GIS-based model choice for computing solar irradiation from DEMs

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ABSTRACT:

Perhaps, climate change has made people to reconsider fossil fuel which is not renewable energy source and limited source. Renewable energy which is continuously replenished has been proposed as an alternative energy. Among many of renewable energy resources, solar radiation provided by the sun is an unlimited energy resource to generate electricity. Consequently, this trend has brought an attention to researchers and government (e.g., national renewable energy laboratory, NREL) for monitoring incoming solar radiation flux. Even though numbers of meteorological stations provide irradiance and meteorological data across the U.S. limited numbers of stations can cause uncertainty in relatively large scale or very small area such as a rooftop. Hence, it is important to computing solar irradiance.

As a matter of fact, various geographic information systems (GISs)-based algorithms using DEMs have played a crucial role to calculate solar irradiance. Nonetheless, it is hard to see what the strengths and weaknesses of these solutions are. Consequently, this study aims to compare GIS-based solutions and to propose how future models might be constructed to provide more

robust estimates of solar radiation flux. Furthermore, this research investigated the dependence of estimation solar irradiance from DEMs on two basic elements of the estimation: (1) the spatial resolution of the DEMs (2m, 10m, and 30m) and (2) GIS-based models: (A) spatial distributed solar radiation model (SRAD), (B) the solar radiation model (r.SUN), and ESRI solar radiation model to compute solar irradiance, specifically how it defines climate parameters. .

We analyzed the results statistically, input parameters to calculate solar radiation flux, and compared the difference results with the actual monitored-values in the California Irrigation Management Information System (CIMIS) which measures solar radiation regularly. We repeated the computations using DEMs of 2-m, 10-m, and 30-m resolutions, covering test areas in the Los Angeles County, California. In addition, we also measured operations time in each models since three models were implemented in different platforms: (A) SRAD: Window prompt command, (B) r.SUN: GRASS, and (C) ArcGIS, respectively.

We conclude that the estimation of solar radiation are fraught with model assumptions, input parameters, and scale effects. Estimations should be approached with great caution in GIS-based analyses.

KEYWORDS: DEM, ESRI solar radiation model, GIS-based model, r.SUN, SRAD