Solar PV Siting Survey for Anchorage, Alaska

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https://github.com/Yueningwang/ASAP

Background and Introduction

Solar energy, one of the green energy, has attracted much attention because of its abundance. The most commonly used device to convert solar energy to electricity is solar panels. However, locating suitable place to install solar panels is time-consuming and inefficient.

In this project, we focus on predicting potential solar sites, including *rooftops, parking lots and parking structures* for commercial photovoltaics. **Solar energy calculation model** is built based on packages in Arcgis Desktop software, such as **aspect, slope and solar radiation**. The input is *Light Detection and Ranging (LIDAR) data*, a remote sensing method utilized by the government. The output is *kml files*, which can be displayed in Google Earth Pro and Google Map. Unlike other PV estimation projects, our project takes *HVAC systems, vents and pipes on rooftops, and parking lots on the ground* into consideration.

Methods and Approaches

In order to compute solar energy, three steps are followed to complete the workflow:

1. Create Masks

First, we need to filter location generating high solar energy. In this case, three conditions are chosen to consider, i.e. **hillshade, aspect and slope**. Hillshade eliminates places where the sun is blocked by other buildings so they cannot receive high solar radiation. The aspect of the solar panels should be south facing or horizontal to have a higher solar power output because Anchorage is located in the northern hemisphere. Slope allows for installing solar panels, which means slope should be less than 35 degrees. All three conditions create masks to detect spots proper to obtain solar energy.

2. Calculate Solar Radiation

After masking, the remaining areas are used to calculate solar radiation. Arcgis has a powerful tool -- Solar Radiation tool, which can derive incoming solar radiation during a year. This is based on **hemispherical viewshed algorithm** developed by Rich and Fu, taking into account direct radiation and diffuse radiation. However, compared to System Advisor Model (SAM), this tool neglects local meteorological data, making the results less accurate.

3. Compute Solar Energy

Combining area of rooftops or parking lots and solar radiation they collect, we can attain the overall solar energy they produce. When converting into kml files, which can open by Google Earth Pro and Google Map, one can easily decide if it is worthwhile to planting solar panels in this specific location.

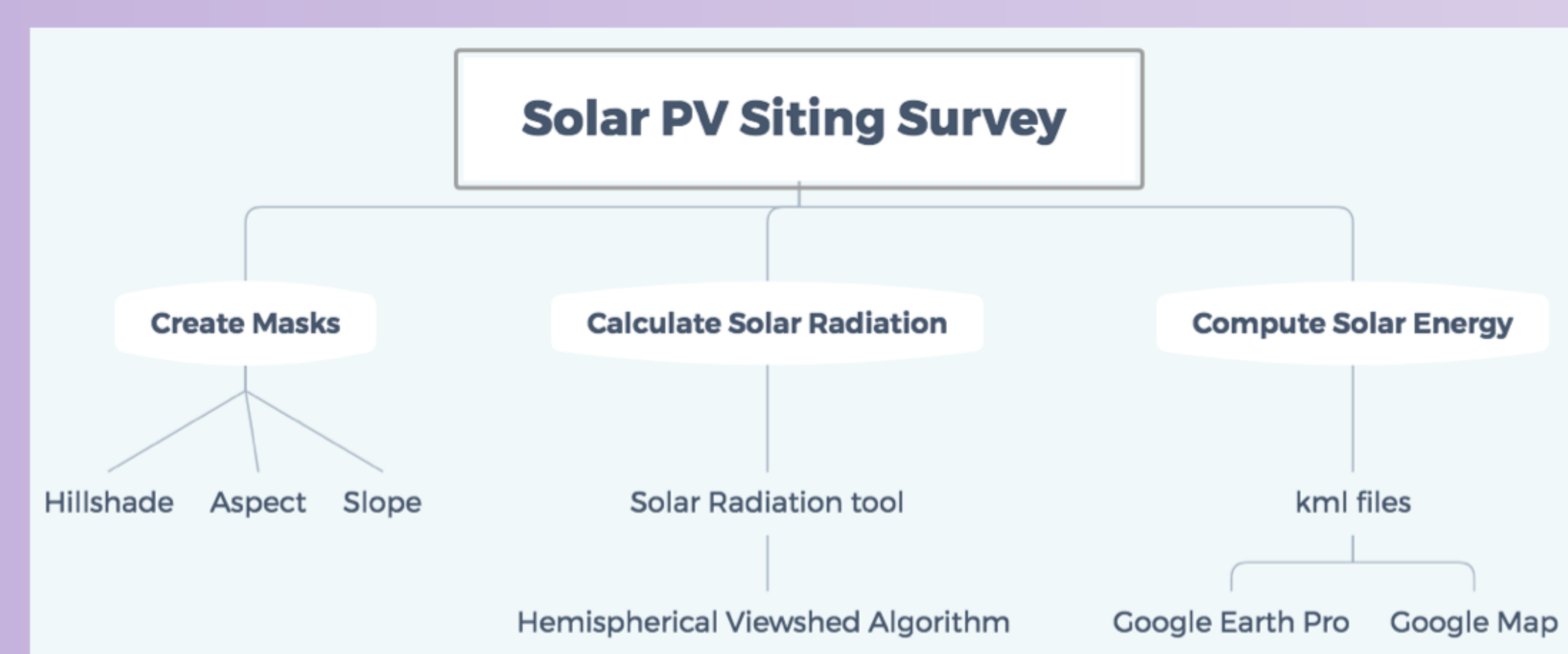

Figure 1 Flowchart of Methods and Approaches

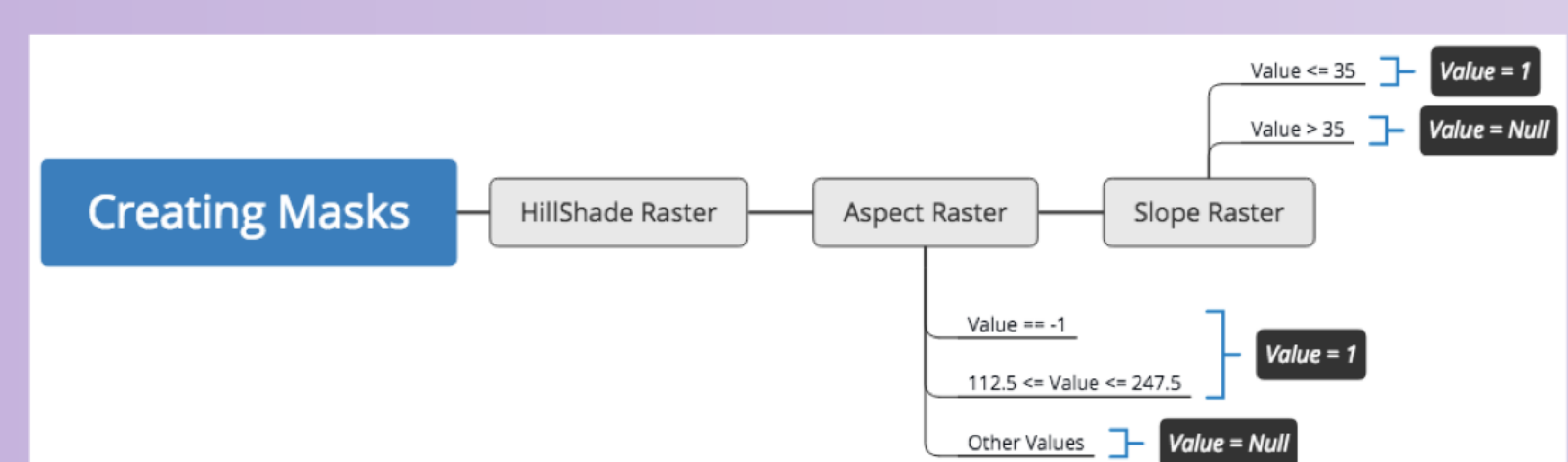

Figure 2 Model Builder of Creating Masks

Results and Conclusion

FID	Shape	CURRENT_TITLE	PHY_ADD	CITYSTZIP	PAR_NUM_F	COUNCIL	PV_POSSIBL	PV_MINIMUM	PV_MAXIMUM
68680	Polygon		333 E TUDOR RD	ANCHORAGE AK 99503	009-132-11-000	Midtown	1561.631008	36.566584	1959.5471
65811	Polygon	Loussac Library	3600 DENALI ST	ANCHORAGE AK 99503	009-081-11-000	Midtown	598.462784	86.767881	770.538873
65848	Polygon	Frontier Building	3601 C ST STE 1140A	ANCHORAGE AK 99503	009-071-18-000	Midtown	517.470729	105.875623	661.621087
117064	Polygon		3750 CENTERPOINT DR	ANCHORAGE AK 99503	009-071-31-000	Midtown	510.331749	145.311395	640.498323
68679	Polygon	Office Depot	201 E TUDOR RD	ANCHORAGE AK 99503	009-132-13-000	Midtown	321.679884	50.09892	409.74063
66093	Polygon	Us Post Office	3720 BARROW ST	ANCHORAGE AK 99503	009-081-23-000	Midtown	319.898084	58.463652	402.210144
119737	Polygon	West Center	4503 BERING ST	ANCHORAGE AK 99503	009-153-39-000	Midtown	315.888314	56.574373	387.870878
116477	Polygon		3801 CENTERPOINT DR	ANCHORAGE AK 99503	009-071-34-000	Midtown	252.486286	56.666249	354.330071
119540	Polygon		3700 CENTERPOINT DR	ANCHORAGE AK 99503	009-071-31-000	Midtown	214.278365	41.625915	305.969848
65722	Polygon	Debenham Plaza	300 W 36TH AVE STE 3	ANCHORAGE AK 99503	009-071-14-000	Midtown	241.530675	85.202938	290.069075
68699	Polygon		341 W TUDOR RD STE 205	ANCHORAGE AK 99503	009-141-37-000	Midtown	211.345536	45.209305	272.600701
68448	Polygon		4333 BERING ST	ANCHORAGE AK 99503	009-142-02-000	Midtown	197.250497	127.860098	240.293357
69084	Polygon		4400 BUSINESS PARK BLVD STE 34	ANCHORAGE AK 99503	009-151-04-000	Midtown	167.191744	52.262544	208.406519
67995	Polygon	State Farm Insurance	4215 CREDIT UNION DR	ANCHORAGE AK 99503	009-141-35-000	Midtown	152.41903	73.97301	183.128991
67244	Polygon		4040 B ST	ANCHORAGE AK 99503	009-141-30-000	Midtown	135.045015	52.641103	168.907887
117401	Polygon		4101 CREDIT UNION DR	ANCHORAGE AK 99503	009-141-34-000	Midtown	130.499436	18.527726	157.04747
67111	Polygon		531 W 41ST AVE	ANCHORAGE AK 99503	009-143-36-000	Midtown	129.305651	75.648497	156.534579
67111	Polygon		531 W 41ST AVE	ANCHORAGE AK 99503	009-143-36-000	Midtown	129.305651	75.648497	156.534579
116476	Polygon	JL Tower	3800 CENTERPOINT DR STE 800	ANCHORAGE AK 99503	009-071-32-000	Midtown	108.759821	8.761965	150.306402
67812	Polygon		4140 B ST	ANCHORAGE AK 99503	009-141-28-000	Midtown	109.809765	27.104634	147.736892
69319	Polygon		4501 BUSINESS PARK BLVD STE 24	ANCHORAGE AK 99503	009-151-11-000	Midtown	121.821985	48.139717	146.716445
69319	Polygon		4501 BUSINESS PARK BLVD STE 24	ANCHORAGE AK 99503	009-151-11-000	Midtown	121.821985	48.139717	146.716445
67703	Polygon		4141 B ST STE 405	ANCHORAGE AK 99503	009-141-29-025	Midtown	110.420099	24.168913	134.951754
65989	Polygon		3695 SPRINGER ST	ANCHORAGE AK 99503	009-072-29-000	Midtown	106.049832	41.245089	134.420041
67345	Polygon		510 W 41ST AVE STE F	ANCHORAGE AK 99503	009-143-36-000	Midtown	108.414896	29.456581	132.686156
69256	Polygon		4411 BUSINESS PARK BLVD STE 46	ANCHORAGE AK 99503	009-151-12-000	Midtown	107.046007	44.367056	130.385508
67535	Polygon		4102 B ST	ANCHORAGE AK 99503	009-141-13-000	Midtown	108.502286	53.083068	129.102278
67535	Polygon		4102 B ST	ANCHORAGE AK 99503	009-141-13-000	Midtown	108.502286	53.083068	129.102278
67535	Polygon		4102 B ST	ANCHORAGE AK 99503	009-141-13-000	Midtown	108.502286	53.083068	129.102278
67216	Polygon		4000 CREDIT UNION DR STE 635	ANCHORAGE AK 99503	009-141-38-000	Midtown	98.624192	7.205935	126.943251
67227	Polygon		4041 B ST STE 104	ANCHORAGE AK 99503	009-141-11-000	Midtown	94.920412	16.327522	125.241538
68103	Polygon		4240 B ST STE 100	ANCHORAGE AK 99503	009-141-21-000	Midtown	102.150415	50.59078	124.767145
68349	Polygon	Hampton Inn	4301 CREDIT UNION DR	ANCHORAGE AK 99503	009-141-39-000	Midtown	113.014883	30.164139	122.878843
68866	Polygon		110 W TUDOR RD	ANCHORAGE AK 99503	009-151-31-000	Midtown	100.928188	43.300892	122.311236
68503	Polygon		4341 B ST STE 303	ANCHORAGE AK 99503	009-141-03-000	Midtown	97.668975	48.059617	119.044543
68875	Polygon		4420 BERING ST APT 3	ANCHORAGE AK 99503	009-153-18-000	Midtown	95.548988	38.141997	117.347386
68875	Polygon		4420 BERING ST APT 3	ANCHORAGE AK 99503	009-153-18-000	Midtown	95.548988	38.141997	117.347386
68875	Polygon		4420 BERING ST APT 3	ANCHORAGE AK 99503	009-153-18-000	Midtown	95.548988	38.141997	117.347386
65733	Polygon	Akusa Financial Center	500 W 36TH AVE STE 12	ANCHORAGE AK 99503	009-071-30-000	Midtown	86.739328	12.320406	114.548901
66656	Polygon	Office Building -Arctic Slope R	3900 C ST	ANCHORAGE AK 99503	009-071-26-000	Midtown	87.582439	7.391545	111.557998
67104	Polygon		521 W 41ST AVE STE 101	ANCHORAGE AK 99503	009-143-36-000	Midtown	86.819286	35.223942	103.745763
67204	Polygon		501 W 41ST AVE STE D	ANCHORAGE AK 99503	009-143-36-000	Midtown	84.166726	33.918391	102.569046
67204	Polygon		501 W 41ST AVE STE D	ANCHORAGE AK 99503	009-143-36-000	Midtown	84.166726	33.918391	102.569046
67204	Polygon		501 W 41ST AVE STE D	ANCHORAGE AK 99503	009-143-36-000	Midtown	84.166726	33.918391	102.569046
67204	Polygon		501 W 41ST AVE STE D	ANCHORAGE AK 99503	009-143-36-000	Midtown	84.166726	33.918391	102.569046
67106	Polygon		511 W 41ST AVE STE 101	ANCHORAGE AK 99503	009-143-36-000	Midtown	74.413826	34.820618	89.683591
67883	Polygon		4201 B ST	ANCHORAGE AK 99503	009-141-07-000	Midtown	73.786535	35.612018	88.351973
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Table 1 Study Case in Midtown Council Displayed in Spreadsheet

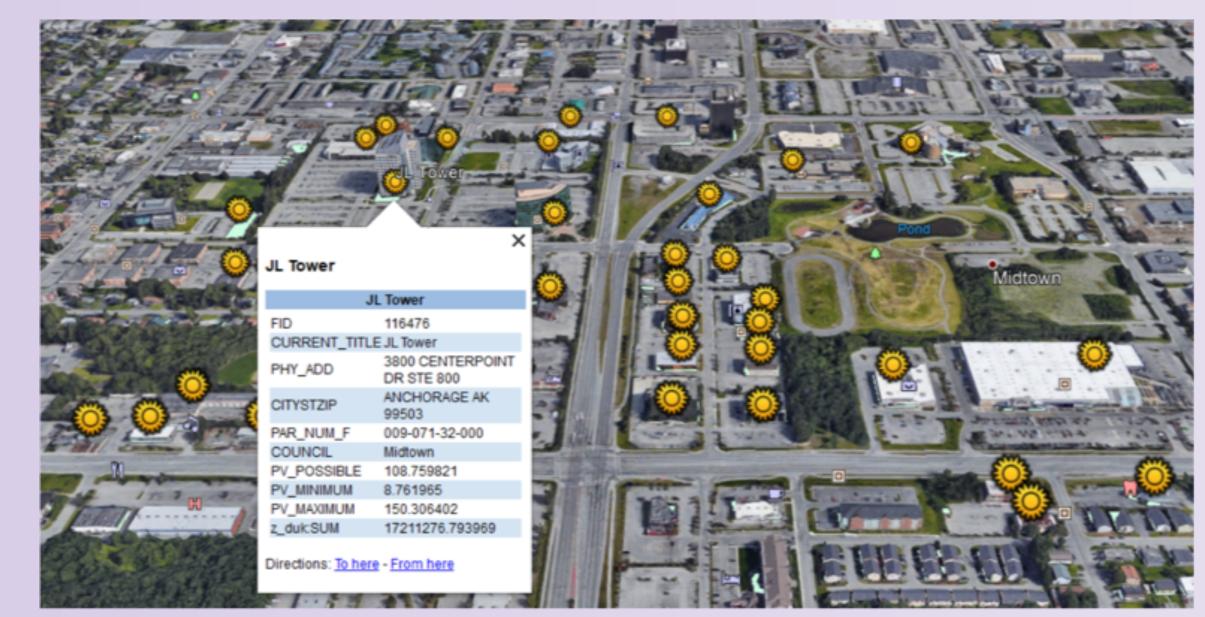

Figure 3 Study Case in Midtown Council Displayed in Google Earth Pro

We take Midtown Council in Anchorage as a study case, other councils and locations can use similar methods, or apply the python module on our GitHub Repository. From the Table 1, a number of potential solar sites are identified, ranging from 70 W to 1500 W during Year 2018. Furthermore, displaying kml files in Google Earth Pro and Google Map makes it easy to locate the sites. For example, in Figure 3, the address of JL Tower, the possible PV solar energy can be readily seen.

In a word, we successfully build **Solar Energy Calculation module** to identify and compute potential solar energy.

Reference:
[1] Andrea Chaves and A. Terry Bahill. *Locating Sites for Photovoltaic Solar Panels Pilot study uses DEM derived from LiDAR.* ArcUser Fall 2010.
[2] Clean Coalition. *Solar Siting Survey Draft Final Summary Report: Solar Photovoltaic (PV) Commercial-Scale Sites for 1,000 kW (AC) and Larger.* August 2017. www.clean-coalition.org

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