uOttawa

Professional Development Club Initiative

Level of Heat Stress Mapping

uOttawa Participants

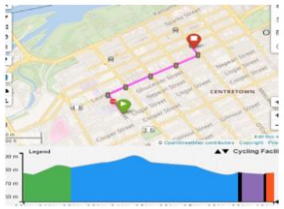
1. Prof. Liam Peyton (Vice-Dean (Graduate Studies) EECS and Professor)
2. Prof. Yongyi Mao (Professor for School of Electrical Engineering and Computer Science, University of Ottawa)
3. Prof. Glen Kenny (Professor for Faculty of Health Sciences, University of Ottawa)
4. Prof. Ahmad Jrade (Associate Professor for Construction Engineering and Management, University of Ottawa)
5. Prof. Bahram Daneshfar (Associate Professor, University of Ottawa)

Students:

- Farzaneh Farshad Process Analyst Intern at City of Ottawa (Jan 2020-Aug 2020) ; Masters in Civil Engineering (uOttawa)
- Simardeep Singh Current Project Manager for LOHS Project; Masters in DTI (uOttawa)
- Parth Patel Masters in Mechanical Engineering (uOttawa)
- Gurbhej Singh Masters in System Science (uOttawa)

Potential Partners

1. City of Ottawa: Original project idea Zlatko, previous Innovation lead for Innovative Client Service Department. Possible continuation with Ottawa Public Health
1. WSP : Anna Robak from WSP's Future Ready program and Jonathan Loschmann from the Ottawa office of WSP. We are submitting a joint proposal to MITACS
1. CAPE: Canadian Association of Physicians for the environment who support projects to better understand how the environment affects human health in order to be a resource to others
2. Bike Ottawa : an incorporated, not-for-profit organization who has done similar projects:







Potential Collaboration with UBC, Vancouver

1. UBC Vancouver conducting similar study to map heat stress
2. Volunteers in Vancouver will traverse a route in the city, equipped with high-tech sensors to monitor temperature as they travel.
3. Our approach uses similar heat stress mapping along with temperature prediction and cooler route suggestion using Machine Learning and ARCGIS models.
4. Similar studies have been conducted for Boston and Tokyo

Challenge Problem

Associated Health problems, sedentary lifestyle, obesity, respiratory disease, diabetes, cardiovascular disease etc. are increasing due to the car dependent cities and suburbs (Cervero & Duncan, 2003)

One of critical fundament of public health and active transport policy is Cycling (Iseki & Tingstrom, 2014)

Average temperatures are creeping up due to the climate change

Project Objective(s)

1. To develop methodology that provides route guidance based on minimizing summer heat load, for walkers, runners and cyclists.

2. Enables safe outdoors access for more hours of the day, as high-heat days increase.

Future Benefits

1. Planning analyses which travellers can make decision of taking routes for cycling based on the effort and energy required
2. Identifying existing, and planning future ‘shade corridors’ for pedestrians and cyclists by prioritize tree planting
3. May lead to a new urban planning metric

Methodologies and Current Progress

1. Extracting route heat from ARCGIS

   Farzaneh Farshad** Process Analyst Intern at City of Ottawa (Jan 2020-Aug 2020)
   Masters in Civil Engineering (uOttawa) (Worked for Winter, Summer 2020)

1. Determine route shading from Google Street View Images

   Simardeep Singh** Current Project Manager for LOHS Project
   Masters in DTI (uOttawa) (Working for Winter, Summer 2020)

1. Instrumented survey bike, directly measure solar load

   Parth Patel, Masters in Mechanical Engineering (uOttawa) (Working for Winter, Summer 2020)

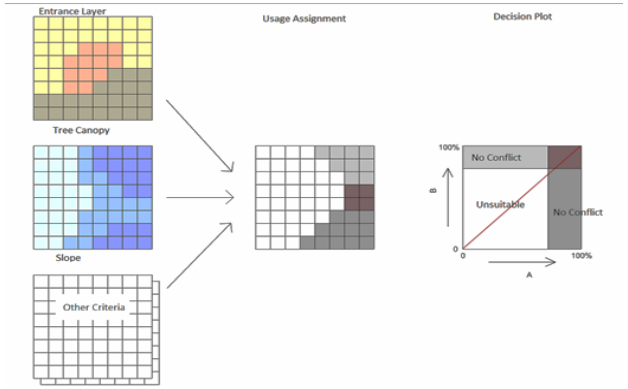
1. Extract shadow map from Openstreetmap 3D models

   Gurbhej Singh, Masters in System Science (uOttawa) (Working for Fall 2020, Winter 2021)

Extracting route heat using ArcGIS

Farzaneh Farshad, Civil Engineering, (Winter, Summer 2020)

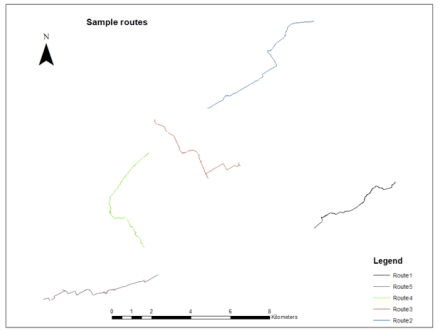
1. Suitability analysis is applied to support decision making with cycling paths.
2. Suitability map is extracted from suitability analysis which shows areas and locations that are ideal for a cycling in form of thematic map (Cycling Suitability Map in terms of Heat Load).
3. Index overlay analysis is one of the most common methodologies in GIS which is usually used in multicriteria issues like site-suitability.
4. Intersection of different levels of rasters and data is done in GIS to produce such a suitability analysis.
5. suitability models determine the best or most desirable locations for the ideal path out of the 5 sample routes in heat events.

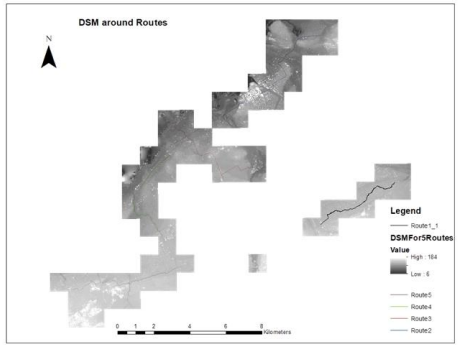


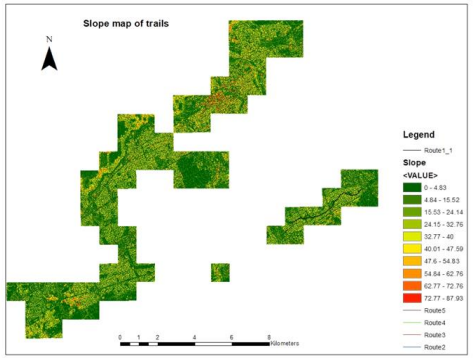
Extracting route heat using ArcGIS

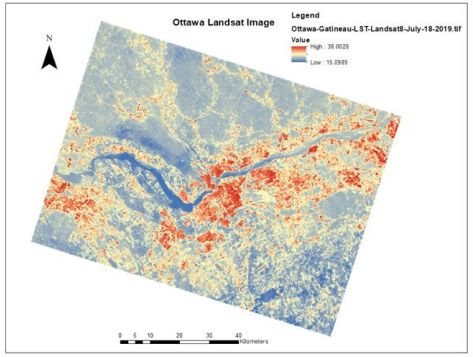
Farzaneh Farshad, Civil Engineering, (Winter, Summer 2020)

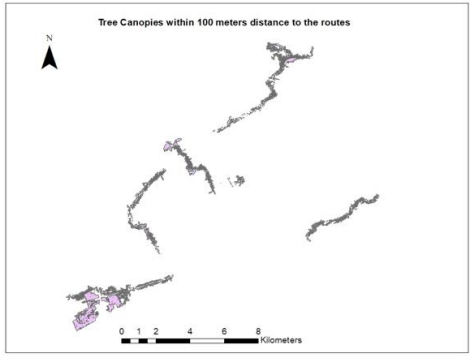
1. Data and Rasters used for the analysis:
2. DSM of Ottawa to extract slope map from
3. Landsat images to extract temperature of the locations in the trails and considering heat island effect
4. Tree canopies around the chosen trails

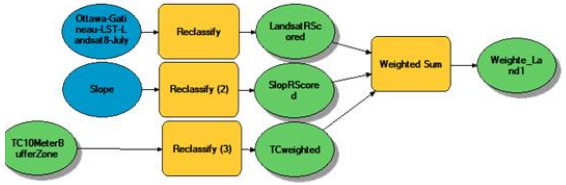




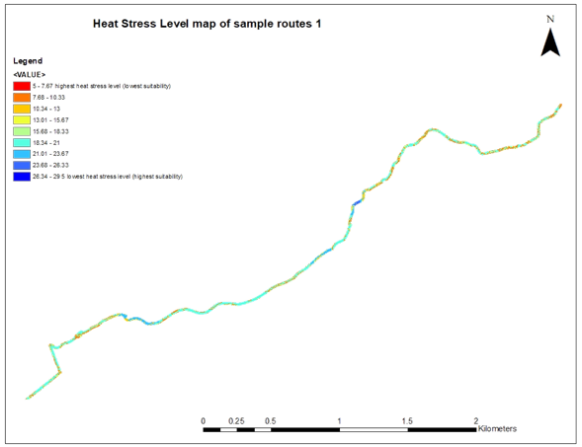


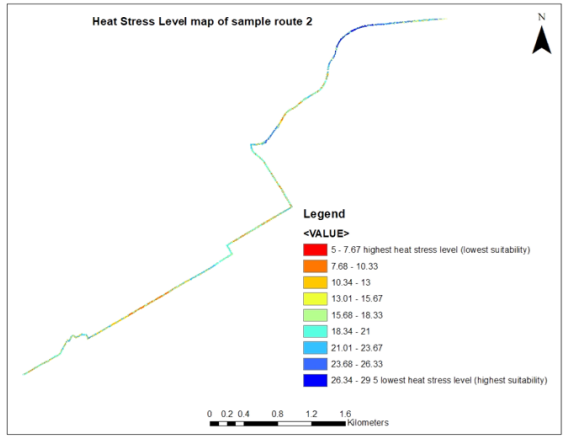


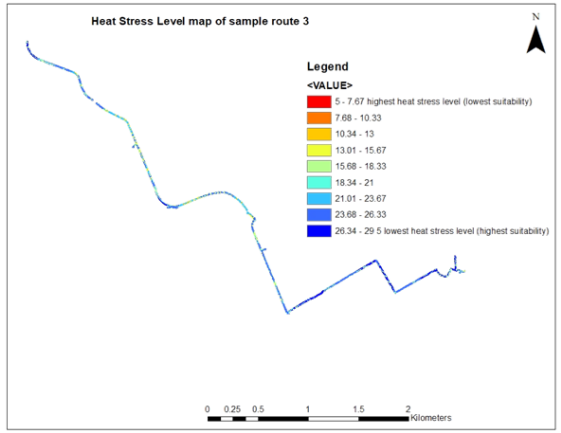


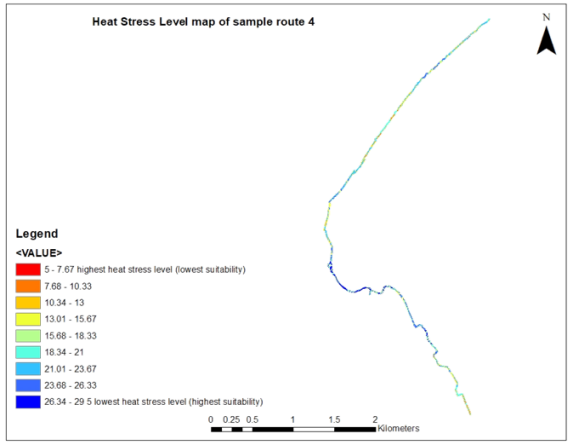


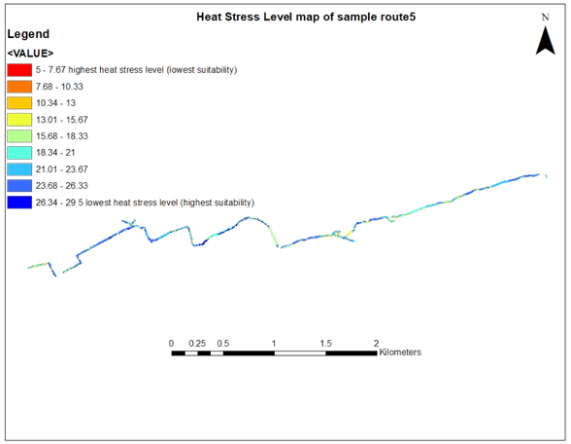
1. Comparing result maps and suitability profiles, we can conclude that route 3, route 4 and route 5 has the less heat stress level respectively along the way. Then route 1 and then route 2 has less heat stress level.
2. The level of the heat is also shown along the way for each route through the maps. It shows which part of the route has more heat stress level.
3. These maps can be used for tree planting. The 1st , 2nd route may need more trees to be planted along the way.





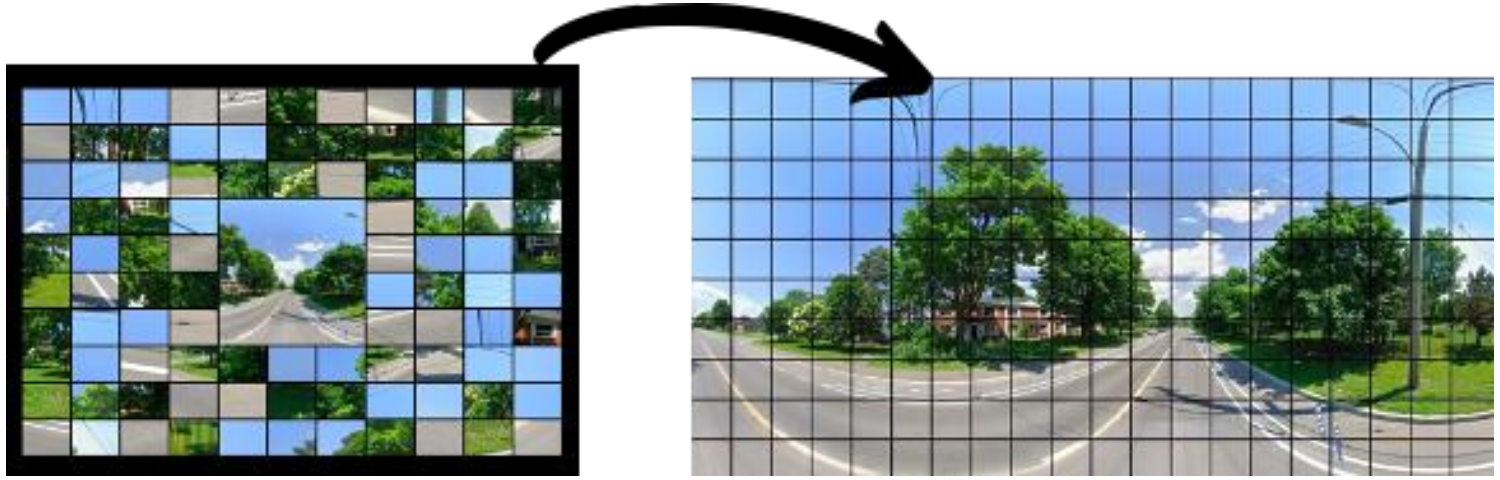






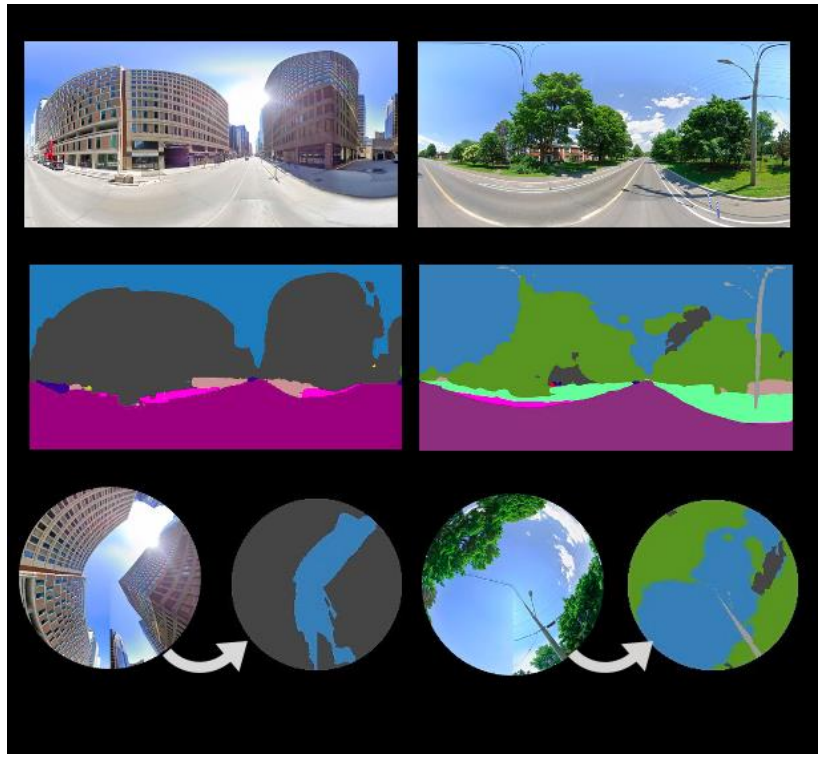
Determine route shading from Google Street View Images (Simardeep Singh, DTI, Summer 2020)

Google Street View, an online service from Google provides panoramic views of the city streets throughout much of the world. By using Google Static Image API, one can request a street view image with the specified location coordinates.



Determine route shading from Google Street View Images (Simardeep Singh, DTI, Summer 2020)

- GSV, SVF and BVF images can be used to segmented through the SEGNET to classify roads, trees and buildings.
- With an extensive SVF sample within a city, one can easily understand the effects of urban geometry on urban environmental indicators such as outdoor thermal comfort, solar radiation, daylight availability, traffic noise, and so on.
- Article for the same soon be published in CSLA Magazine



Determine route shading from Google Street View Images (Simardeep Singh, DTI, Summer 2020)

Currently, we are targeting the Sky view factor, Green View Factor and Building View Factor for major routes of Ottawa to map the greenery of the routes of Ottawa and further collaborate with Bike Routing Techniques and Shadow Calculation to truly design new cooler routes



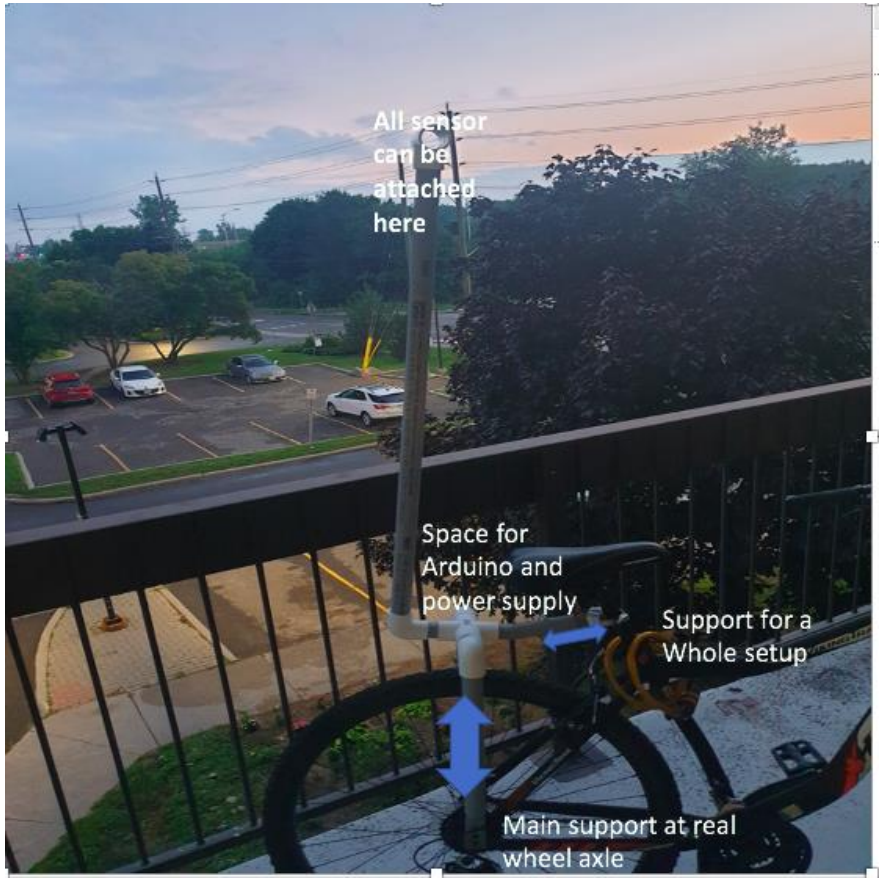
Instrumented survey bike, directly measure solar load

(Parth Patel, Summer 2020, Mechanical)

- By collaborating with CEED (uOttawa), sensors are being installed on a bike cycle to measure humidity, temperature and latitude and longitude of bicycle routes across Ottawa.

Here are the list of sensors installed in the bike:

- Arduino
- Temperature sensor: DS18B20
- Humidity Sensor: DHT 11
- GPS module: GP20U7
- Real Time clock: DS1307
- Solar cell: Silicon solar cell
- Arduino Uno X 2 (And now new microcontroller ATMEGA 2560)



Instrumented survey bike survey sensor log

(Parth Patel, Summer 2020, Mechanical)

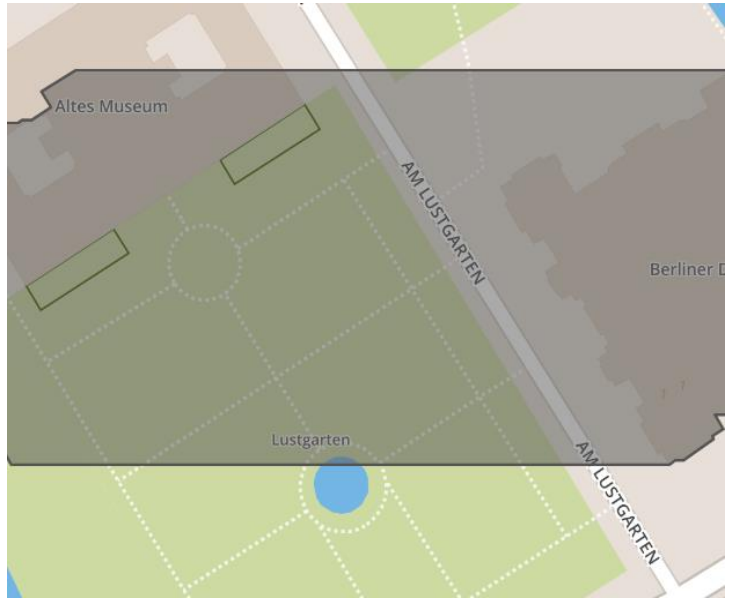
- Data collection for 5th August through bike sensor(s)
- Latitude, Longitude, Date, Time, Humidity and Temperature are captured
- Will be used to analyze the routes and match the results with Machine Learning Models

Date	Time	Latitude	Longitude	% Humi	Temper	Heat In
8/5/2020	13:36:11	45.40841LAT	-75.66309LON	49.00%	28.50C	83.30F
8/5/2020	13:36:12	45.40841LAT	-75.66309LON	49.00%	28.50C	83.30F
8/5/2020	13:36:12	45.40841LAT	-75.66309LON	49.00%	28.50C	83.30F
8/5/2020	13:36:13	45.40845LAT	-75.66310LON	49.00%	28.50C	83.30F
8/5/2020	13:36:14	45.40845LAT	-75.66310LON	49.00%	28.50C	83.30F
8/5/2020	13:36:14	45.40845LAT	-75.66310LON	49.00%	28.50C	83.30F
8/5/2020	13:36:45	45.40845LAT	-75.66310LON	49.00%	28.50C	83.30F
8/5/2020	13:36:46	45.40846LAT	-75.66311LON	49.00%	28.50C	83.30F
8/5/2020	13:36:47	45.40846LAT	-75.66311LON	49.00%	28.50C	83.30F
8/5/2020	13:36:47	45.40846LAT	-75.66311LON	49.00%	28.50C	83.30F
8/5/2020	13:36:48	45.40846LAT	-75.66311LON	49.00%	28.50C	83.30F
8/5/2020	13:44:09	45.40850LAT	-75.66308LON	48.00%	27.90C	82.22F
8/5/2020	13:44:10	45.40850LAT	-75.66308LON	48.00%	27.90C	82.22F
8/5/2020	13:44:10	45.40850LAT	-75.66308LON	48.00%	27.90C	82.22F
8/5/2020	13:47:54	45.40861LAT	-75.66319LON	47.00%	27.90C	82.22F
8/5/2020	13:47:55	45.40861LAT	-75.66319LON	47.00%	27.90C	82.22F
8/5/2020	13:47:56	45.40861LAT	-75.66319LON	47.00%	27.90C	82.22F

Calculate and Project Shadows of Buildings using Python and OpenStreetMap

(Gurbhej Singh, Fall 2020, System Science)

- Open Street Maps will be used to download a map of a certain road in GeoJSON format.
- Map will be analysed to get the coordinates and height of buildings around the road.
- Geographic coordinates will be transformed to projected coordinate system(like EPSG:3978) for creating height map using Python.
- Height map will be transversed for each building to calculate the length and position of its shadow according to sun's position at a certain time.
- Shadows will be projected on an image for the better visualization.



Thank You