Using high-resolution remote sensing images to detect suitable rooftops for solar PV installation in urban areas. Case study in Da Nang City

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Introduction

- **Project’s name:** “Assessment of Technical Rooftop Solar PV Potential in Vietnam”
- **Implemented by:** Effigis, Geo-Solutions Inc., Canada & CEFD
- **Donor:** World Bank
- **Area of Interest (AOI):** The most densely-populated urban areas in Da Nang City
- **Aims of the study:**
  - To detect, characterize and assess the solar PV potential of all Da Nang rooftops;
  - To apply ‘good practices’ criteria related to PV system implementation to rank their suitability.
  - Subsequently, the 500 most suitable rooftops were selected for terrain survey and upcoming PV implementation.
Approach methods

Rooftop solar PV technical potential

Digital Surface Model (DSM)
Digital Terrain Model (DTM)
Digital Height Model (DHM)

Rooftop footprint
Building height
Roof slope & aspect
Suitable surface area
Ratio of shaded surface area
Rooftop type
Obstructions
Landuse type

Global Solar Atlas
SOLARGIS

ORGANISED BY

FIG

PLATINUM SPONSORS

esri
Trimble
Results from WV3 images

1: Segmentation

2: Classification

3: Fusion

4: Manual quality check
### Some statistics

**Surface areas**

<table>
<thead>
<tr>
<th>Description</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total surface area of the AOI</td>
<td>174,690,000 m² (175 km²)</td>
</tr>
<tr>
<td>Total surface area of the detected rooftops</td>
<td>28,613,785 m²</td>
</tr>
<tr>
<td>Total surface area of suitable rooftops</td>
<td>9,145,406 m²</td>
</tr>
<tr>
<td>Surface area of suitable rooftops as percentage of total rooftops</td>
<td>32 %</td>
</tr>
<tr>
<td>Surface area of suitable flat rooftops without obstructions</td>
<td>3,967,929 m²</td>
</tr>
<tr>
<td>Surface area of suitable flat rooftops with 0-10% obstructions</td>
<td>818,634 m²</td>
</tr>
<tr>
<td>Surface area of suitable flat rooftops with 10-30% obstructions</td>
<td>376,657 m²</td>
</tr>
<tr>
<td>Surface area of suitable flat rooftops with &gt;30% obstructions</td>
<td>7,733 m²</td>
</tr>
<tr>
<td>Surface area of suitable two-sided rooftops</td>
<td>3,681,278 m²</td>
</tr>
<tr>
<td>Surface area of suitable four-sided rooftops</td>
<td>88,515 m²</td>
</tr>
<tr>
<td>Surface area of suitable other (complex, curved, circular) rooftops</td>
<td>204,662 m²</td>
</tr>
</tbody>
</table>

**PV capacity**

<table>
<thead>
<tr>
<th>Description</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total estimated roof PV capacity</td>
<td>1,140 MW</td>
</tr>
<tr>
<td>Estimated PV capacity on flat rooftops without obstructions</td>
<td>494 MW</td>
</tr>
<tr>
<td>Estimated PV capacity on flat rooftops with 0-10% obstructions</td>
<td>102 MW</td>
</tr>
<tr>
<td>Estimated PV capacity on flat rooftops with 10-30% obstructions</td>
<td>47 MW</td>
</tr>
<tr>
<td>Estimated PV capacity on flat rooftops with &gt;30% obstructions</td>
<td>0.96 MW</td>
</tr>
<tr>
<td>Estimated PV capacity on two-sided rooftops</td>
<td>458 MW</td>
</tr>
<tr>
<td>Estimated PV capacity on four-sided rooftops</td>
<td>11 MW</td>
</tr>
<tr>
<td>Estimated PV capacity on other (complex, curved, circular) rooftops</td>
<td>25 MW</td>
</tr>
</tbody>
</table>
Data validation

Visual inspection and interviewing

3D model of rooftop
conducted survey of 108 rooftops to identify: rooftop area, height, slope, aspect, roof type, etc.
GEO Data mapping

Web-based solar GEO Data

Derived rooftop technical information

Total yearly PV energy produced by Da Nang rooftops in MWh

Rooftop solar PV technical potential
Conclusions

• Da Nang City has a huge potential for producing PV electric energy from its rooftops (total estimated electricity potential: 3,200 GWh), in which large area rooftops share **52 % (of 1.1 GW)**

• The outcomes of this study support Da Nang decision makers to plan and develop the renewable solar energy sector

• Assuming only 5 % of all suitable rooftops are used for PV systems, **160 GWh (6.96 % of needs)** could be produced by solar PV sources. This proportion exceeds the governmental target of 6.5 % of renewable energy source by 2020
References

- N. M. Salih M. Kadhim, M. Mourshed, M. T. Bray, 2015, SHADOW DETECTION FROM VERY HIGH RESOLUTION SATELLITE IMAGE USING GRABCUT SEGMENTATION AND RATIO-BAND ALGORITHMS. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XL-3/W2, 2015