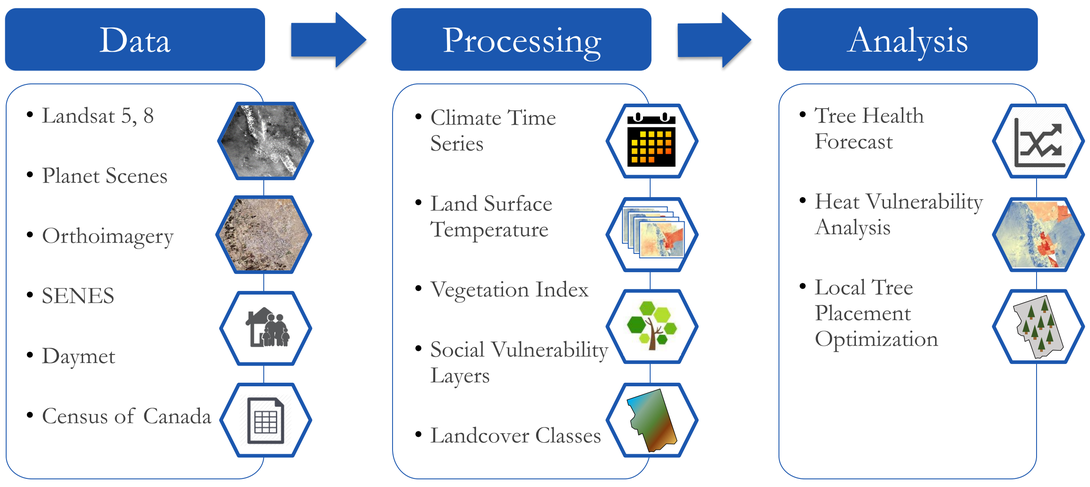
Utilizing NASA Earth Observations to Assess Urban Forest as an Adaptation Strategy for Extreme Heat in Ajax, ON, Canada

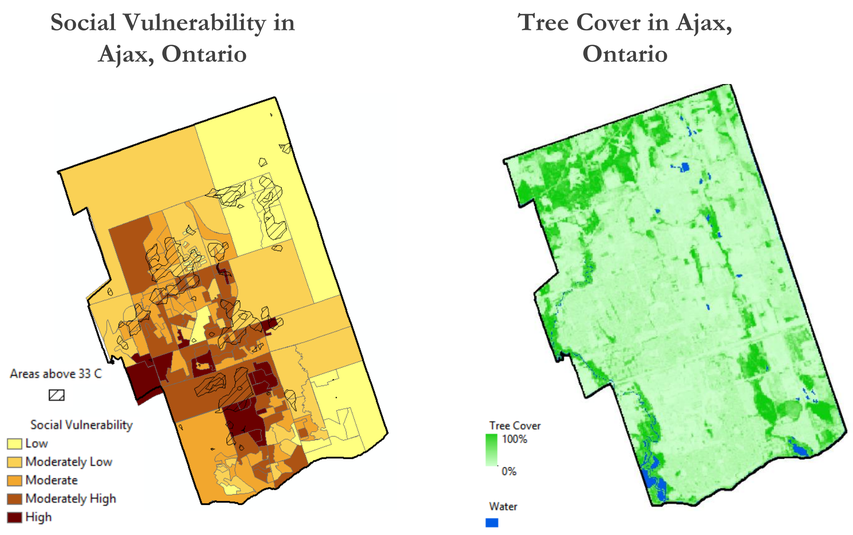
Abstract

The town of Ajax, Ontario received a report from Specialists in Energy, Nuclear and Environmental Sciences (SENES) Consultants detailing the likely changes in local weather patterns for 2040-2049. The climate model predicts an increase in the frequency and intensity of monthly rainfall, a decrease in annual snowfall, and an increase in average annual temperature of approximately 4 °C. The Town of Ajax, Operations & Environmental Services aims to take early action to mitigate the potential impacts of these changes, such as increased tree fatalities and extreme temperature. In particular, tree fatalities due to increased stress, disease, and infestation are of special concern because trees are an important resource for ameliorating extreme temperatures via shading and evapotranspiration. To create a model for how tree stress varies in conjunction with climate variables, Landsat 5, Landsat 8, and high-resolution imagery from 2000 to 2016 were used to estimate the tree canopy coverage and land cover classes. Combined with meteorological data, these classifications were used to examine the relationship between tree stress and climate variables such as temperature and precipitation. To supplement these results, the group used an ENVI-MET model simulation to perform a case study that determined the optimal tree placement and orientation in a vulnerable residential area within the city. These results will provide city planners with tools needed to plan for the predicted increase in extreme heat events and mitigation of the effects on the community.

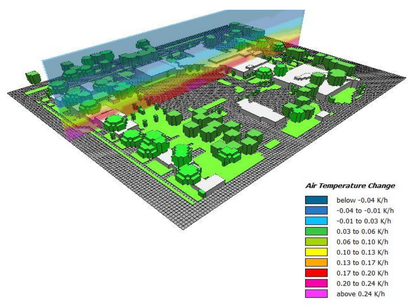
Methodology



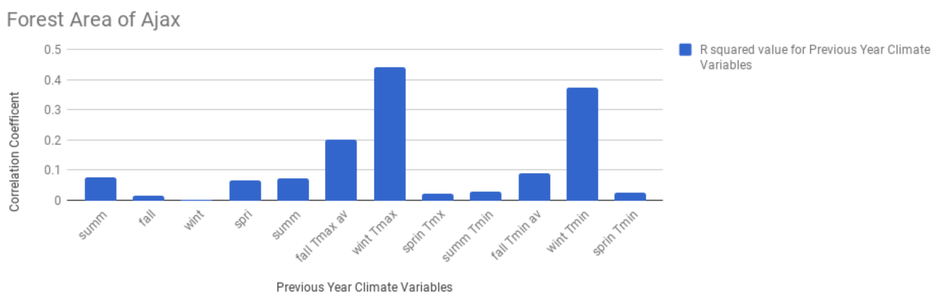
Results



The map on the left is a compositional map of a social vulnerability index and land surface temperatures for 2016. The overlapping areas between the two areas represent geographic locations where the populations are most vulnerable to extreme heat. The map on the right displays Ajax tree cover for 2016, calculated using a Random Forest regression with Landsat 8 surface reflectance data.



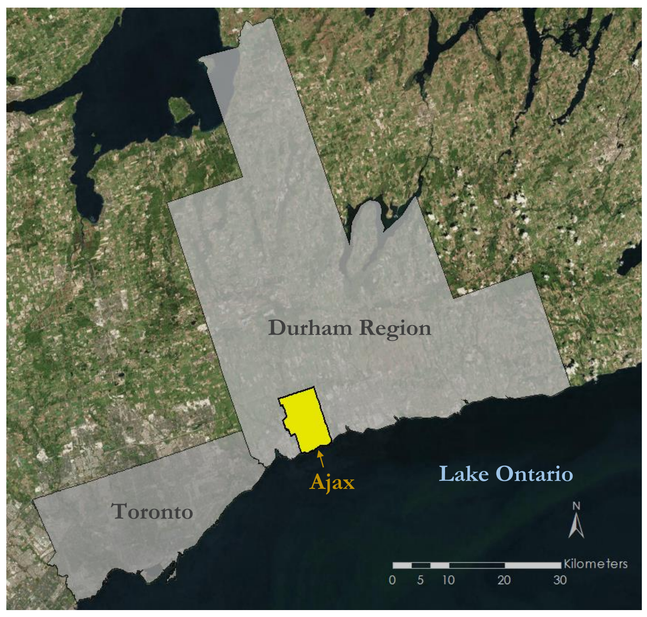
The image to the left shows how air temperature flux varies around Ajax's Town hall. The vegetated areas have a lower temperature flux than the paved areas, indicating that added vegetation could reduce the maximum temperature and increase thermal comfort. The graph below depicts correlation coefficients for climate variables of the previous year as a function of annual NDVI averaged out in forested areas of Ajax for the 2000 – 2016 time period. Average maximum winter temperatures are shown with the highest R-squared value at 0.4.



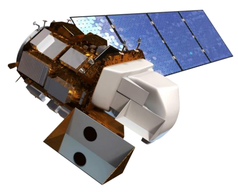
Objectives

- **Analyze** arrangements of trees, at the block scale, that will help mitigate the vulnerability and risks associated with extreme heat
- **Forecast** tree stress based on projected changes in weather patterns
- **Identify** regions where Ajax residents are most vulnerable to extreme heat
- **Create** a 2017 land use and land cover classification for the town of Ajax, Ontario

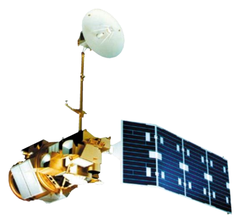
Study Area



Earth Observations



Landsat 8



Landsat 5

Project Partners

- Town of Ajax, Operations & Environmental Services
- Great Lakes and St. Lawrence Cities Initiative
- Arizona State University, Urban Climate Research Center

Conclusions

- Some results indicate that average maximum and minimum temperatures of the previous winter may be a rough indicator of tree health in areas with natural cover.
- Areas with consistent tree cover tended to be in residential areas.
- Low correlation between climatic variables & NDVI in residential areas may be due to residential areas being better managed.
- Areas in central Ajax tend to be more vulnerable to extreme heat.

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