The importance of high-quality data about wind energy infrastructures for biodiversity conservation

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Introduction

Research question

Onshore wind power is being developed steadily across the Mediterranean, with wind farms that are often proposed in biodiversity hotspots. Zonation policies are needed to minimize their impacts. Although these policies are using maps of wind turbines that are produced by open-source initiatives and/or research groups, to the best of our knowledge no research validated these against high-quality satellite and/or aerial images. In this study we compared 3 available datasets of wind-energy infrastructures against aerial images for Sardinia (Italy).

Methods

Mapping existing turbines

We downloaded the location of wind turbines that are operating in Sardinia from Smeraldo et al. (2020), Open Street Map (https://openinframap.org) and Atla Impianti, the official dataset of turbines receiving governmental incentives (https://www.gse.it/dati-e-scenari/atlaimpianti).

Creating a buffer and a grid

After having pooled together the three datasets, we created a buffer with a radius of 5 km around each turbine. Then this area was divided into a 500 m grid, with a total of 24,631 cells spanning across 8,123 km^2 or 33.8% of the area of Sardinia.

Fig. 1. An example of a wind turbine, detected from an aerial picture on Google Satellite at a 1:500 scale (picture obtained from Google).

Using aerial pictures

We overimposed high-resolution aerial images from Google Satellite to the grid. Then, we checked the number of wind turbines that occurred in each cell at a 1:500 resolution. Wind turbines were counted by three independent researchers.

Retrieving future wind power projects

To map the potential number of wind turbines that are expected to be built over the next few years, we downloaded each wind farm project that had been submitted to the Italian Ministry of the Environment since 2020 (https://va.mite.gov.it/it-IT).

Mapping planned turbines

For each wind power project we manually georeferenced the coordinates of its planned wind turbines, from maps that were contained in preliminary environmental impact assessment reports.

Current issues

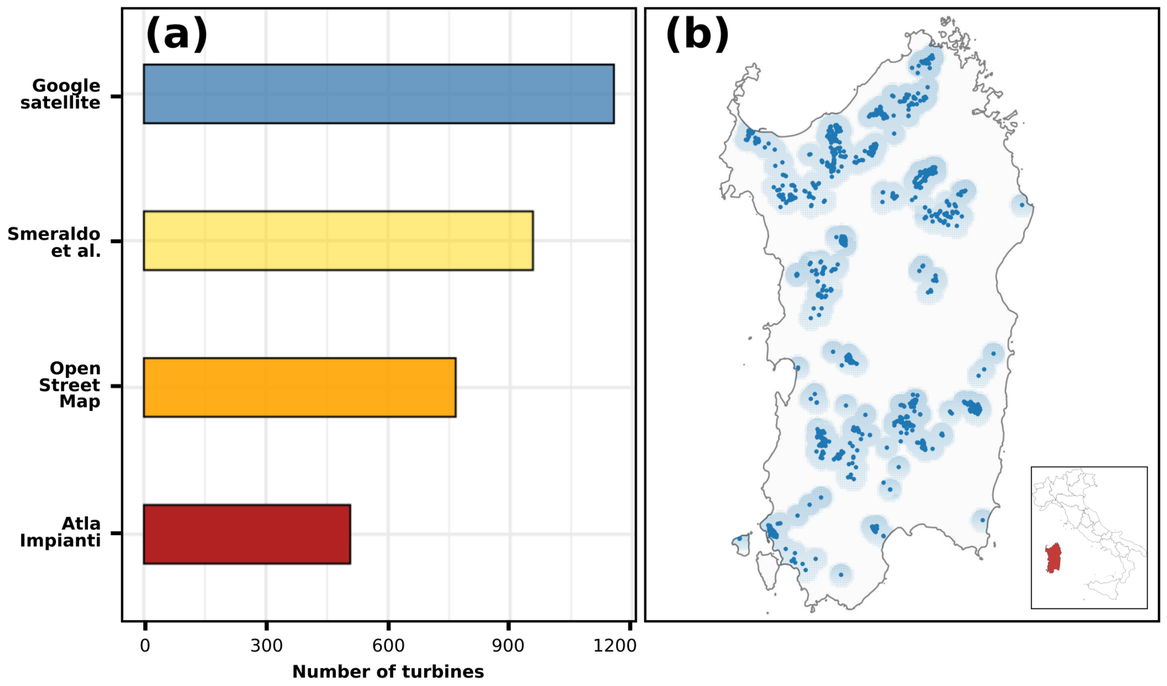

Fig. 2. Comparison between the different number of turbines according to the different data sources (a) and the area covered by our sampling (b, turbines in dark)

Major discrepancies

The analysis of aerial images allowed us to identify 1,155 operating turbines. This value was much higher than turbines reported by Smeraldo et al. (n = 914), Open Street Map (n = 766) and Atla Impianti (n = 507).

Hotspots of wind energy development

Wind tubines are concentrated on two major belts in Northern and Southern Sardinia. With minor hotspots also on the West Coast. These areas are key for the Griffon vulture (*Gyps fulvus*), due to the presence of two colonies and a release site.

A major increase in the near future

When considering wind power projects submitted to the Ministry for the Environment, these envision a total of 1,026 new turbines. Therefore, onshore turbines in Sardinia will increase by up to 89%, a dynamic that could significantly increase their cumulative impacts.

Key points

High-quality data

Our findings emphasize the need to assess existing maps of wind energy infrastructures and define clear quality standards. Existing datasets might seriously underestimate operating turbines and/or accumulate major bias in a few years. In turn this could bias impact assessments.

Aerial images: a powerful tool

Aerial images are a powerful tool for conservation zonation. We developed an accurate map covering an area of 8,123 km^2, in a time of approx. 3 months. This shows that even small conservation groups can engage in the participatory mapping of wind energy at conservation hotspots.

The way ahead

Future studies should focus on develop large-scale maps depicting the density of energy-related infrastructures. Spatially-balanced sampling can be used to interpolate densities across large spatial scales, while checking aerial images on few sampling sites. Sampling schemes can also be used for the periodic monitoring of infrastructure development. These maps can be combined with data about animal movement, obtained from GPS telemetry, and species distribution models, to identify potentially problematic areas for renewable energy development and assist zonation and/or the implementation of mitigation measures.

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