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Determinants of the global distribution of solar PV parks

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Suitability maps for solar photovoltaic (PV) parks are key in estimating potential supply of these resources. These maps are typically created based on expert judgement using variables such as resource availability (irradiation), topography (e.g. slope), socio-economic factors (e.g. distance to urban areas), infrastructure (e.g. distance to roads and transmission lines), land cover type, and / or ecological functions (e.g. protected areas). However, such priori expert-based suitability maps do not necessarily match up with the actual spatial distribution of solar PV or wind parks.

Here we aim to understand the determinants of the actual global distribution of solar PV parks by relating the locations of utility-scale solar PV parks worldwide to the above-mentioned variables. Specifically, we develop a generalized linear mixed-effects model to predict the probability of occurrence of a PV park at a certain location, based on variable values at each PV location as well as randomly selected locations where PV parks are absent. We furthermore include country as random effect to take into account inter-country differences in renewable energy policies. We then use the model to create a global 1km resolution map of the likelihood of finding a solar PV park and identify the most important determinants of their distribution.

Finally, we compare our findings to the suitability maps currently used by the integrated assessment model IMAGE, which are based on expert judgement using land cover, ecological functions, infrastructure, socio-economic factors and topography. From this comparison and our identification of the most important determinants, we can deduce what drives geographical patterns in the actual distribution of renewable energy facilities, which can be used to improve suitability maps in future integrated assessments of the energy transition.