# Using LiDAR Data to Identify Ideal Solar Panel Placement in Lawrencetown, Nova Scotia

Aila Jalo

Centre Of Geographic Sciences

## Project Overview

The goal of this project was to use LiDAR data to determine the most ideal locations for solar panels on the buildings in Lawrencetown, Nova Scotia. This analysis focused on the best solar panel placement for the Centre of Geographic Sciences building, the blockhouses and the Exhibition Grounds.

LiDAR data was provided by the Applied Geomatics Research Group and was collected on August 28, 2017. The LiDAR data was projected in NAD 83 (CSRS), UTM Zone 20, and elevations in CGVD13. A multipatch shapefile of the buildings in town were also provided for use in the project.

## Data Preparation

To conduct an analysis of the solar radiation and solar panel placement, the provided data needed to be converted to the proper file formats. A python script was created to automate the workflow.

The first step in the python script involves importing the required modules and then setting the variables, spatial reference and environments (Figure 1 and 2).

Next, the LAS point cloud was converted into a LAS dataset, which was then converted to a raster image (Figure 3). The building multipatch shapefile was also converted to a raster image, so that it could be used as an input in the solar radiation tool.

FIGURE 1: importing modules and setting variables

```
##############################
## IMPORT MODULES AND TOOLS ##
##############################

# os module
import os

# shutil module
import shutil

# shutil module
import arcpy

print(' Imported Modules: os, shutil, arcpy ')

###################
## SET VARIABLES ##
###################

print(' ')
print(' ===== SETTING DIRECTORIES AND DATA FILE PATHS ===== ')
print(' ')

## Set all variables
spatial_ref_name    = "NAD 1983 CSRS UTM Zone 20N"              # spatial reference
spatial_ref         = arcpy.SpatialReference(spatial_ref_name)  # spatial reference variable
root_dir            = r"C:\\Jalo_Lab3"                          # root directory
output              = "Jalo_Lab3_Output"                        # output folder name
output_path         = os.path.join(root_dir, output)            # output folder path
gdbase              = "Jalo_Lab3.gdb"                           # geodatabase name
gdbase_path         = os.path.join(output_path, gdbase)         # geodatabse folder path
data_og             = "Lab3_data"                               # original data folder name
data_og_path        = os.path.join(root_dir, data_og)           # original data folder path
data_copy           = "data_copy"                               # duplicate data folder name
data_copy_path      = os.path.join(root_dir, data_copy)         # duplicate data folder path
las                 = "ltown_Solar.las"                         # las file
las_path            = os.path.join(data_copy_path, las)         # las file path
bldg_patch          = "LTown_Buildings_Multipatch.shp"          # building multipatch name
bldg_patch_path     = os.path.join(data_copy_path, bldg_patch)  # building multipatch path
bldg_raster         = "LTown_Bldg"                              # building raster name
bldg_raster_path    = os.path.join(gdbase_path, bldg_raster)    # building raster path
lasd                = "ltown_Solar.lasd"                        # las dataset name
lasd_path           = os.path.join(data_copy_path, lasd)        # las dataset path
lasd_raster         = "lasd_raster"                             # las dataset raster name
lasd_raster_path    = os.path.join(gdbase_path, lasd_raster)    # las dataset raster path
lasd_terrain        = "lasd_terrain"                            # terrain file name
lasd_terrain_path   = os.path.join(gdbase_path, lasd_terrain)   # terrain file path
solar               = "solar_radiation"                         # solar radiation file name
solar_path          = os.path.join(gdbase_path, solar)          # solar radiation file path
```

## How is solar radiation calculated?

Solar radiation is calculated using the Area Solar Radiation tool in ArcGIS Pro. This tool uses a raster image representing the roof areas and heights of buildings and the location of the buildings to calculate the incoming solar radiation that would hit the rooftops in a chosen time period.

## Why calculate the solar radiation for the winter?

The incoming solar radiation is at its peak during the summer months in the northern hemisphere, and at its lowest during the winter months. The days are also shorter, meaning less total sunlight will be hitting the rooftops during the day. To ensure that solar panels will be able to provide enough useful power during the winter, the solar radiation is calculated using the winter months. If the solar panels can receive enough incoming solar radiation during the shortest days, then they would for sure be able to provide adequate power during the summer. If the solar panels are placed somewhere where they would not receive solar radiation during the winter, then they would be useless for roughly 1/3 – ½ of the year.

FIGURE 2: setting environments

```
######################
## SET ENVIRONMENTS ##
######################

# Current time, start of hydrological flattenin
# start = datetime.now()

print(' ===== SETTING ENVIRONMENTS ===== ')
print(' ')

# set workspace
arcpy.env.workspace = data_copy_path
# allow output overwrite
arcpy.env.overwriteOutput = True
# output coordinate system
arcpy.env.outputCoordinateSystem = spatial_ref
```

FIGURE 3: LAS dataset and building preparation

```
# create las dataset - Create Las Dataset tool
print(' Creating LAS dataset ')
arcpy.management.CreateLasDataset(las_path,
                                  lasd_path,
                                  "",
                                  "",
                                  spatial_ref,
                                  "COMPUTE_STATS",
                                  "RELATIVE_PATHS",
                                  "NO_FILES")

# convert las dataset to raster - Las Dataset To Raster tool
print(' Converting LAS dataset to raster ')
arcpy.conversion.LasDatasetToRaster(lasd_path,
                                    lasd_raster_path,
                                    "ELEVATION",
                                    "BINNING MAXIMUM LINEAR",
                                    "FLOAT",
                                    "CELLSIZE",
                                    0.25,
                                    1)

# building multipatch to raster - Mutipatch To Raster tool
print(' Converting building multipatch to raster ')
arcpy.conversion.MultipatchToRaster(bldg_patch_path,
                                    bldg_raster_path,
                                    0.25)

# area solar radiation - Area Solar Radiation tool
print(' Calculating solar radiation ')
# setting time span for solar radiation (Jan01-Mar31) - Time tool
timeConfig = arcpy.sa.TimeMultipleDays(2022, 1, 90)
solar = arcpy.sa.AreaSolarRadiation(bldg_raster_path,
                                    "",
                                    200,
                                    timeConfig)
```

## Analysis

Areas which receive the highest amount of solar radiation are rooftops where the plane faces south, such as the ones in Figure 4. The one which face north receive the least amount of incoming solar radiation. Small roofs which are flat are for the most part represented by a pinkish-purple colour, meaning they do not receive as much sun as the larger flat buildings.

Looking at the COGS building (Figure 5), solar panels would be best placed on any of the flat surfaces of the roof, where the roof is orange. Because the roof is entirely made up of flat surfaces, the only place which would not work would be areas of the roof that are purple, as they are receiving less solar radiation due to the obstruction of another part of the roof. The best placement for the blockhouses would be the southern facing roofs, which are yellow in Figure 5.

At the Exhibition grounds, the best locations would be the southern facing rooftops which are bright yellow in Figure 6. The next best place to put the solar panels would be the buildings running north-south by the river, whose roof planes are orange in Figure 6. While these roofs are probably receiving enough sun and solar panels could be placed there, the solar panels would still need to face the sun for them to be most effective. The solar panels would not be as effective if they were lying flat against these roofs. The panels would need to be placed facing the sun, which would not be very aesthetically pleasing, and the panels in the back would end up being partially blocked by any panels in front.

FIGURE 4: Solar radiation example

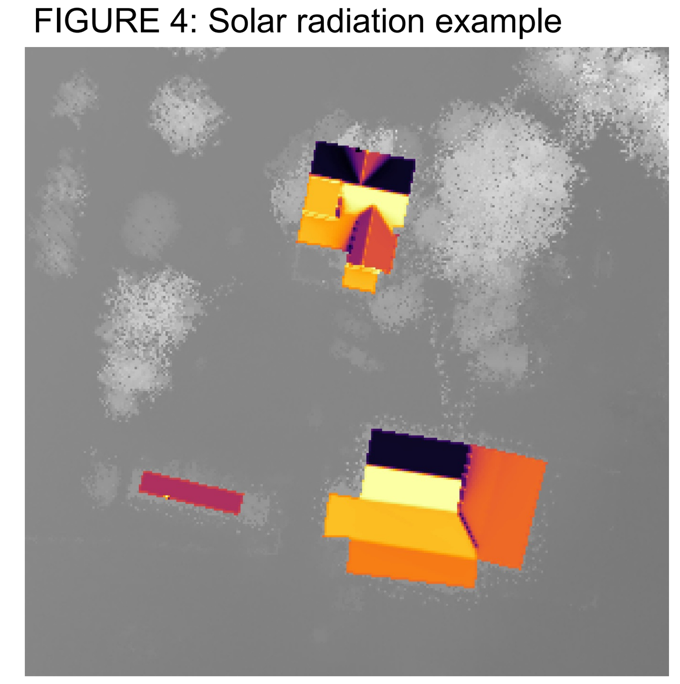


FIGURE 5: COGS campus

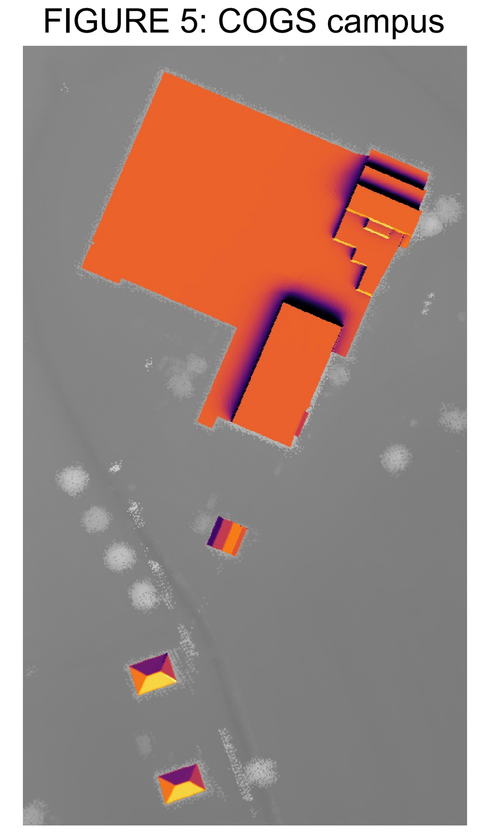
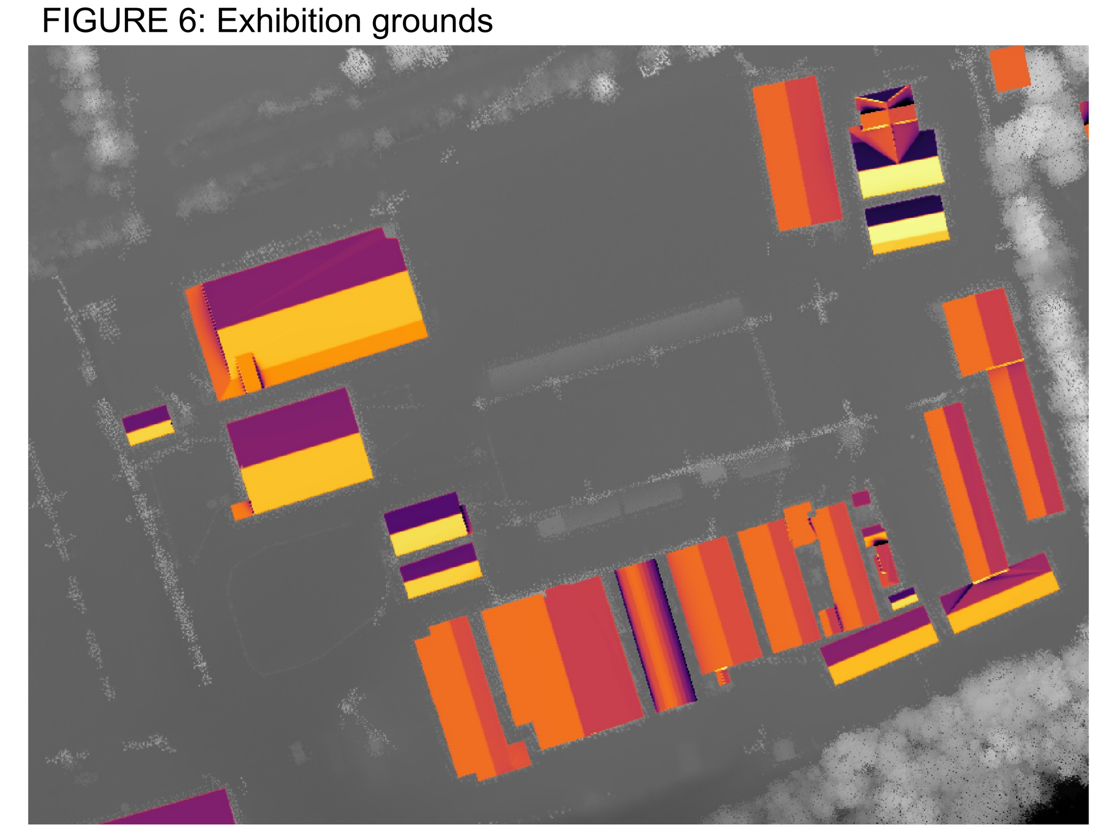
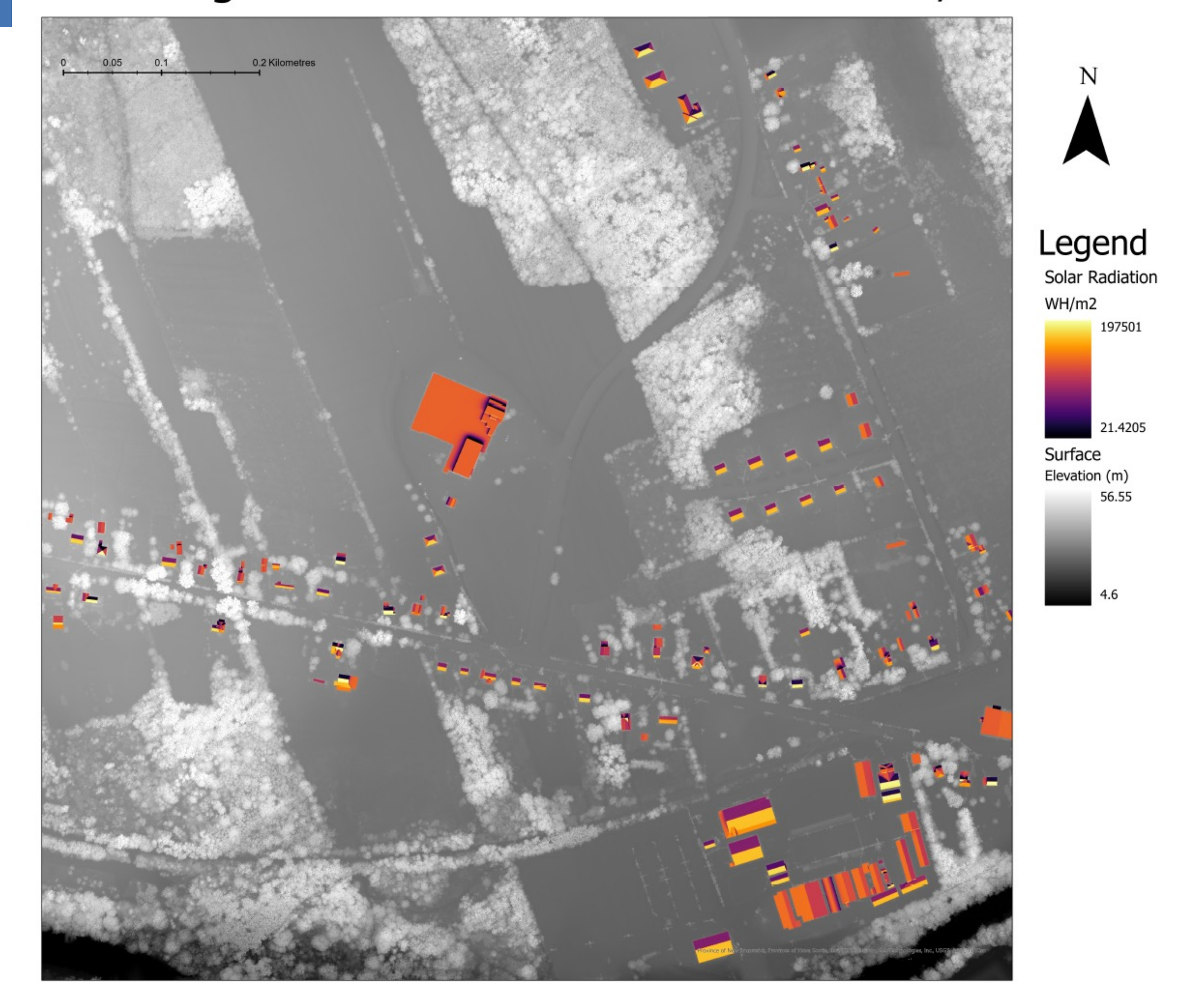
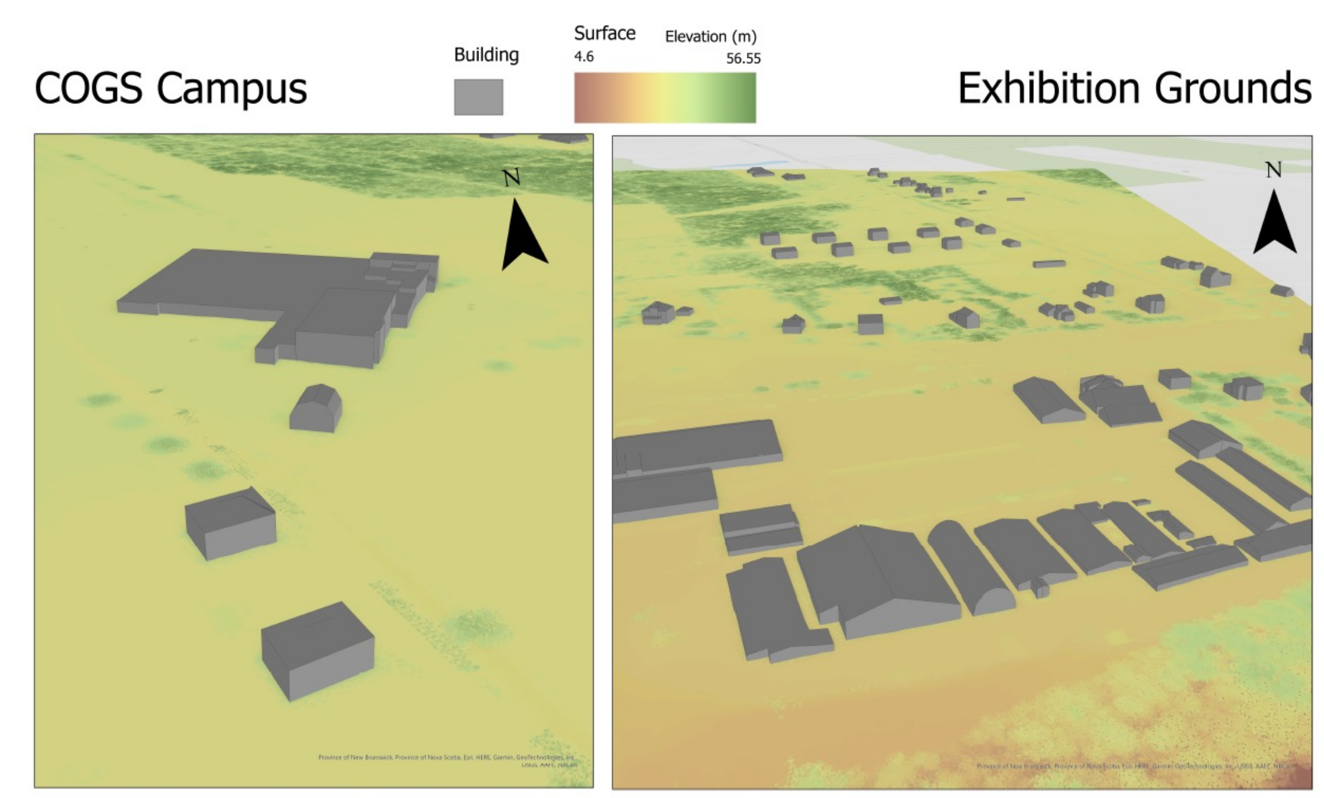


FIGURE 6: Exhibition grounds



Incoming Solar Radiation in Lawrencetown, Nova Scotia




## References and Citations

Maps produced with ESRI ArcGIS Pro.

LiDAR data: Applied Geomatics Research Group, August 28, 2017

Projection: Universal Transverse Mercator, Zone 20 North.

Coordinate System: NAD 83 (CSRS)

Elevation: CGVD13

This poster is produced by Aila Jalo as a portion of the requirements for the Remote Sensing program at the Centre of Geographic Sciences, NSCC, Lawrencetown, Nova Scotia.

This project is unedited, unverified and intended for education purposes only.



Centre of Geographic Sciences

COGS | nscc