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Estimating the amount of cloud cover (in oktas) using photovoltaics

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Unlike conventional power generation or non-variable renewable energy sources, solar energy is considered a variable energy source. This is due to the fact that electricity production from solar technologies is highly dependent on the intensity of the incident solar irradiance which varies, amongst other factors, on the presence of clouds in sky. Thus, a lot of researchers have used various meteorological stations and/or computational algorithms to associate solar irradiance with energy production from solar energy systems.

In this paper, the opposite approach is being attempted, and we present the development of a simple method for the estimation of cloud cover (in oktas) using photovoltaic (PV) systems as ground-based irradiance sensors. The methodology utilizes geographic information systems (GIS) geoprocessing to calculate cloud coverage over an area of 10 km x 10 km by examining six different scenarios using 30, 50, 75, 100, 500 and 1000 randomly distributed residential PV systems (each 3kWp). For each scenario, 350 different fractal-based cloud shadows (50 per okta) were produced, and the accuracy of the estimated cloud coverage based on the number of stations being shaded was calculated and presented in a confusion matrix.

Results have shown that there is a positive correlation between the number of stations used and the accuracy of the estimation. While scenario one with 30 PV stations has produced an average accuracy of only 64%, the accuracy increased to 94% when 1000 PV stations were used. Given the fact that a sporadic populated area of 10 km x 10 km consists of more than 30,000 houses and that it is not unreasonable to assume that 3% of the houses will have PVs on their rooftops, we believe that PV data can provide interesting meteorological information.