-rolling’ algorithm has allowed for some raised features to be reduced closer to ‘bare-earth’ elevations (e.g. small buildings, small blocks of forest cover), many features are still raised above ground surface, such as larger buildings, larger forest stands and other raised features. The DSM and DTM were then created by MGSS staff using the Classified LAS.

The derived products (Classified LAS, DSM and DTM) are a result of a completely automated process. These products are not intended to be a definitive final product to support all types of business needs. It is intended to assist users in further refinement of the elevation. Here is a list of known issues:

- The water contains a lot of noise and is not flat or flowing downstream.
- The pixel correlated elevation (raw LAS) was unable to penetrate dense canopy and therefore there is a lack of points to truly represent the surface in canopy.
- There are many erroneous points that have not been classified properly. These points will be represented in the DSM or DTM as either a pit or a spike.

2.1 Classified LAS, DSM and DTM

After releasing the DRAPE 2014 DEM and the DRAPE 2014 Raw LAS, MGSS staff worked with the raw point cloud LAS data to create a Classified LAS, Digital Surface Model (DSM) and a Digital Terrain Model (DTM) as seen in Figure 2.

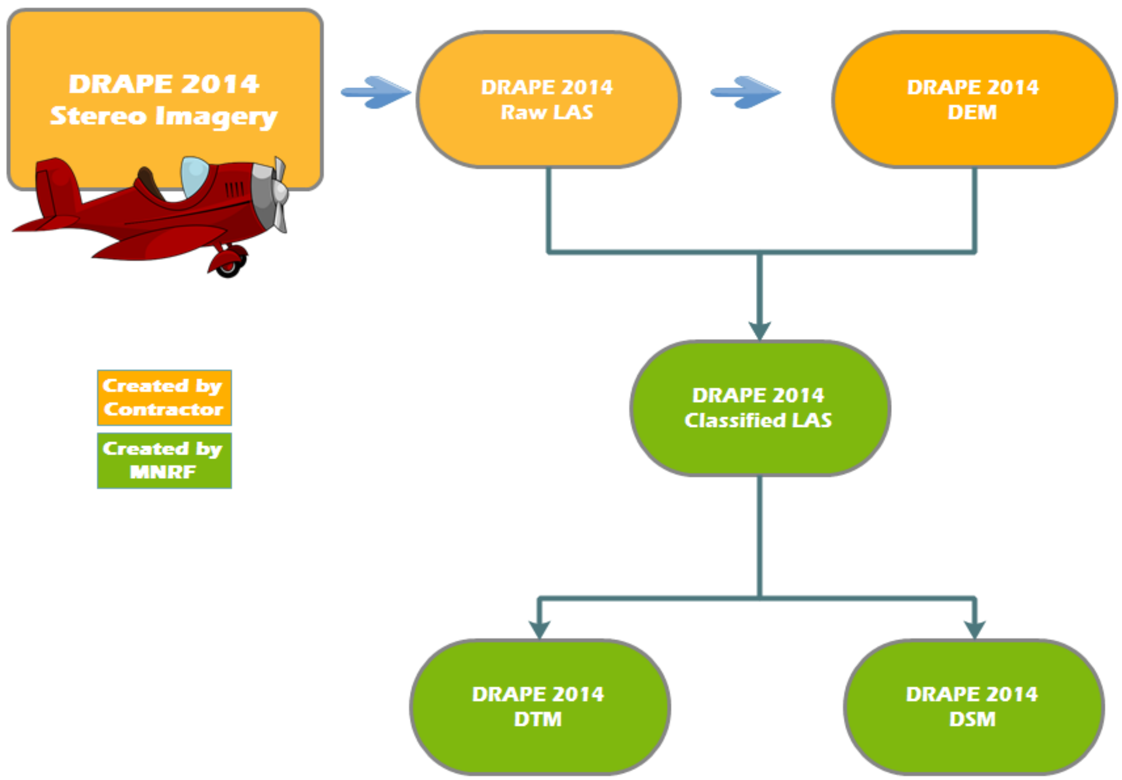

Figure 2: DRAPE Products

2.1.1 Classified LAS

The raw point cloud from the overlapping flight lines were resampled to 50cm and retiled into 1km by 1km tiles and reassembled back into LAS format. This reduces redundant points as well as reducing the number of points. During the retiling, a comparison with the DRAPE 2014 DEM was done to automatically assign the LAS classification. If the DEM was within 50cm vertically, it was assigned a LAS code of 2 (ground) otherwise it was a LAS code of 0 (unassigned).

2.1.2 DSM

The DSM raster was created by the using all the points (ground and unclassified) from the Classified LAS to create a raster product. This is a 2m resolution product matching the same tiling and resolution as the DEM. In the production of this raster, the adjacent 8 tiles are also used to prevent any edge effects.

2.1.3 DTM

The DTM raster is produce from only the ground classified points, then compared with the DSM to ensure that no DTM point would be higher than the DSM.

2.2 Data Delivery Format

DRAPE 2014 DSM and DTM is currently stored and distributed through [Land Information Ontario (LIO) Metadata Tool](https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home) (https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home).

Both DRAPE 2014 DSM and DTM products can be downloaded in nine packages (see figure 3). Each package contains multiple tiles in image format (.IMG).

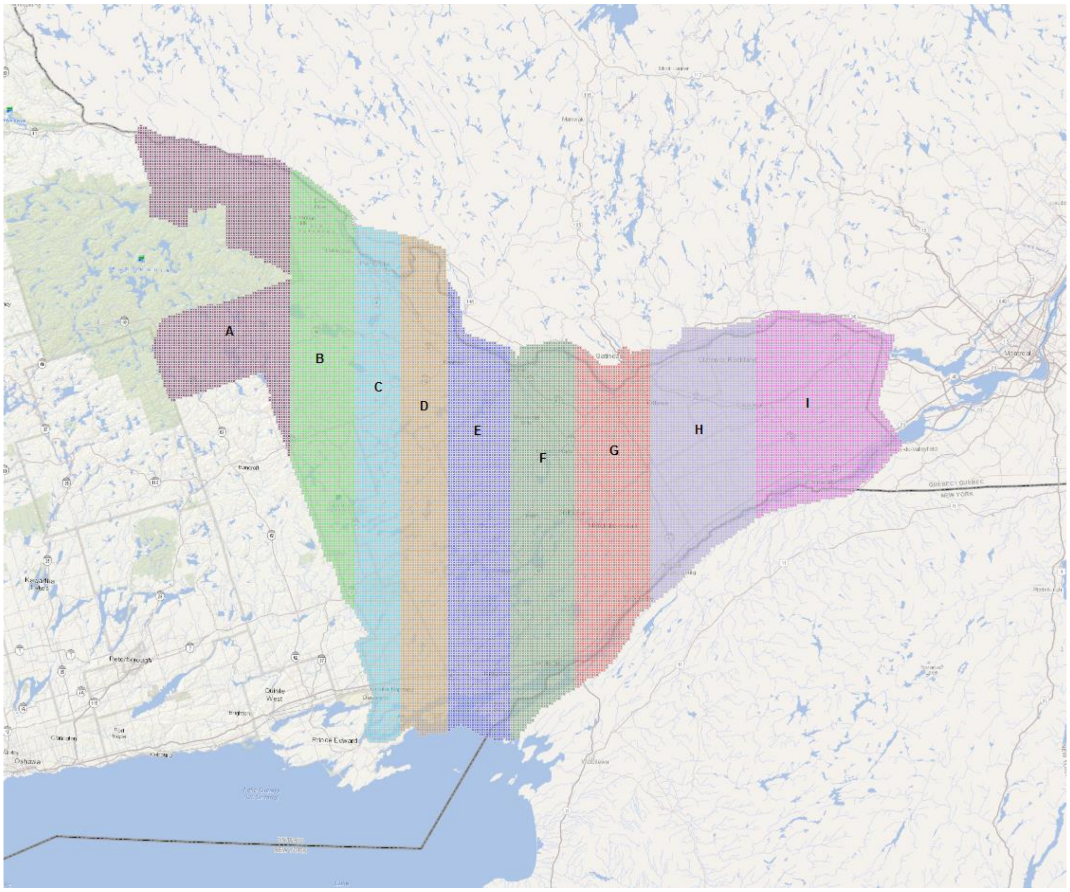

Figure 3: Nine Downloadable Packages

2.3 Use Restrictions

The DRAPE 2014 DSM and DTM are both considered Open Data. You are free to copy, modify, publish, translate, adapt, distribute or otherwise use the Information in any medium, mode or format for any lawful purpose. If you do any of the above you must use the following attribution statement "Contains information licensed under the Open Government Licence – Ontario."

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