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Estimating Solar Energy Potential in Ottawa's Sandy Hill Neighborhood using ArcGIS Pro

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Introduction

This project aims to determine the solar power potential of the Sandy Hill neighborhood in Ottawa, Canada. To achieve this goal, we used spatial analyst tools in ArcGIS Pro, specifically the Area Solar Radiation tool, to calculate the amount of solar radiation received by each suitable rooftop in the neighborhood.

The Area Solar Radiation tool is a powerful spatial analysis tool that uses a Digital Surface Model (DSM) and other input parameters to generate a raster layer showing how much solar radiation each cell in the DSM receives. In this project, we used this tool to identify suitable rooftops for solar panel installation and estimate the potential electric power production of these rooftops.

Using this approach, we were able to identify the areas in Sandy Hill that have the highest solar power potential and estimate the total amount of power that could be produced by the neighborhood. This project showcases the potential of spatial analysis tools in identifying suitable areas for renewable energy projects.

Slope & Aspect

Slope and aspect maps play a vital role in estimating the potential for solar energy generation in a particular area. Slope maps provide information about the steepness of the land surface, which affects the amount of solar radiation captured by solar panels. Steeper slopes may not be as ideal for solar power generation as they receive less direct sunlight and may require additional engineering to support solar panel installations. In contrast, flatter areas receive more direct sunlight throughout the day and may be more suitable for solar power generation.

Aspect maps are equally crucial in solar power estimation as they indicate the direction that the slope faces. This direction also impacts the amount of solar radiation that solar panels can capture. In the northern hemisphere, slopes facing south receive the most direct sunlight and are therefore more ideal for solar power generation. On the other hand, in the southern hemisphere, slopes facing north are more suitable for solar power generation.

Combining slope and aspect maps with other spatial data such as solar radiation and weather data helps in estimating the potential for solar energy generation in a specific area. This estimation can be used for planning and optimizing the placement and orientation of solar panels and determining the potential energy yield of a proposed solar power project.

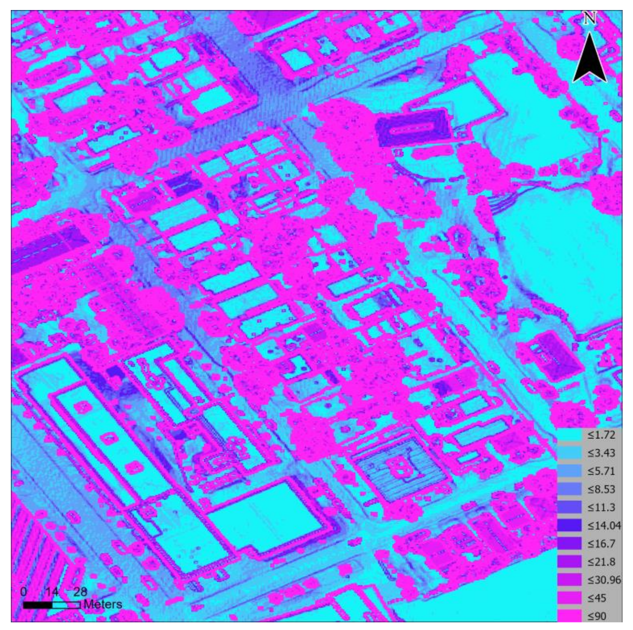

Figure 2. Raster showing slope of a part of Sandy Hill. Slope values are displayed in degrees.

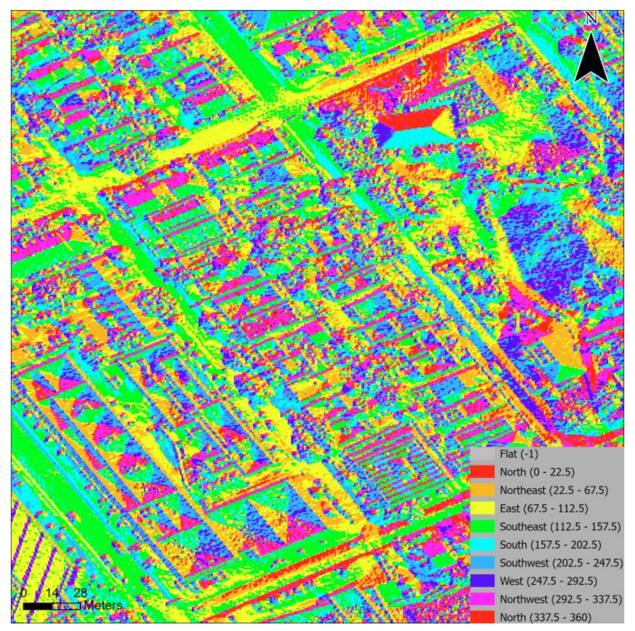

Figure 3. Raster showing aspect of a part of Sandy Hill.

Methodology

Mapping solar energy: using Ontario's publicly available Digital Surface Models (DSMs) [1] , elevation contours [2], buildings footprints [3] and other thematic data such as water bodies (all clipped using Sandy Hill neighborhood boundaries [4]), ArcGIS's Area Solar Radiation spatial analyst tool was used to model the amount of solar radiation each raster cell for buildings in the Sandy Hill neighborhood of Ottawa received in the year 2022. The data was then aggregated to determine the solar radiation received by each building in the neighborhood.

Identifying suitable rooftops: Using Surface Parameters (Spatial Analyst Tools) and by using the DSM as input and then the output for the following criteria, the suitable buildings were selected using SQL queries based on the following criteria:

1. a slope of 45 degrees or less, as steep slopes tend to receive less sunlight, using slope raster layer.
2. at least 800 kWh/m2 of solar radiation, using the created solar radiation raster, using solar radiation raster layer.
3. not face north, as north-facing rooftops in the northern hemisphere receive less sunlight, using both slope and aspect layers, removing slopes lower or equal to 10 and aspects with value greater than 22.5 and less than 337.5.

Calculate power per building: the electric power production potential was then calculated for each suitable building by multiplying the usable solar radiation by assumed efficiency and performance ratio values (!Solar_Radiation_MWh! * 0.16 * 0.86), resulting in an estimate of the total electric power production potential of the neighborhood.

3D Scene: finally, the suitable buildings were symbolized and displayed in a 3D scene using a TIN created out of contour lines and water bodies.

Results

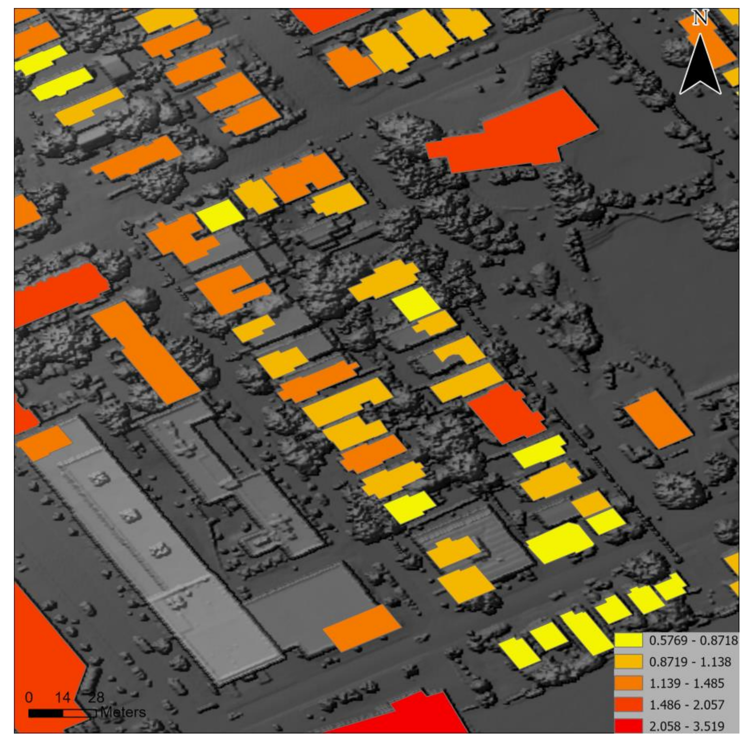

Figure 4. Suitable building polygon features over Hillshade and DSM raster layers of a part of Sandy Hill. Values are Log10 of Electrical Production in MWh for 2022.

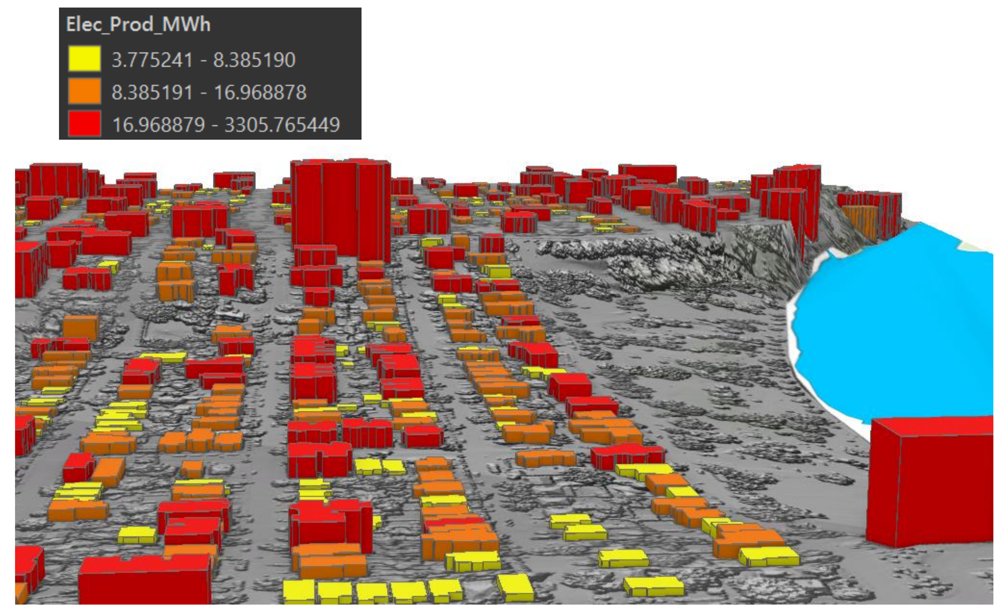

Figure 4. Suitable building scene view in ArcGIS Pro shaded with Electrical Production in MWh for 2022. TIN used as elevations surface for ground, DSM and Hillshade used as base layers. Water bodies displayed in blue.

Mean	29.50445
Median	11.69226
Std. Dev.	116.6105
Rows	1313
Count	1313
Nulls	0
Min	3.775241
Max	3305.765
Sum	38739.35
Skewness	20.08191
Kurtosis	510.0043

Table 1. Summary table of the estimate Electrical Production in MWh for the suitable buildings for 2022.

Out of the original 2216 building in the input data, 1313 were found suitable after applying the three discussed criteria.

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In 2022, Sandy Hill neighborhood had the potential to generate over 38,000 MWh.

Discussion

we can see that although there were 2216 buildings in the Sandy Hill neighborhood, only 1313 of them met the three criteria to be suitable for solar panel installation. This represents a 40% reduction in the total number of buildings in the area, indicating that not all rooftops are appropriate for solar panel installation.

Of the suitable buildings, the results show that the average potential solar radiation per square meter was 29.5 kWh, with a median value of 11.7 kWh. The high standard deviation of 116.6 kWh and a positive skewness and kurtosis suggest that the data is heavily right-skewed and that there are many buildings with low potential solar radiation but also a few with high potential.

Overall, the results indicate that the Sandy Hill neighborhood has significant potential for solar power generation. The total electric power production potential was over 38,000 MWh in 2022, which is a substantial amount of energy that could be harnessed from solar panels on suitable rooftops. These results could inform future decisions regarding the implementation of solar power infrastructure in the neighborhood.

References

Coordinate system: WGS 84 - UTM 18T
Datum: WGS84

[1] Ontario Digital Surface Model (Lidar-Derived), Ontario GeoHub https://geohub.lio.gov.on.ca/maps/mnrf::ontario-digital-surface-model-lidar-derived/explore (last visited Feb. 21, 2023).

[2] Contours, Ontario GeoHub https://geohub.lio.gov.on.ca/datasets/mnrf::contour/explore (last visited Feb. 21, 2023).

[3] Building Footprints, Open Ottawa https://open.ottawa.ca/datasets/building-footprints/explore (last visited Feb. 21, 2023).

[4] Neighborhood Boundaries, Open Ottawa https://open.ottawa.ca/datasets/ottawa::ottawa-neighbourhood-study-ons-neighbourhood-boundaries-gen-2/explore

ArcGIS Online Scene link:
https://cogsnscc.maps.arcgis.com/home/item.html?id=fc6d68d11f5e44719c15932852b6d457

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