DIPLOMA THESIS

GIS-BASED SOLAR PHOTOVOLTAIC MODELLING IN THE URBAN AREA

WHY SOLAR? WHY GIS?

Electricity generation and industry are the two dominant CO_2-emitting businesses, accounting for about 65 per cent of all energy-related CO_2 emissions in 2017 (IRENA, 2017)

Transition to Renewable Energy

Solar energy is one of the renewable energy resources that are easily accessible in terms of its abundance and maturity

Solar radiation is also influenced by the topographical condition as well as meteorological and atmospheric characteristics of each location.

GIS can be orchestrated to provide high-resolution topographical data input and calculate solar radiation in an urban area using GIS analysis.

SUSTAINABLE DEVELOPMENT GOALS

7 AFFORDABLE AND CLEAN ENERGY — Ensure access to affordable, reliable, sustainable and modern energy for all

THESIS AIM

Use the GIS approach to model the potential of solar rooftop PV in the urban area

OBJECTIVES

Identify Geographic Information System (GIS) based algorithm to model the solar PV potential.

Assess the potential of solar PV for electricity generation in the urban area.

Visualize the estimation of solar PV potential on the rooftop per building within an integrated spatial data infrastructure

STUDY AREA, DATA & SOFTWARE

STUDY AREA

Morumbi District, São Paulo, BR

DATA SOURCE

Topographic & Administration data
- LiDAR point cloud (0.5m res.)
- Building footprint
- District boundary

→ Geosampa-Sao Paulo govt. open data portal

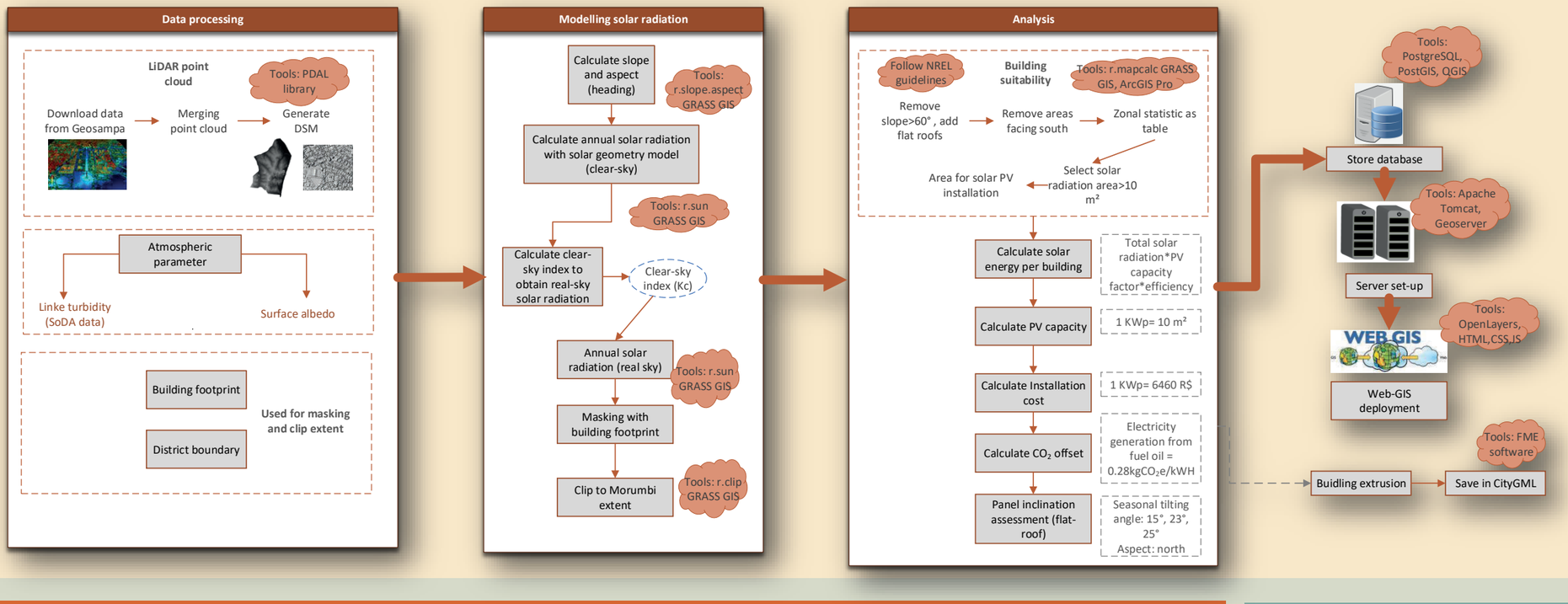
Atmospheric/climate data
- Linke turbidity -> SoDA database
- Surface albedo -> Publication by Ferreira et al. (2011) verif. by Copernicus Global Land service (Proba-V mission)

Solar radiation, PV specs
- Diurnal irradiation -> IAG weather station
- Solar radiation data from SONDA, LABREN laboratory & ERA5 (Copernicus CAMS)
- PV specification and installation guide -> NREL USA
- Brazil solar energy market -> Americadosol project report

SOFTWARE & TOOLS

- pdal — Point Cloud and DSM extraction
- GRASS GIS — Solar radiation calculation
- ArcGIS Pro / QGIS — Feature editing and attribution
- FME — FME software – data type conversion ; building extrusion
- PostgreSQL + PostGIS, Apache Tomcat, GeoServer — Backend development
- HTML, CSS, JS, OpenLayers — Front-end development

WORKFLOW



NOTE:

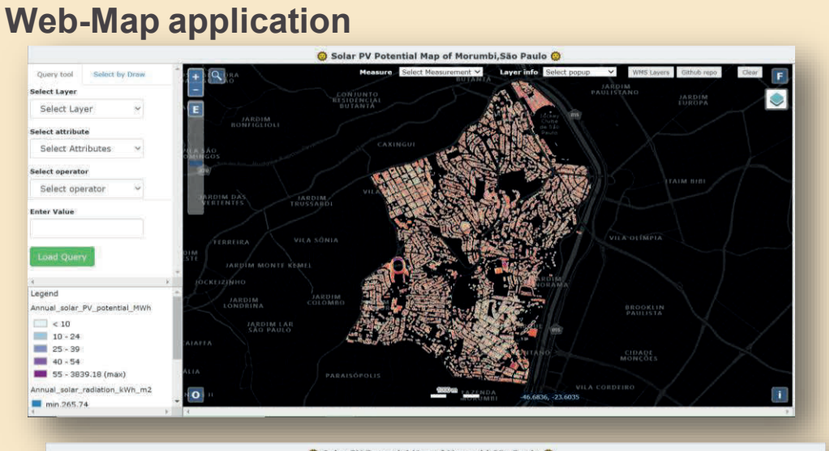
The optimal azimuth for the panel arrangement due to shadow casting was not considered in this research

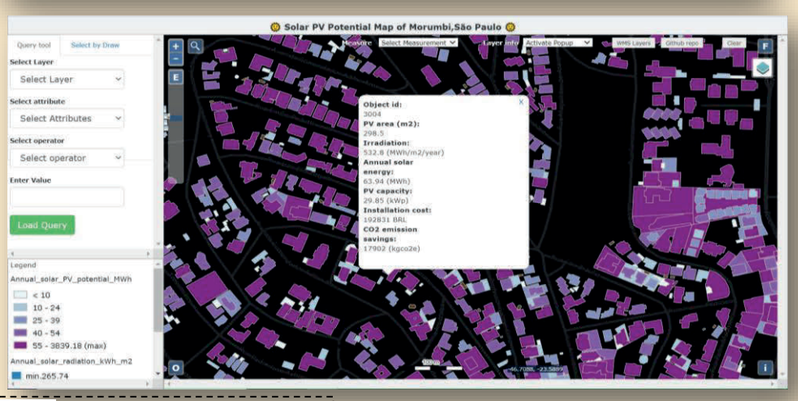
The storage system using battery and inverter is not considered.

It is assumed that the panel installation would be parallel to the roof surface.

RESULT

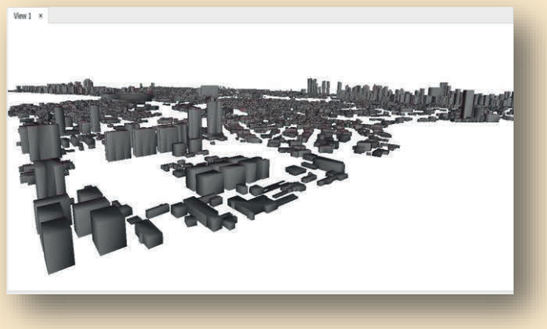
Web-Map application



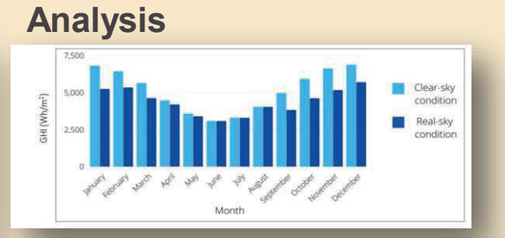


Scan here for the link to **Web-map app**

CityGML



Analysis



	Smallest available area for solar PV installation	Largest available area for solar PV installation
Coordinates	23° 34' 48" S, 46° 43' 12" W	23° 35' 59" S, 46° 43' 9" W
Annual energy yield (MWh)	1.19	3,839.18
Area for PV installation (m²)	10.25	17,022.25
Preview picture *(overlaid with Orthophoto from Geosampa)*		

CONCLUSION

The percentage of suitable buildings for the solar PV installation is high, reaches 92% of the whole building in the study area.

GIS is proved to effectively address the complicacy in identifying solar energy potential from photovoltaic installation in the study area, specifically at the building level.

The result of the model could provide the information that the GIS-based algorithm is robust for determining solar radiation in the study area. The entire modelling workflow can also be applied to solve a similar task in other study areas.

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Reference

AGUGIARO, G., NEX, F., REMONDINO, F., FILLIPI, R., DROGHETTI, S., & FURLANELLO, C. (2012). Solar Radiation Estimation on Building Roofs and Web-Based Solar Cadastre. ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, I(2), pp. 177-182. doi:10.5194/isprsannals-I-2-177-2012

NGUYEN, H., PEARCE, J. (2010). Estimating Potential Photovoltaic Yield with r.sun and the Open Source Geographical Resources Analysis Support System. *Solar Energy, 84*(5), pp. 831-843. doi:10.1016/j.solener.2010.02.009

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