Suitable Locations for Solar Panel Farm Development in the Niagara Region

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1.0 Research Problem/Objective

The purpose of the project is to find the most suitable locations to implement solar panel farms (fig. 1) throughout the Niagara Region. This is an important study as renewable use is increasing in the modern world, largely due to the environmental impacts of other forms of energy production. Additionally, Canada has invested heavily in renewable energy, and more specifically, $4.5 billion has been invested in Ontario alone (CBC, 2015). This project will help allocate that money, and any future investments wisely. This study is not meant to challenge previous information or assumptions but rather to assist in ideal placement of solar panel farms in the Niagara Region.

Figure 1: Solar Panel Farm, Source (solarcentury)

2.0 Research Methodology

Methodology was broken into four components. They are shown below.

2.1 Data Acquisition

Data was obtained from GeoScholarsPortal with access through Nipissing University. The data used is listed below:
- Base map of the region
- Topographic data (DEM)
- Roads, rivers, lakes, city centres
- Transmission lines
- Land use data

2.2 Preprocessing

All data was set to the proper projected coordinates (NAD_1983_UTM_Zone_17N). Then all data was clipped to the base map of the study area. Then the create layer from selection tool was used to get transmission lines and city centres shapefiles. Please refer to Appendix A for a complete flowchart showing steps in preprocessing.

2.3 Criteria

Project was completed in GIS using a Multi Criteria Evaluation (MCE) using both Weighted Linear Combination (WLC) and Boolean Intersection methods. The criteria used for this process as well as their weightings is as follows:

2.3.1 Accessibility/Boundaries

- Roads: 10m away but within 750m to avoid encroaching on existing roads while reducing construction costs associated with access road construction
- Lakes: at least 500m away to avoid environmental impact
- Rivers: at least 500m away to avoid environmental impact
- Transmission Lines: no more than 200m away to avoid construction costs associated with additional power line introduction.
- Population Centres: 4km away but within 20km to avoid construction to close to existing development while avoiding excessive travel from city centres for construction and maintenance.

2.3.2 Topography

- Slope and Relief: preferred areas are flat to reduce additional construction costs associated with building on a sloped surface.
- Aspect: In Northern Hemisphere solar panels should be pointed south to be exposed to the most sun.

2.3.3 Land Use/Type

- Land Type: types like forest and water are unacceptable, while barren or non-vegetated land is ideal
- Land Use: urban and active agricultural land should be avoided, while idle agricultural lands or unused land is preferred.

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2.4 Analysis

Analysis was broken into four different sections. They are listed below.

2.4.1 Topography Analysis

Elevation data, slope, aspect, and relief were calculated from the acquired DEM. They were inputted into raster calculator to create a map showing preferred locations regarding regional topography (Figure 2). Please refer to Appendix A for a complete flowchart showing steps taken in topographic analysis.
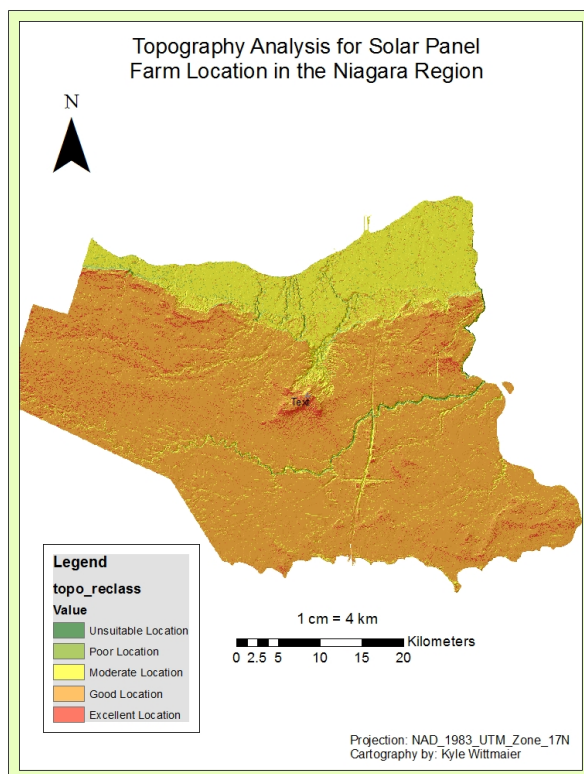

Figure 2: Topography Analysis for Solar Panel Farm Location in the Niagara Region

2.4.2 Accessibility/Boundaries

Euclidean distance for population centres, transmission lines, lakes, rivers, and roads were calculated. Datasets were classified and reclassified to rank preferable locations. They were then inputted to raster calculator to create a map showing preferred locations regarding accessibility/boundaries (Figure 3). Please refer to Appendix A for a complete flowchart showing steps taken in accessibility/boundary analysis.
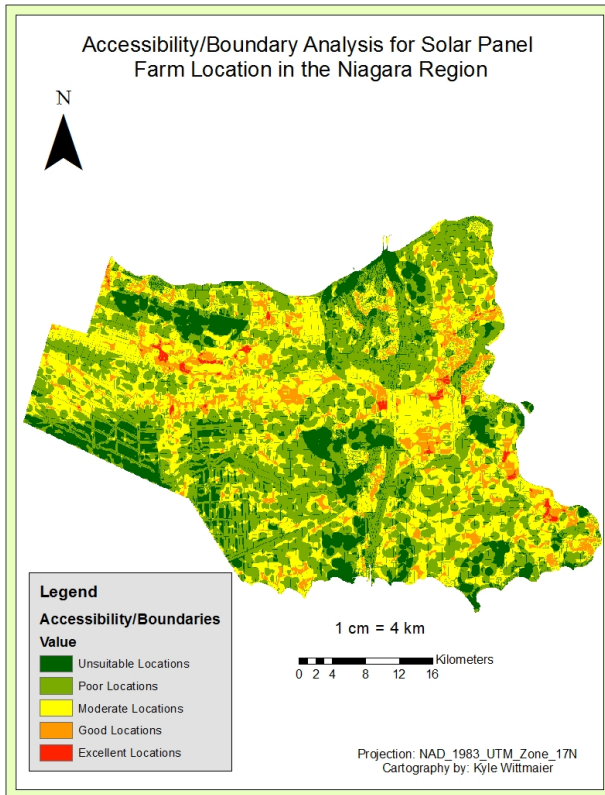
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Figure 3: Accessibility/Boundaries Analysis for Solar Panel Farm Location in the Niagara Region

2.4.3 Land cover/use Analysis

Land use data was converted to raster then classified and reclassified to rank preferable locations and shown on a map (Figure 4) Please refer to Appendix A to see all steps taken in the land cover/use analysis.
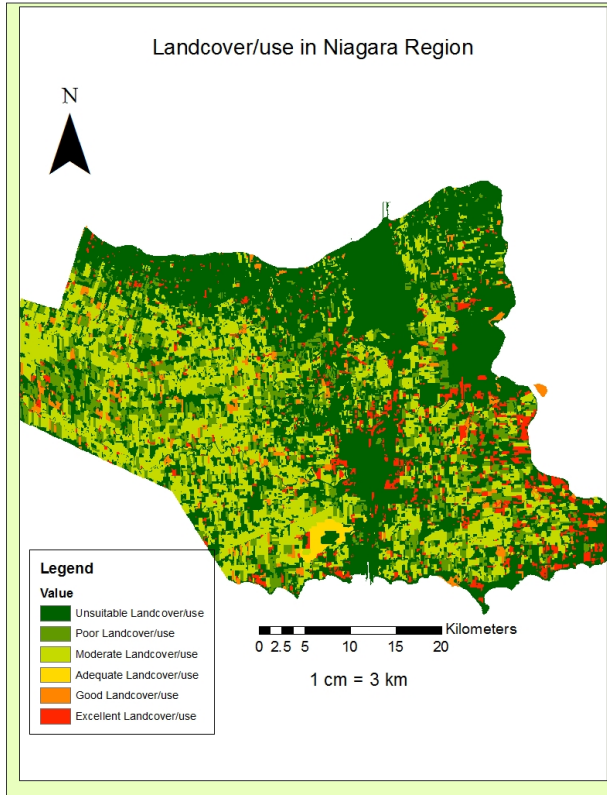
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Figure 4: Land Cover/Use Analysis for Solar Panel Farm Location in the Niagara Region

2.4.4 Final Combination of Factors

Final topography, accessibility/boundaries, and land cover/use maps were weighted using the Weighted Sum tool. Boolean logic was then applied to the accessibility/boundaries data to remove restricted locations, creating the final map showing suitable locations. Please refer to Appendix A to see a complete flowchart showing all steps taken during the final combination.

3.0 Results

The results (Figure 5) show there are limited areas in the Niagara Region that are suitable for solar panel farm location. However there are some areas that would be suitable. Three notable clusters of suitable locations appear. One is in the western portion of the region and is south of the Lincoln residential area. Another is in the eastern portion of the map and is southwest of the Niagara Falls residential area. The third is in the southeastern portion of the region and is northeast of the Lincoln residential area. The southwestern portion of the region is void of suitable areas largely due to the lack of transmission lines in the area.
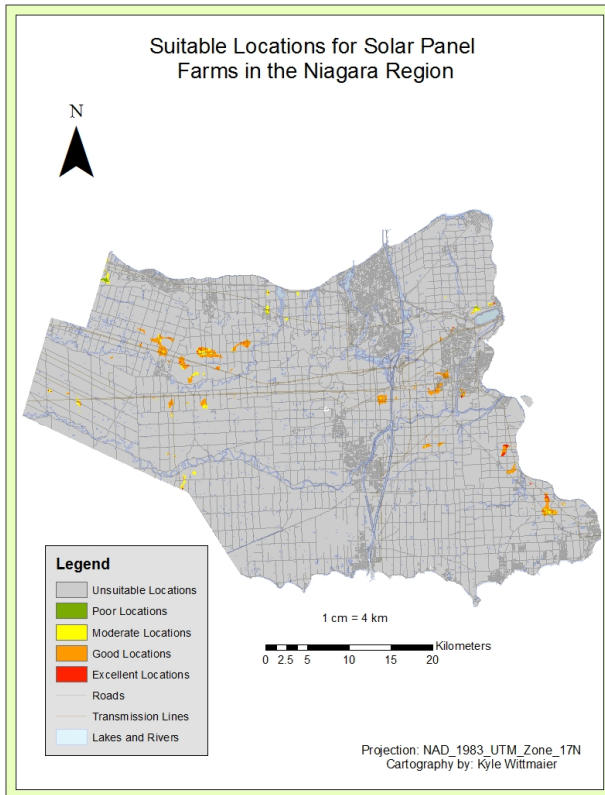
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Figure 5: Suitable Locations for Solar Panel Farm Development in the Niagara Region

4.0 Final Thoughts and Considerations

The $4.5 billion that Ontario recently invested will be split among different forms of renewable energy. When discussing the development of solar panel farms, areas near Lincoln, Niagara Falls, and Fort Erie are prime target areas. Due to the Niagara Region being a small area geographically, the study was operated under the assumption that the solar irradiance was uniform across the region. Characteristics of adjacent land are also important when thinking of solar farm locations. For example. They should not be placed next to areas of high elevation or in valleys due to limited sun exposure. Simply using elevation as a factor in the MCE method may not be ideal as an area with high elevation may still be adjacent to an area with even higher elevation, limiting sun exposure. Providing a topographic map to avoid construction in these areas may be beneficial. It would also help to obtain Landsat imagery of the region to create an accompanying image using PCI Geomatica classifying different land cover types to ensue solar panels are not constructed next to forested areas limiting sun exposure. You could also use the land cover/use map created in step 2.4.3.
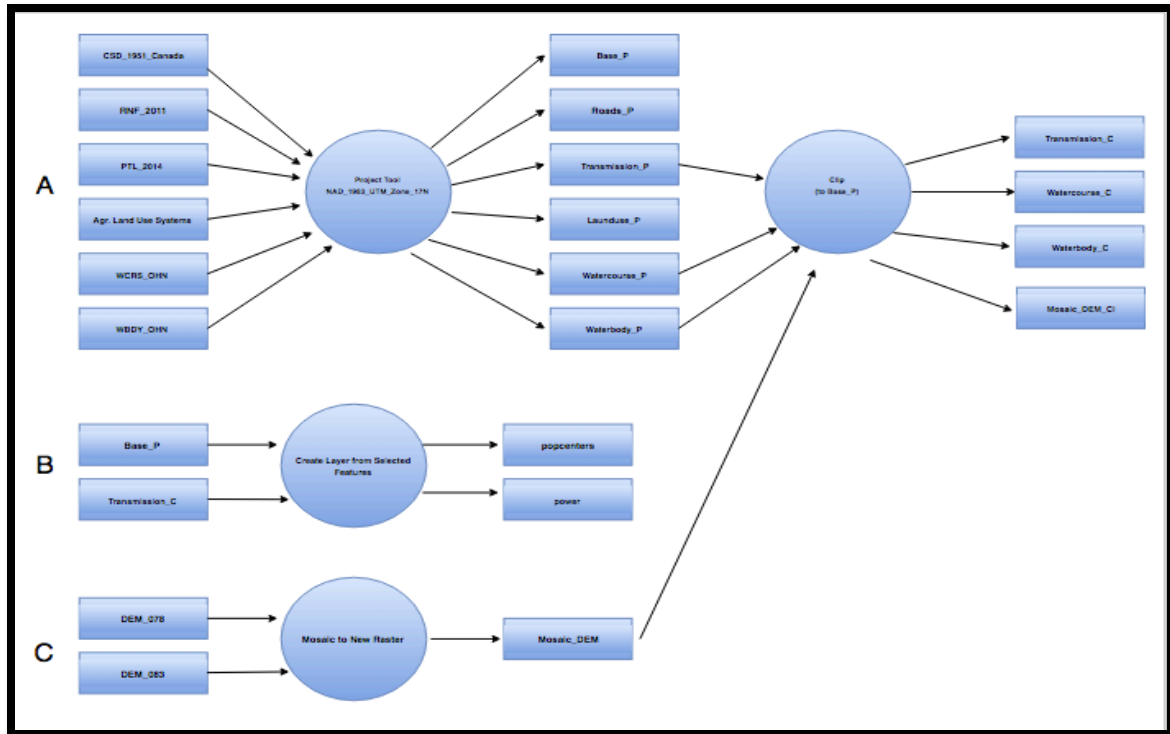
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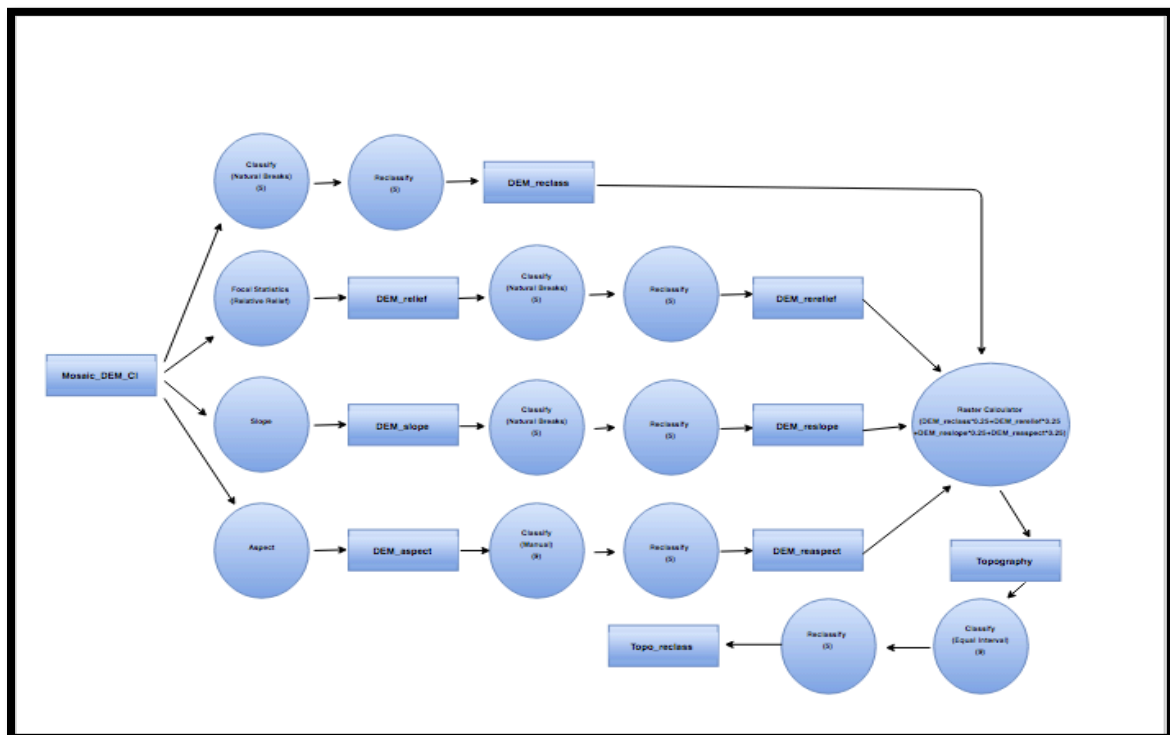# Appendix A: Flowcharts

Figure 6: Preprocessing Flowchart

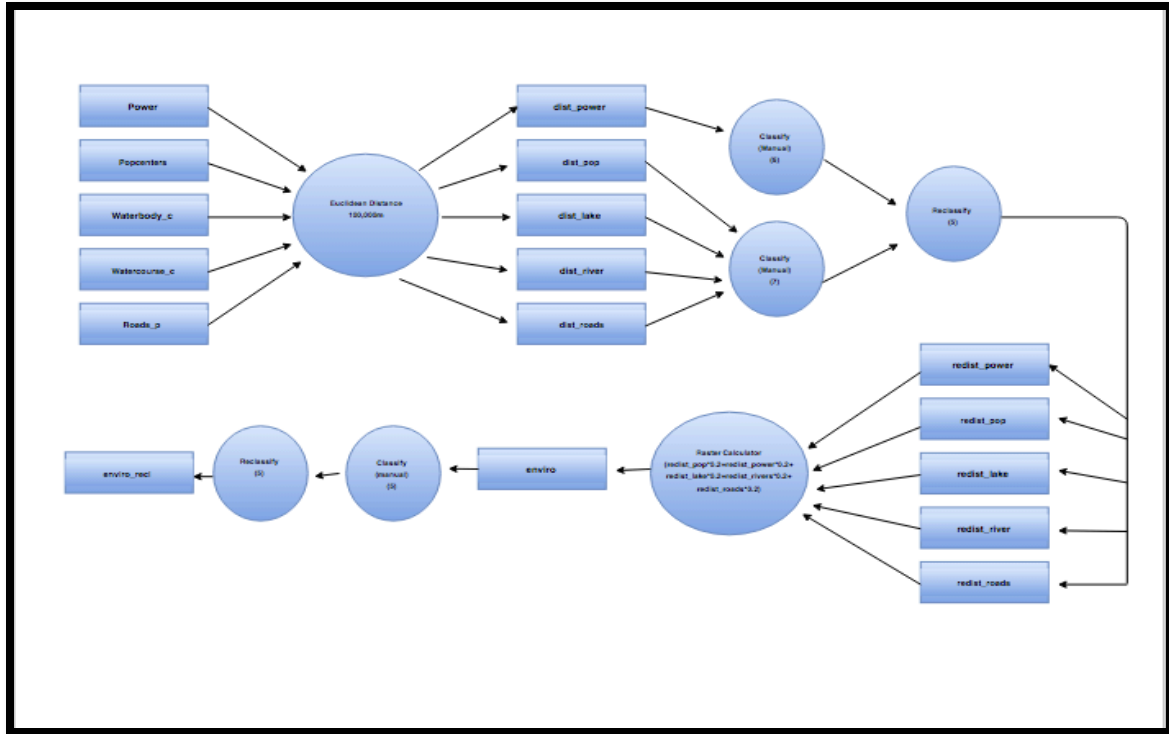

Figure 7: Topography Analysis Flowchart

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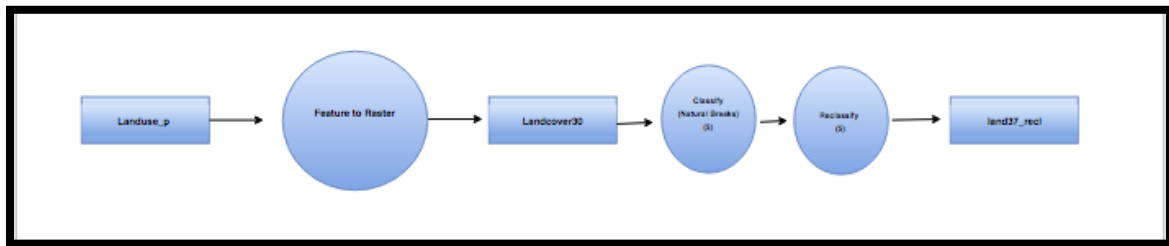**Figure 8: Accessibility/Boundaries Flowchart**

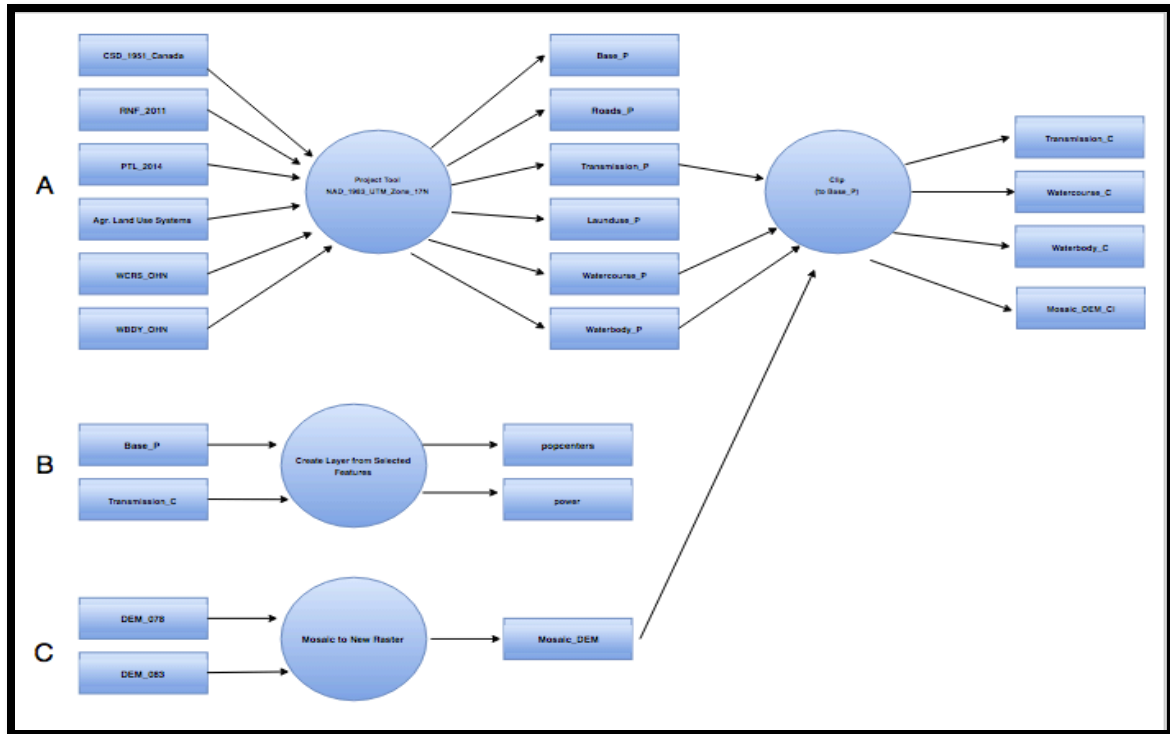**Figure 9: Land Cover/Use Flowchart**

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Figure 10: Final Combination of Factors Flowchart

References

$11B invested in renewable energy in Canada in 2014: Report. (2015, September 17). *CBC News*. Retrieved February 2, 2016, from http://www.cbc.ca/news/business/11b-invested-in-renewable-energy-in-canada-in-2014-report.

Janke, J. R. (2010). Multicriteria GIS modeling of wind and solar farms in Colorado. *Renewable Energy, 35*(10), 2228-2234.