Wind farms and mires in the Basque Country and north-west Navarra, Spain

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SUMMARY

Mires occur in the Basque Country and north-west Navarra (northern Spain) due to the Atlantic influence on climate. They are most frequent in the north and become rarer to the south. True peatland is found at only six locations, but there are also some para-peaty habitats associated with springs and flushes which have very thin discontinuous peat layers. Although small, this mire territory straddles the boundary between two separate autonomous communities where different regulations and management guidelines apply. Both communities have developed extensive plans to exploit wind energy, and the summit ridges of many of the mountain ranges now carry long strings of turbines. Consequences for the Basque and Navarran mire ecosystems are reviewed. Because little is known about these habitats, they went largely unnoticed during the process of wind farm planning and were thus exposed to enormous risk. Nonetheless, the impacts of development so far have been limited by careful practice combined with the fact that the locations of most of the mires do not coincide exactly with the favoured locations for wind turbines. The only blanket bog is situated in the Zalama area, where plans to build a wind farm have been abandoned for a combination of reasons. Paradoxically, the wind farm planning process was instrumental in raising social and political awareness of this important peatland, leading to a very promising level of interest in its conservation and restoration amongst local institutions.

KEY WORDS: aeolian energy impact, conservation, para-peaty habitats, peatland, Zalama blanket bog.

INTRODUCTION

The Basque Country and Navarra are contiguous but separate autonomous communities lying between the Gulf of Biscay in the Cantabrian Sea to the north, the Upper Ebro Valley to the south, the Cantabrian Ranges to the west and the Pyrenees to the east. The Atlantic influence on climate extends across an area of approximately 10,000 km^2 between latitude 43º29'–42º29' N and longitude 1º07'–3º28' W, which includes the whole of the Basque Country but only the north-western part of Navarra (Figure 1). This area contains the north–south gradient from the mild and wet Atlantic climate of the Eurosiberian region to the much drier climate of the Mediterranean region. Annual rainfall ranges from 2,000 mm in northern littoral areas to 300 mm in the southernmost part of the area, over a distance of only 100 km. Another climatic gradient operates from the Atlantic west to drier and more continental conditions in the Pyrenees to the east. Altitude increases from sea level in the north to 1,544 m (Aitzgorri) and 1,570 m (Ortzanzurieta) before descending to 385 m in the Ebro Valley in the south. The climatic transition is interrupted by a series of low east–west mountain ranges that influence air flow, giving rise to orographic rain on northern slopes and consequently drier and sunnier conditions on southern slopes.

The solid geology consists of extensive Mesozoic calcareous bedrock with some included sandstone and small areas of Paleozoic granite, schist and gneiss. The original vegetation was predominantly forest, but this it is now limited to the mountains by anthropic influence associated with a high but unevenly distributed human population. The various environmental gradients mean that plant biodiversity is high (Aizpuru *et al.* 1999). The strongest vegetation gradient is from north to south, and there is a lower rate of endemism than in the surrounding territories. The Atlantic influence results in the presence of small mire systems that become more localised as they approach the distributional limit imposed by climate to the south.

Long strings of wind turbines have been installed on the summit ridges of some of the mountain ranges within the last few years. Although different regulations and management guidelines apply within the Basque Country and Navarra, both local governments take pride in their environmental profiles and regard wind energy as sustainable, clean and efficient. Therefore both have independently developed plans to build extensive wind farms. Information on the plans is available

from official materials such as the Sector Territorial Plan for Aeolian Energy in the Basque Autonomous Community (PTSEE) (Basque Government 2002) and a number of Environmental Impact Assesment (EIA) documents. In this paper we review information from these sources in combination with our own extensive knowledge of the mires of this area; and on this basis we examine the consequences of wind energy development for the local mire and peatland resource.

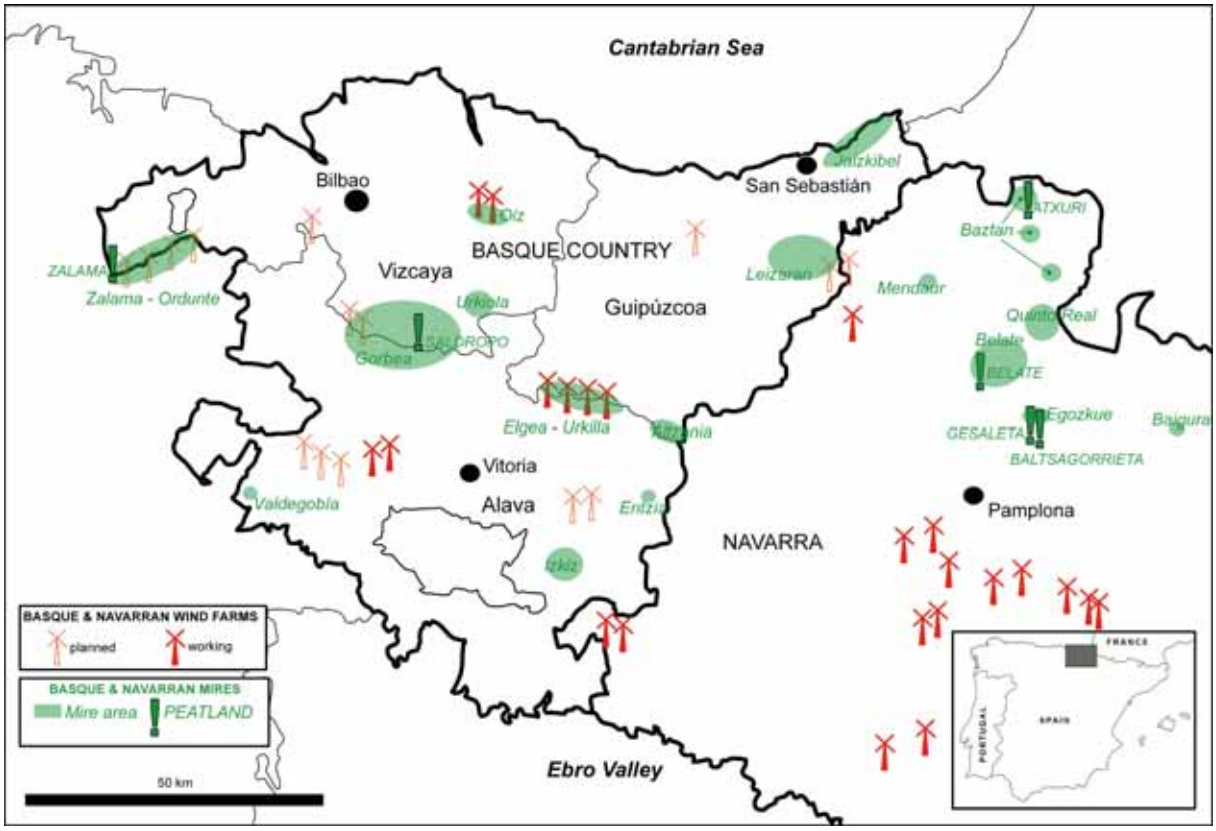

Figure 1. Location of mire systems and wind farms (planned and operational) in the Basque Country and north-west Navarra.

OVERVIEW OF MIRE SYSTEMS

The first account of the mires of the Basque Country and north-west Navarra was presented by Allorge (1941). Over the last 20 years their floristics (vascular plants and bryophytes) have been studied by several authors (Aseginolaza *et al.* 1988, Heras & Infante 1990, Onaindía & Navarro 1986, Zendoia *et al.* 2003), and more recent work has focused on other aspects such as the characterisation of peat deposits (Heras 1992, Heras & Infante 2004, Heras *et al.* 2006) and habitat cartography (unpublished work carried out in 2005). The presence of mire systems is determined by the following three factors:

- the climate, which biases the distribution of mire systems towards the north where rainfall is highest, especially in the mountains;
- the Mesozoic bedrock, which supports mire formation only in areas where limestone is not predominant; and
- the deeply dissected topography which rules out permanent flooding and the development of extensive wetlands.

A remarkable and characteristic feature of the Basque and Navarran mire systems is that they are located in mountainous terrain. True peatlands (defined as extensive peat deposits more than 0.5 m deep) are exceptional, whereas para-peaty habitats are much more common. The latter are typically spring and flush areas with mire vegetation, often including *Sphagnum* species. Their soils consist predominantly of clay or sand, normally with high content of well-decomposed organic matter, but peat

is very shallow and discontinuous or totally absent. These are highly valuable ecosystems because they harbour many mire bryophytes and other plants which are fairly common in central and northern Europe but localised and very rare in the Iberian Peninsula. However, it is important to distinguish clearly between the para-peaty habitats and the floristically and biogeographically related true peatlands because of the extremely high ecological and historical value of the peat archive.

At least 17 mire areas can be distinguished in the Basque Country (11 areas) and north-west Navarra (6 areas) (Figure 1). Table 1 gives a summary of their main features. These areas are very different from one another, and the following are notable:

- Gorbea contains a large number of mires, together with a raised bog (Saldropo) which was entirely destroyed by peat extraction in the 1980s (Infante & Heras 1987a, b);
- Zalama-Ordunte is extensive, and again contains a large number of mires as well as the most easterly Iberian blanket bog, Zalama Bog (Heras & Infante 2004);
- Gesaleta and Baltsagorrieta poor fens are extraordinary and remarkable because they are the only pristine peatlands in the Basque Country and Navarra; and finally
- Atxuri and Belate sloping fens, although severely affected by anthropic disturbance, must be mentioned.

Except for the Zalama blanket bog and the extinct Saldropo raised bog, the Basque and Navarran mire systems are minerotrophic in origin. The usual water sources are lithological contacts between permeable and impermeable rocks, normally sandstone aquifers sandwiched between clayey rocks, but in some cases the water originates from very thick colluvial deposits and scree.

Table 1. Summary of mire areas in the Basque Country and north-west Navarra.

	Mire area	Important peat deposits	Versant	Conservation status	Protection status
BASQUE COUNTRY	Gorbea	Saldropo (extinct raised bog)	Atlantic-Mediterranean limit	good – medium	SCI natural park
	Izkiz	-	Mediterranean	good – medium	SCI natural park
	Zalama-Ordunte	Zalama (blanket bog)	Atlantic-Mediterranean limit	good – bad	SCI
	Valdegobia	-	Mediterranean	good – medium	-
	Leizaran	-	Atlantic	good – medium	-
	Jaizkibel	-	Atlantic	medium – bad	SCI
	Urkiola	-	Atlantic-Mediterranean limit	good – medium	SCI natural park
	Elgea - Urkilla	-	Atlantic-Mediterranean limit	good – medium	-
	Altzania	-	Atlantic-Mediterranean limit	good – medium	SCI natural park
	Entzia	-	Mediterranean	medium – bad	SCI
	Oiz	-	Atlantic	good – medium	-
NAVARRA	Belate	Belate (fen)	Atlantic-Mediterranean limit	good – bad	SCI
	Baztán	Atxuri (fen)	Atlantic	good – bad	SCI (partially)
	Quinto Real	-	Atlantic-Mediterranean limit	good	SCI (partially)
	Egozkue	Gesaleta & Baltsagorrieta (poor fens)	Mediterranean	very good	SCI
	Baigura	-	Mediterranean	good	SCI
	Mendaur	-	Atlantic	good – bad	-

Both the true peatlands and the para-peaty habitats are important biotopes with huge implications for nature conservation and land management policies. Many plant and animal species thrive exclusively in these mires. For example, populations of plants such as *Drosera intermedia*, *Eriophorum vaginatum*, *Lycopodiella inundata*, *Pinguicula lusitanica* and *Rhynchospora fusca*, which are very rare and regionally threatened in Spain, occur at some sites in the Baztan, Izkiz, Jaizkibel and Zalama-Ordunte areas. Some habitats that are listed in the European Habitats Directive (EU 1992) have also been recorded. Finally, because the are located in the headwaters of main rivers, they play a decisive role in hydrological regulation.

Nonetheless, several threats hang over the Basque and Navarran mire systems. Peat extraction has totally destroyed Saldropo Bog, and erosion linked to fire and cattle management is reducing the extent of the Zalama blanket bog. The desiccation and degradation of the Atxuri and Belate fens is also related to cattle management. For para-peaty habitats, the most common threat is again cattle husbandry. Trampling and overgrazing by cattle has been noted in practically all mire areas and severely affects certain sites, for example in the Jaizkibel area (Zendoia *et al.* 2003). Sometimes, modification of the traditional cattle management regime accelerates degradation by increasing the stocking density. Another serious threat is infilling by sediment washed in from nearby areas that have been disturbed by construction work for roads and mountain tracks. Occasionally these habitats are severely affected by water abstraction for cattle drinking troughs and water supplies for nearby villages. Finally, and most recently, a new threat has appeared, namely wind farm plans (Heras & Infante 2005a).

DEVELOPMENT OF WIND FARMS

Both the Basque Country and Navarra are favoured for wind energy projects because of their location, their lower average altitude than both the Pyrenees to the east and the Cantabrian Mountains to the west, and the suction effect of the Ebro Valley. In Navarra, development began in December 1994 with a pilot installation of six turbines in Sierra del Perdón, south of Pamplona (Figure 1). This was followed by an installation at Leitza-Beruete in 1996, and then by a more ambitious plan from the company Energía Hidroeléctrica de Navarra S.A. (EHN) for 18 wind farms (some in several phases) plus four in reserve, with a total installed capacity of 636 MW. After this, only experimental turbines would be allowed. All of the planned wind farms had been built, achieving over 900 MW capacity, by 2005. No mire systems were affected because central and southern Navarra proved to have higher wind potential than the north-west, where only one site (Leitza-Beruete) was developed.

The Basque Government's PTSEE (Basque Government 2002) was integrated with a wider plan for self sufficiency in energy, and of course followed the lead of Navarra. Every west–east mountain range of altitude greater than 700 m was considered and 29 possible locations for wind farms were identified. In the elimination process that followed, eleven sites were rejected for environmental reasons, five due to technical difficulties relating to construction, and two more because they proved to have low generation potential. Of the eleven suitable locations that remained (Table 2), only three (Oiz, Elgea-Urkilla and Badaia) have been developed so far. However, in contrast to the situation in Navarra, there are some impacts on mires.

Table 2. List and characteristics of admissible wind farms in the Basque PTSEE.

Location	Length (km)	Number of turbines	SCI or natural park	Status
Ordunte	19.9	156	ES2130002 Ordunte	withdrawn
Ganekogorta	4.8	48	-	planned
Oiz	4.9	35	-	operational
Gazume	1.7	17	ES2120008 Ernio-Gazume	planned
Mandoegi	12.6	105	-	planned
Kolometa	16	166	ES21100009 Gorbeia Natural Park	planned
Elgea-Urkilla	19.4	167	-	operational
Arkamo	8.4	70	ES2110004 Arkamo-Gibijo-Arrastaria	planned
Badaia	18.6	137	-	operational
Iturrieta	9.1	71	ES2110022 Entzia	planned
Cruz de Alda-Arlaba	7.6	68	ES0000246 Sierras Meridionales de Alava	planned

EFFECTS OF WIND FARMS ON MIRES

Superposing the distributions of mire systems and the eleven permitted Basque Country wind farms shows that there is no risk at some locations (e.g. Ganekogorta, Mandoegi and Iturrieta) because the mires lie on slopes below the ridges, and at others (Arkamo, Badaia, Cruz de Alda-Arlaba) because there are no mires due to calcareous geology. Wind farms and mire systems coincide at four locations, namely Elgea-Urkilla, Oiz, Kolometa and Ordunte.

Although the process of choosing the best locations for wind farms was quite reasonable and included detailed assessment of potential impacts (EIA), some points must be noted in relation to peatland and para-peaty habitats:

- Only impacts directly associated with the turbines were considered; those caused by access and installation of the electrical connections were omitted. In fact, the location and extent of the mire systems mean that the main problems are associated much less with the turbines themselves than with the construction of access roads and electrical connections (Table 3).
- Any type of forest, regardless of its conservation status or value, is arbitrarily afforded the highest conservation status, whilst - probably reflecting social perceptions - the "short" vegetation is considered to be of much lower value.
- The presence of threatened flora and/or rare and unique habitats does not automatically rule out development. Moreover, the rather old vegetation map and data used for the analysis (Aseginolaza *et al.* 1992) had its own habitat classification which was translated into Habitats Directive coding, and this could have caused some mistakes in the evaluation. In other words, the elimination process at the beginning of the PTSEE was based on unreliable information about the mire systems.

Table 3. Summary of wind farm impacts on Basque mire systems.

	Turbines	Electrical station	Electricity line	Access road
Oiz	NO	NO	NO	NO
Elgea-Urkilla	NO	NO	YES	YES
Ordunte (withdrawn)	YES	NO	YES	YES
Kolometa	YES	NO	YES	YES

Elgea-Urkilla was the first wind farm to be built, in 2003 (BOPV 103 28 Mayo 2003 Resolución 3041). This mountain range extends for 11 km and has 23 small para-peaty habitats (Figure 2) whose presence was acknowledged in the PTSEE. EIA requirements were set for identifying and mapping wetland areas so that they would not be damaged by construction works, and additionally for the presence of a botanist during all works to ensure that no threatened flora were eliminated. Despite these precautions, there were some problems. Although very few of the para-peaty habitats coincided exactly with turbine sites, construction of the access road destroyed two of them, namely Keixtuigaina-1 and Usabakotxena (Figure 3). At Keixtuigaina-1, the only population of *Juncus squarrosus* in this mountain range (and one of only three Basque sites for the species) is now damaged along with the rest of the mire vegetation. Usabakotxena has been completely drained and now retains only some *Juncus effusus* as a memorial. Overall, approximately 9% of the local para-peaty habitat was lost. Nonetheless there was a positive outcome for public education because the developer (Eólicas de Euskadi S.A.) now organises guided tours which present the wetlands as points of interest (Figure 3).

Oiz Wind Farm was built in 2003–4. As at Elgea-Urkilla, the EIA (BOPV 122 23 Junio 2003 Resolución 3671) required mapping of all wetlands and the presence of a specialist during construction to ensure that none of the populations of threatened plants was destroyed. The small para-peaty habitats are situated on a south-west facing slope, mostly below and at least 200 m away from the turbines (Figures 4 and 5). The only wetland close to the turbines and the access road (Oiz-10) was meticulously respected throughout the works, even though it was already affected by a cattle trough, a fountain and a mountain refuge (Figure 4).

Figure 2. Plan for Elgea-Urkilla Wind Farm. The string of turbines is indicated by the red line, and para-peaty habitats are shown in yellow.

Figure 3: Elgea-Urkilla Wind Farm. Upper left: general view. Upper right: information post marking para-peaty habitat as a point of interest for visitors. Lower row: damaged para-peaty sites Keixtuigaina-1 (left) and Usabakotxena (right).

Figure 4. Oiz Wind Farm. Left: view of turbines above one of the para-peaty sites. Right: disturbed site Oiz-10.

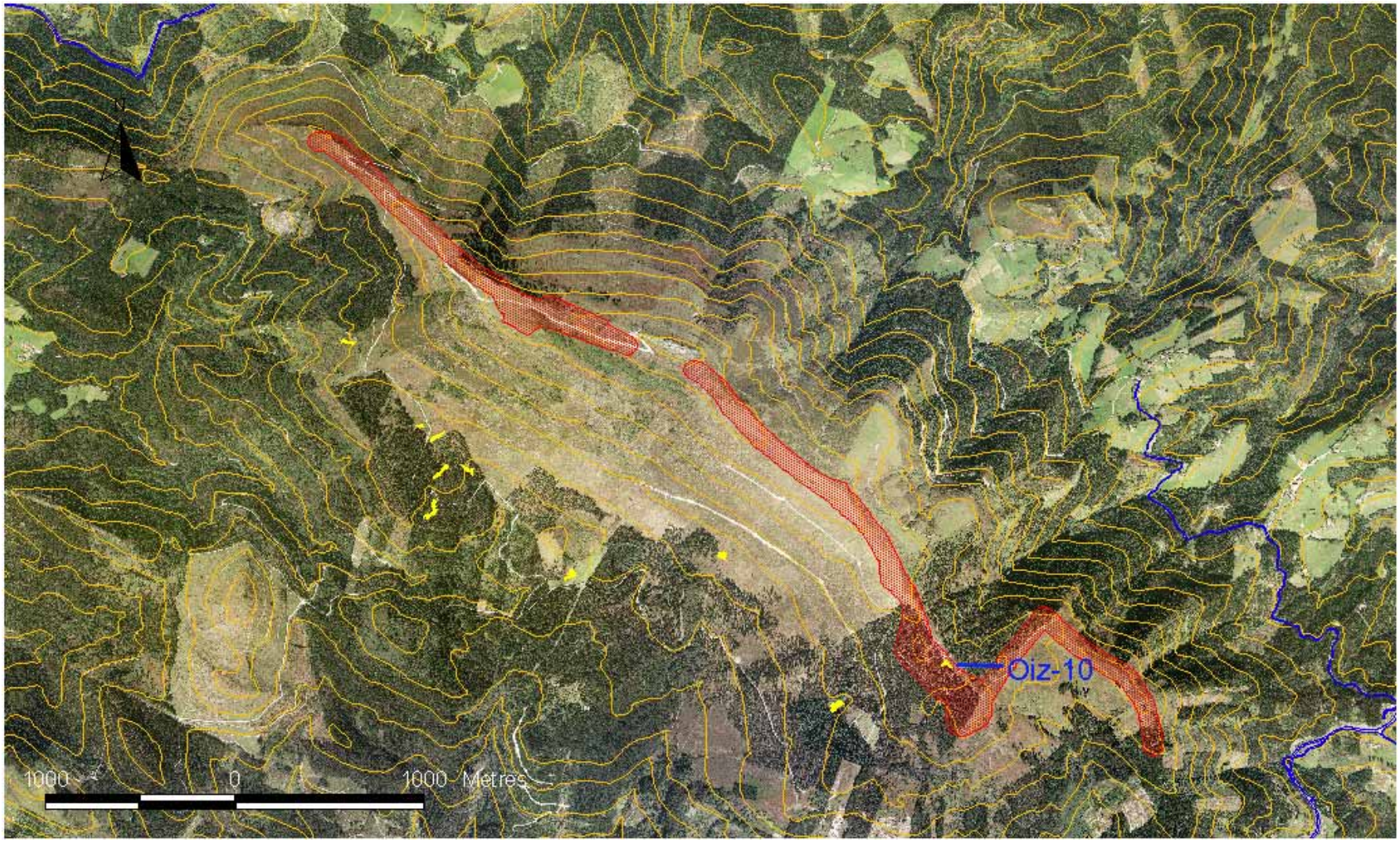

Figure 5. Plan for Oiz Wind Farm showing the turbine line (red) and para-peaty habitats (yellow).

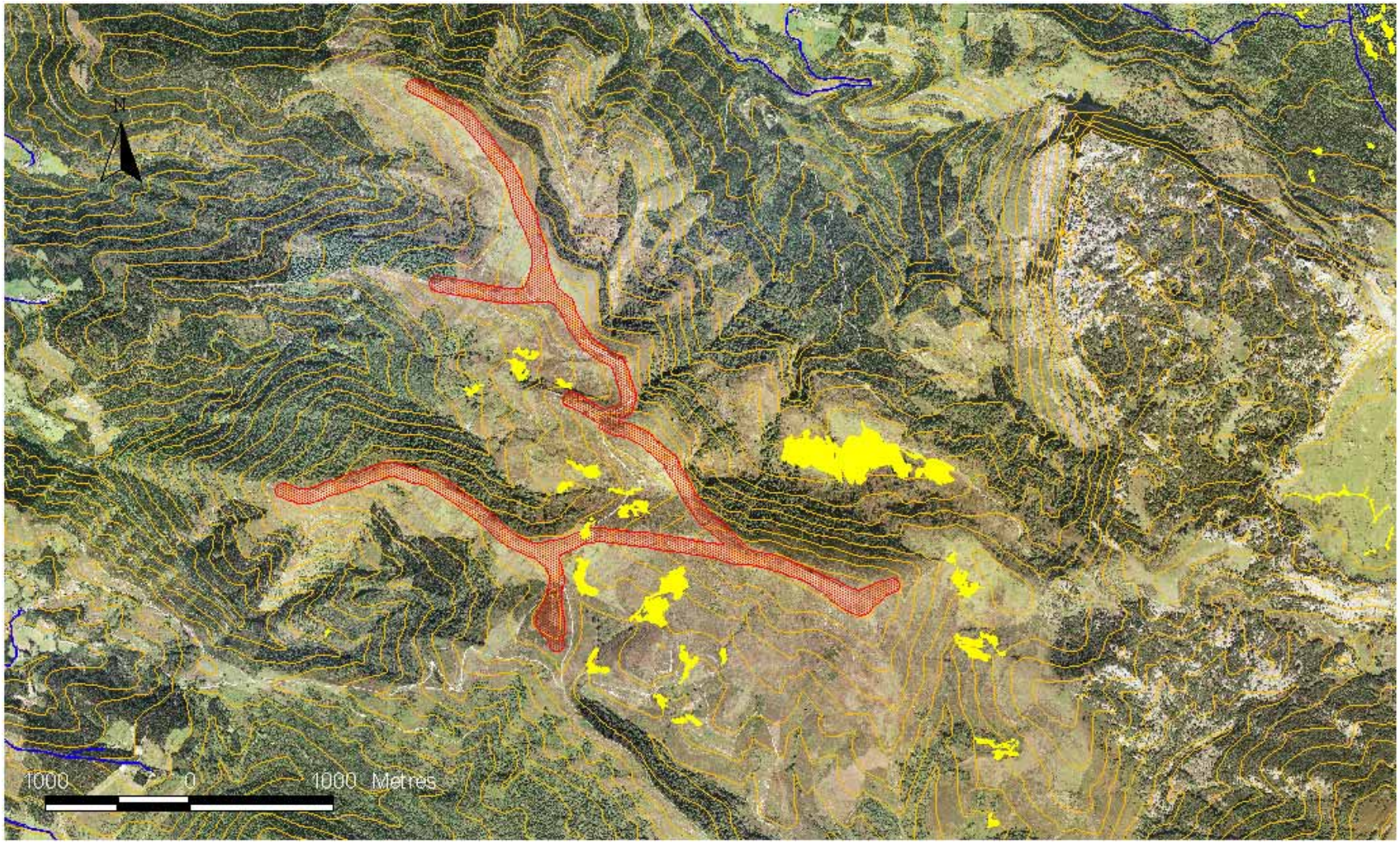

Figure 6. Plan for Kolometa Wind Farm, showing the proposed line of turbines (red) and para-peaty habitats (yellow).

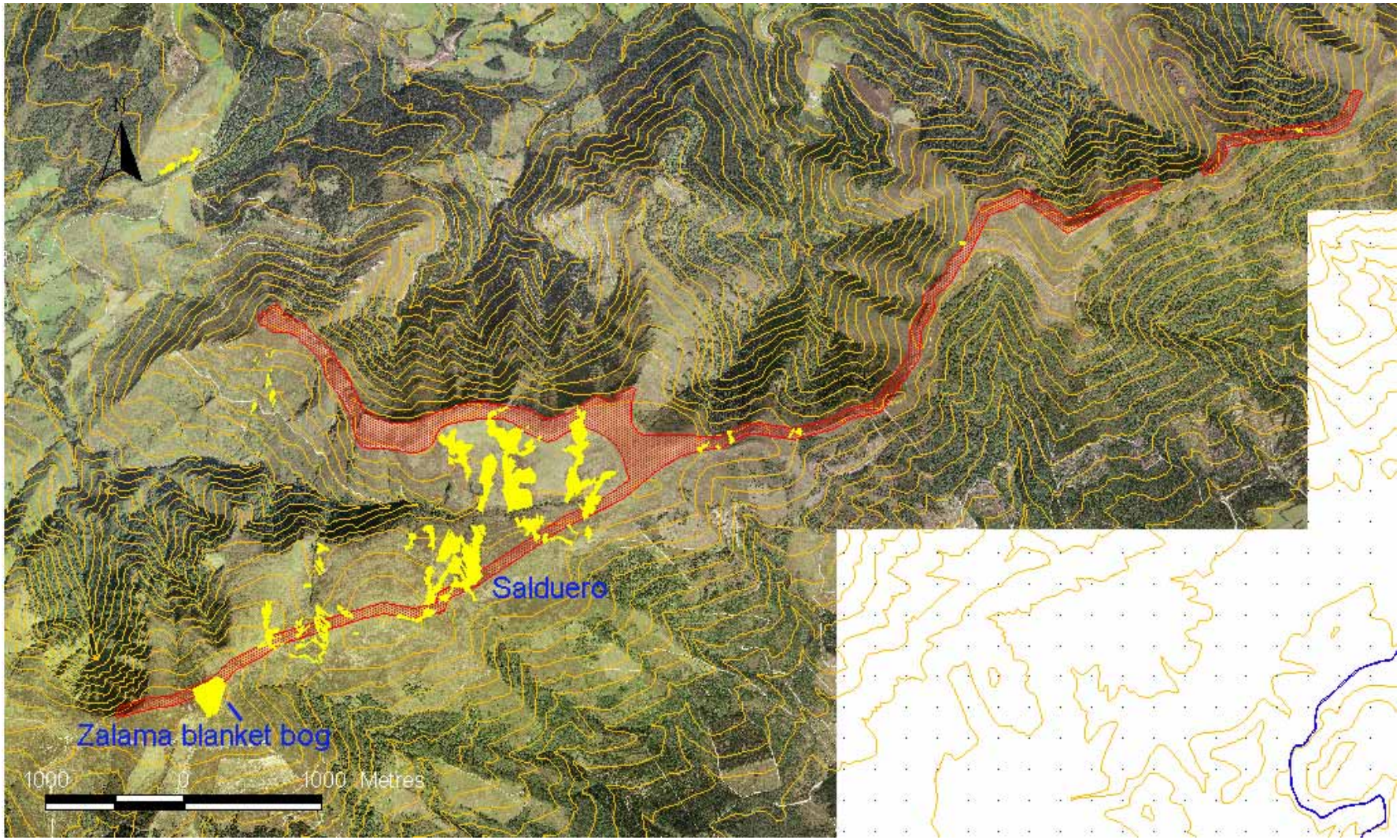

Figure 7. Plan for Ordunte Wind Farm showing the proposed line of turbines (red) in relation to Zalama Bog and para-peaty habitats in the Salduero sector (yellow).

Kolometa (Figure 6) lies within Gorbeia Natural Park. This project is currently in the very first phase of planning and could face serious opposition from the Scientific Committee for the natural park, which has already publicly stated its disapproval. The mire complex here is dense and fairly extensive, and some of the mires occupy saddle positions between summits, making them vulnerable during the construction of both the turbines and the access road

The plan for **Ordunte** Wind Farm was officially launched in May 2004. At 19.9 km long, this is one of the largest installations in the PTSEE (Figure 7). There were some special problems, listed below.

- The area to be developed comprises two sectors with different needs and vulnerability. The Zalama sector contains the Basque Country's only blanket bog, and the Salduero sector its most dense mire system (Figures 7, 8).
- The site extends southwards to the boundary of another autonomous community (Castilla-León), which was hardly considered during the EIA process. As a result, the positions of the turbines were adjusted to bring them away from the boundary, making them a closer threat to the Zalama and Salduero mire systems.
- The Basque Plan for Aeolian Energy was completed before the Zalama peatland was correctly identified and classified.

Although the Zalama blanket bog was described as such in 2002 (Heras 2002), the presence of this

Figure 8. Mires at the Ordunte Wind Farm site, namely the Zalama blanket bog (above) and the Salduero para-peaty sector (below).

Natura 2000 habitat in Spain was not officially acknowledged until 2004 (2004/813/EC). Meanwhile, wind farm construction through the entire length of the peatland had been planned (Figure 7), threatening to obliterate it. However, once the presence of blanket bog had been confirmed, the developer (again Eólicas de Euskadi S.A.) withdrew the turbines from this area and committed to funding a restoration plan, including a detailed map (Murillo 2004), to improve the condition of the bog as compensation for the wind farm. The second threatened sector was Salduero, a vast area with numerous wetlands, some minor peat deposits and some transitions to wet heath. Not only would turbines be sited in the mires, but also the planned access road and the electrical connector line would cut through them at numerous points. Associated risks included infilling, alteration of their vegetation through hydrological disturbance, and the introduction of calcareous leachate from the road materials. In this case, Eólicas de Euskadi supported detailed mapping of Salduero (Murillo 2005) (Figure 9), together with an inventory and a study of the potential effects of Ca^{2+} from leachate and the mitigation measures that would be needed to avert any problems (Heras 2005). Eventually, despite all the efforts of Eólicas de Euskadi, the Ordunte proposal was rejected in March 2006 (BOPV 195 11 Octubre 2006 Resolución 5008), principally on ornithological and landscape grounds.

The EIA process induced an extraordinary social awareness (Figure 9), as can be shown by the following two examples:

- The environmental association "Karrantza Naturala" submitted a petition (Nº 0569/2004) to the European Parliament about the threatened status of the Zalama blanket bog.
- The local government (Diputación Foral de Bizkaia) collaborated with the organisers of the Galarleiz alpine marathon, which is held every July on the Ordunte summits, to produce a publicity leaflet on the natural history of the area (Heras & Infante 2005b). They also re-routed a path to avoid the bog.

Thus the increased knowledge and social awareness arising from the unsuccessful wind farm planning process have transformed Ordunte into a target area for nature conservation, by involving all stakeholders - even those from the neighbouring Castilla-León autonomous community. The final positive outcome is that restoration of the Zalama blanket bog - which otherwise would never have taken place - is now being planned as a joint venture by the governments of Bizkaia and Castilla-León.

Figure 9. The planned Ordunte Wind Farm: increasing knowledge and institutional/social awareness. Top: mapping in Salduero. Centre: site meeting of representatives of the institutions involved in restoration and conservation activities. Bottom: information board at Salduero.

CONCLUSION

Our review has shown that the impacts of wind energy development on Basque Country and north-west Navarran mires have so far has been relatively small, on account of:

- the limited extent of most wetlands;
- the fact that they occur mostly on slopes, the turbines being placed preferentially on the summits;
- the low wind resource of the north-west part of Navarra, where most of the peatlands and para-peaty habitats of this administrative area are located; and
- the care shown both in the Basque Government's EIA work and by the developers during construction.

Nonetheless, the risks have been enormous due to inadequate knowledge of the area's peatlands and para-peaty habitats, especially in the case of the Zalama blanket bog and the Salduero para-peaty habitats.

Paradoxically, the example of Ordunte Wind Farm eventually provided the most positive outcome of all for mire conservation. Although construction of this wind farm would have finally industrialised the Ordunte range, it is fair to say that the area was already under threat. The mires were becoming increasingly degraded due to intensification of cattle grazing and associated activities such as scrub clearance and burning as well as by recreational activities involving quad bikes, mountain bikes and all-terrain vehicles. The EIA process has substantially increased our knowledge of the mire systems, avifauna and archaeology, and prospects for the future are now considerably brighter.

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