

## IS BIRD CONSERVATION A BARRIER TO WIND ENERGY?

Izabella de Camargo Aversa; Juliana Polizel; Marcelo Montaña  
São Carlos School of Engineering — EESC/USP  
University of São Paulo — Brazil

### Abstract

Project's location is a major aspect to prevent significant adverse impacts on biodiversity, such as mortality of birds and bats, disturbance of migratory routes, and loss of habitats. The identification of alternatives that presents adequate environmental conditions is essential requirement for Environmental Impact Assessment (EIA). However, EIA literature features the poor consideration of alternatives. This study presents the application of a methodology for integration of birdlife conservation during the identification of suitable areas for wind energy. This methodology is based on criteria defined through a review of literature and the creation of suitability map using GIS tools and multi-criteria decision making. Topics covered by suitability maps include protected areas, habitats of migratory and endangered birds, breeding areas, and wind speed. The Brazilian state of Bahia was the object of study, since it has important birdlife and great wind power installed capacity. The current location of wind farms indicates that the sites selection presumably was based on technical aspects over environmental criteria. However, the results indicate that the birdlife conservation is not a barrier for wind energy expansion, since a scenario of expansion is possible when restrictions that prevents tradeoffs between its conservation are considered. This study aims to contribute towards the improvement of the alternative sites identification, and of EIA process.

Keywords: Wind energy; alternatives; Environmental Impact Assessment

### 1. INTRODUCTION

A number of principles and fundaments have been shaping Environmental Impact Assessment (EIA) theory and practice since its origins. The "*establishment of the preferred or most environmentally sound and benign option for achieving proposal objectives*" is advocated by the International Association of Impact Assessment (IAIA) as an Operating EIA Principle (IAIA, 1999). Considering that EIA aims to ensure that environmental considerations are explicitly addressed and incorporated into the decision making process (IAIA, 1999), the quality of a decision depends on the quality of alternatives to be previously evaluated (STEINEMANN, 2001). According to the US Council on Environmental Quality (CEQ, 1987), for example, the analysis of alternatives must be considered the "heart" of EIA processes. However, the poor consideration of alternatives associated with different impact assessment processes is highlighted by the literature (BOND; POPE, 2012; FARIA, 2011).

Wind energy projects may cause significant environmental impacts in the avifauna (TABASSUM et al., 2014). It tends to be of particular relevance to EIA effectiveness when environmental aspects are not properly taken into consideration for the selection of a suitable location (STEINEMANN, 2001). The following are some of the impacts associated with the wind energy projects reported in literature: increased mortality of birds and bats, disturbance of migratory routes and on birds' breeding, feeding, and roosting behaviours, and habitat loss (DAI et al., 2015; DREWITT; LANGSTON, 2008; RODRIGUES et al., 2015).

The bird vulnerability and mortality at wind power facilities depend on site-specific, species-specific and seasonal factors (BARRIOS; RODRÍGUEZ, 2004). Raptors are considered more susceptible to wind farms than other species (WANG; WANG, 2015). They represented 65% of carcasses found in a study in California (ORLOFF; FLANNERY, 1992). Evidence also shows that the risk of impacts are greater for facilities located near migratory routes and important resting, breeding, and foraging areas (OUAMMI et al., 2012; TABASSUM et al., 2014; TRAVASSOS et al., 2005). Dahl et al. (2012) observed reduced breeding success of white-tailed eagles near a wind farm, when compared to a period preceding its construction.

Wind energy generation requires larger areas when compared to non-renewable resources, which may cause conflicts with protected areas and habitats conservation (BROOK; BRADSHAW, 2015). Globally installed wind capacity has jumped from 24 GW in 2001 to more than 486 GW in 2016 (GWEC, 2017). Therefore, this intensive expansion predicted must be accompanied by an equivalent effort focused on the identification of

suitable areas so that wind energy expansion can be evaluated against biodiversity conservation (SANTANGELI et al., 2016). The question that may pose from this context is reflected in the title of the paper - is there any significant conflict between wind energy expansion and bird conservation objectives?

The present paper is focused on the analysis of locational alternatives to windfarms integrated to birdlife protection. The objectives here are to identify potential conflicts with the current location of windfarms in a biodiverse territory and to support the identification of suitable areas (to energy production and to environmental/bird protection). For that, the Bahia state (Brazil) was used as a case study and a suitability map combining wind potential and environmental constraints was developed.

## 2. METHODS

Watson e Hudson (2015) highlighted two main tools for planning and decision-making process with spatial character: Geographic Information System (GIS) and multi-criteria decision making (MCDM). The multi-criteria analysis stands out in the energy planning (POHEKAR; RAMACHANDRAN, 2004; WATSON; HUDSON, 2015).

The suitability map was developed with 1-km resolution data, publicly available and accessed in the websites of government bodies (MINISTÉRIO DO MEIO AMBIENTE-MMA, 2016; INSTITUTO CHICO MENDES DE CONSERVAÇÃO DA BIODIVERSIDADE-ICMBio, 2016; CENTRO DE PESQUISAS DE ENERGIA ELÉTRICA, 2017). To create the suitability map it was considered the concept of “constraints” and “factors”. The constraints are areas considered unsuitable to wind farms, in this case, areas important to birds life conservation. The environmental constraints for windfarms considering birdlife conservation are represented by areas of occurrence of migratory or endangered bird species, breeding, and protected areas, according to the Brazilian law (Law nº 9.985/2000 and Portaria nº 126/2004).

Factors are associated with the fact that the greater distance from constraints leads to greater suitability. For this study, the factors were the surrounding of breeding areas, areas with the presence of endangered or migratory birds, and windspeed. All factors were assumed to have equal importance. The average annual windspeed at 100 m was considered as single technical factor for wind energy production. Areas with windspeed between 5–6 m/s were considered minimally suitable (BABAN; PARRY, 2001), between 6–7 m/s regular and above 7 m/s highly suitable.

In spite of the fairly large number of studies about the factors that influence on mortality rates and vulnerability of certain bird, uncertainty remains as to its causes and effects (AMERICAN WIND WILDLIFE INSTITUTE, 2017; BRIGHT et al., 2008). In such cases, the precautionary principle was introduced by the adoption of buffer zones. The criteria for buffer zones were based on Dahl et al. (2015) that identified reduced reproductive success of white-tailed eagle in territories out to 1 km from wind turbines and increased mortality among adult eagles out to 5 km radius. A buffer of 1 km is also recommended for breeding areas of capercaillie (LAG-VSW, 2007 apud BRAUNISCH et al., 2015<sup>1</sup>). Therefore, for areas with the presence of species of endangered or migratory birds the radius of 5 km was applied as “constraints”.

### 2.1 Case study

The case study used in this article was the state of Bahia, Brazil. This state stands out in the national context of wind energy and richness of biodiversity (LISTA VERMELHA DA BAHIA, 2016). Bahia state takes second place in installed wind capacity in the country, with more than 2.4 GW from 11.7 GW of total installed wind capacity in Brazil (ONS, 2018).

Brazil takes second place in bird diversity in the world, with 1980 species, of which at least 234 are endangered (MMA, 2016) and 197 species present any migratory pattern (ICMBio, 2016). In Bahia were recorded 823 bird species and the Family with more endangered species is Acciptridae (35 endangered species) (LISTA VERMELHA DA BAHIA, 2016). The Acciptridae Family is considered one of the most vulnerable to collision with wind turbines (BARRIOS; RODRIGUEZ 2004, TRAVASSOS et al. 2005).

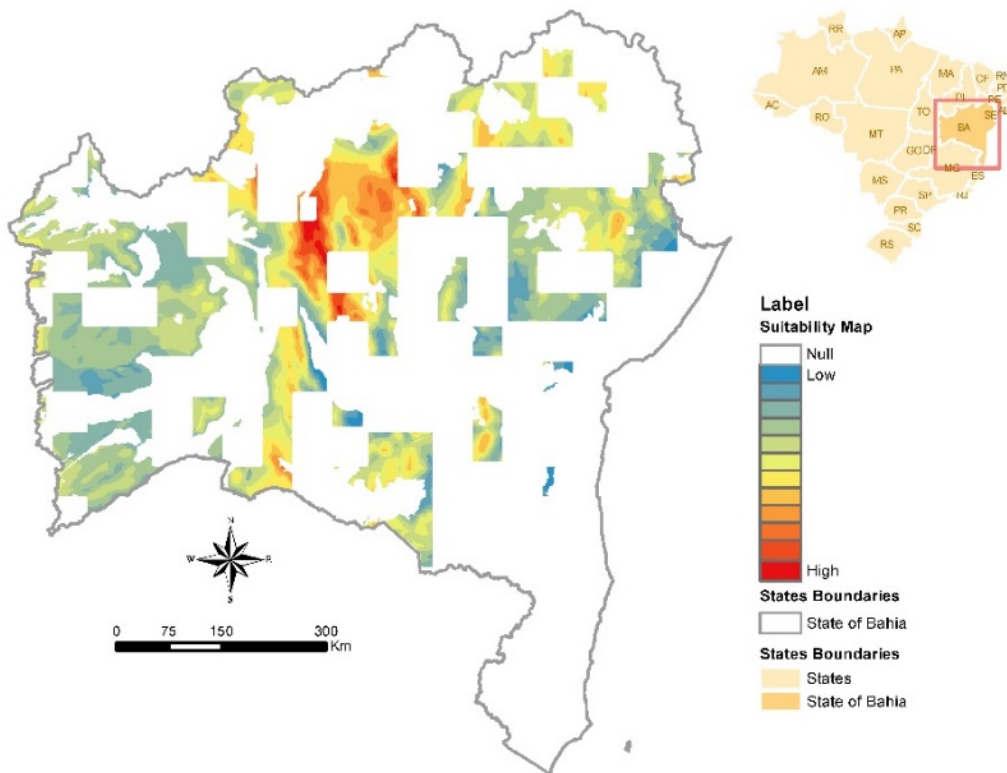
<sup>1</sup> Länder-Arbeitsgemeinschaft der Vogelschutzwarten (LAG-VSW). Abstandsempfehlungen zu bedeutsamen Vogellebensräumen sowie Brutplätzen ausgewählter Vogelarten. 2007. Berichte zum Vogelschutz, 44, 151–153.

### 3. RESULTS AND DISCUSSION

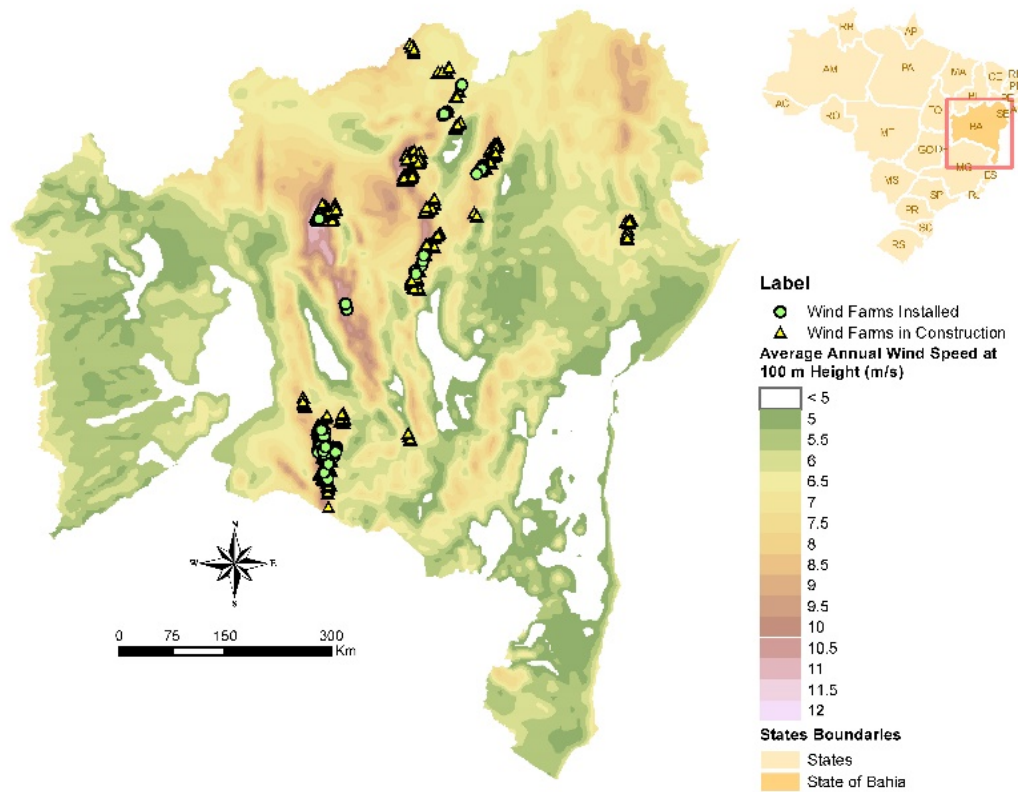
The results are shown in the **Chart 1** and **Figures 1** and **2**. The **Figure 2** presents the suitability map, where areas with constraints are in white and the most suitable areas in red.

The **Chart 1** presents the quantified areas that meet the technical requirement (windspeed) and areas with environmental constraints. In Bahia, 317,727 km<sup>2</sup> have windspeed higher than 6.0 m/s (at 100m height), of which about 63.5% presents environmental constraints. Therefore, there are 115.895 km<sup>2</sup> suitable to wind farms, considering environmental and technical criteria. Areas with high technical suitability (windspeed above 7 m/s) and without environmental constraints where accounted for about 53,300 km<sup>2</sup>. Therefore, considering the size of some wind farms (15–100 MW) in Brazil that requires areas around 0.4 to 11 km<sup>2</sup>, there are significant suitable area for wind energy expansion in the state of Bahia. Furthermore, if it's considered areas minimally suitable (windspeed above 5 m/s), there are more than 177.000 km<sup>2</sup> suitable for wind energy with less risks of impacts on birds diversity. Therefore, the results indicate that if the criteria for bird conservation were included in environmental studies for alternative sites analysis, the installation of wind farms in areas with great windspeed would still be possible.

**Figure 2** and **3** illustrate the location of wind farms installed and in construction in Bahia on a layer of windspeed and on the suitability map, respectively. It can be observed that the majority of wind farms is located in areas with windspeed higher than 7 m/s. However, **Figure 3** shows that the wind farms are also located in areas with environmental constraints for bird conservation. This reveals that bird conservation criteria are overlooked or neglected during the identification of potential location for wind farms. In addition, it confirms the prioritization of technical aspects over environmental constrains still for the wind farms in construction.



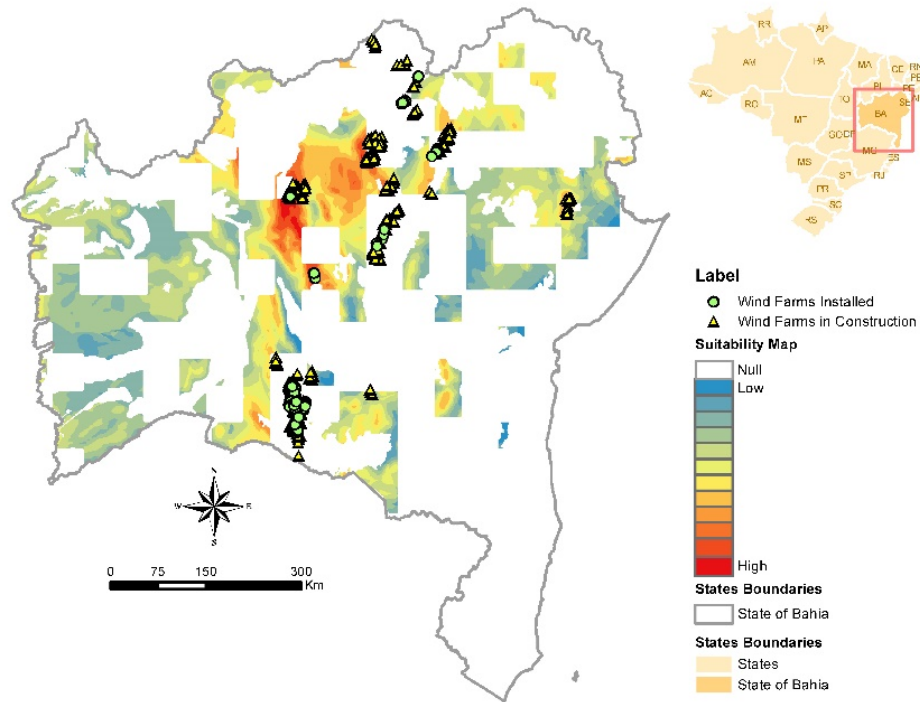
**Figure 1 – Suitability Map for wind energy**



**Figure 2: Location of wind farms and windspeed**

**Chart 1: Quantified suitable areas in terms of technical and environmental constraints**

| Windspeed (m/s)   | Total (km <sup>2</sup> ) | Area with environmental constraints (km <sup>2</sup> ) | Suitable areas (km <sup>2</sup> ) | %           |
|-------------------|--------------------------|--|-----------------------------------|-------------|
| < 5.0             | 67,753                   | -  | -                                 | -           |
| 5.0 – 6.0         | 181,742                  | 120,536  | 61,206                            | 33.7        |
| 6.0 – 7.0         | 158,731                  | 96,136   | 62,595                            | 39.4        |
| 7.0 - 12.0        | 158,996                  | 105,696  | 53,300                            | 33.5        |
| <b>TOTAL</b>      | <b>567,222</b>           | <b>322,368</b>   | <b>177,101</b>                    | <b>35.5</b> |
| <b>6.0 – 12.0</b> | <b>317,727</b>           | <b>201.832</b>   | <b>115.895</b>                    | <b>36.5</b> |



**Figure 3: Location of wind farms on the suitability map**

#### 4. CONCLUSIONS

EIA is an important instrument for the biodiversity conservation (IAIA, 2005), since it requires an analysis of alternatives sites and information gathering about the area of interest for the project. Moreover, EIA is recognized as an important decision-support tool by the Convention on Biological Diversity (CBD), the Ramsar Convention, and the Convention on Migratory (IAIA, 2005).

About 63.5% of the area with wind energy potential (windspeed above 6.0 m/s) is located within environmental constraints, considered in this article. Nevertheless, a large portion remains suitable in terms of birdlife conservation for the installation of hundreds of windfarms. Therefore, birdlife conservation is not a limiting factor to the expansion of wind energy sector in Bahia, and must be taken into account in the planning phase, what could be done by means of Environmental Impact Assessment.

Albeit the extensive area with technical and environmental suitability in Bahia state, the majority of wind farms was installed or are being installed in areas with environmental constraints, especially where was registered endangered bird species. This represents an obstacle for biodiversity conservation and evidence the prioritization of economic aspects to locate the wind farms. Therefore, this paper highlights the importance of initiatives to promote biodiversity and other aspects to find the preferred location of wind farms.

Given that social constraints were not analysed in this study and that the suitability map was developed in a macro scale, the reported outcomes must be understood as a first initiative to identify the most suitable areas for wind energy.

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