



**ENVIRONMENTAL  
IMPACT ASSESSMENT** For  
**WIND FARM DEVELOPMENTS** **2012**

A Guideline Report



*Empowered lives,  
Resilient nations.*

# ENVIRONMENTAL IMPACT ASSESMENT

## For WIND FARM DEVELOPMENTS

*A Guideline Report*  
2011

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This report has been prepared by Biotope for the UNDP-CEDRO Project.

**September 2011**

# Acronyms

COM: Council of Ministers

CDR: Council for Development and Reconstruction

IEE: Initial Environmental Examination

MOE: Ministry of Environment

NGO: Non Government Organization

ES: Environmental Statement

MoEW: Ministry of Energy and Water

CEDRO: Country energy efficiency and renewable energy demonstration project

EIA: Environmental Impact Assessment

UNEP: United Nations Environment Program

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## Preface

The Government of Lebanon, through a Ministerial Declaration and through the Ministry of Energy and Water's (Bassil, 2010) Policy Paper for the Electricity Sector (published in June 2010) have set the target of 12% of total energy supply to come from renewable energy sources by 2020. The MoEW believes that the development of wind energy in Lebanon would play a crucial role towards reaching that target, particularly after the publication of the national wind atlas in January 2011 by the CEDRO project where it indicated that Lebanon has at least 1500 MW of wind power potential (CEDRO, 2011).

The commitment of the MoEW and other stakeholders in Lebanon towards energy efficiency and renewable energy systems stems from a commitment to the importance of such measures and technologies in finding solutions for the electricity sector in Lebanon, and most importantly in finding new ways and opportunities to fight the threats that climate change is highly likely to cause and the need to enhance a country's energy security.

To this extent, the CEDRO project has initiated a guideline report for the 'environmental impact assessment (EIA) of wind farm projects'. It is hoped that Lebanon follows international standards in wind farm licensing, in which one of the main pre-requisites for granting wind farm development licenses is the implementation of EIAs. Only after the wind farm proposed development passes the EIA recommendation and/or modifies the project in accordance to the identified mitigation measures to be granted that acceptance, would a license be granted.

This report sets the general principles and procedures to implement EIA for wind farm development in Lebanon.



Picture 1: Wind farm project in South of France



# Chapter 1 - Introduction

## 1. Environmental Impact Assessment (EIA)

EIA is a planning and decision making tool that contributes to environmental protection based on understanding the environmental consequences a proposed project may have prior to its implementation. The process thus enables decisions to be taken that minimise environmental effects while maintaining the objectives of the project proposal, or preventing actions that will be costly to the environment. EIA is therefore an important tool in ensuring sustainability and provides information so that sustainable decisions can be made.

This booklet is aimed at providing environmental consultants and practitioners with introductory guidelines to conducting EIAs for wind power developments within the context of Lebanon. These guidelines will outline the policy and legislative setting for EIAs in Lebanon; provide an overview of the EIA process in general, followed by an overview of EIAs specific to wind power installations.

## 2. International environmental policy and law relevant to EIAs

International environmental law and policies are relevant to or applicable to the EIA systems of all countries. These can be divided into:

- Non-binding instruments, such as the Rio Declaration, that establishes important principles for sustainable development, including those which need to be reflected in EIA arrangements (e.g. the application of the precautionary principle);
- Legal conventions and treaties related to environmental protection at the global or regional level, which carry obligations for signatory countries that may be met through EIA arrangements;
- Legal conventions and protocols that apply specifically to EIA arrangements of which the Espoo Convention is the most notable example.

A number of international environmental agreements established substantive obligations on the countries that ratify them. The Conventions on Climate Change and Biological Diversity Change are flagship agreements because of their global scope, the importance of the issues that are addressed and their ratification by a large number of countries. In particular the Rio Declaration stipulates the importance of conducting EIAs for development projects that will have a detrimental effect on the environment under Principle 17, and identified EIA as an implementing mechanism for the Convention on Biological Diversity and Climate Change. EIA is specified as a mechanism for implementing certain aspects of both agreements. More generally, it can ensure that the proposed actions of signatory countries are in compliance with these and other international environmental agreements.

### 3. EIA Requirements of International Organizations

The World Bank and the regional development banks, such as the African Development Bank, European Bank for Reconstruction and Development, and the European Investment Bank, have well-established EIA procedures which apply to their lending activities and projects undertaken by borrowing countries (World Bank 1989, 1999 and 2005). Although their operational policies and requirements vary in certain aspects, development agencies follow standardised procedures for the preparation and approval of EIA reports. Although the legislative frameworks of EIAs that are increasingly being introduced into developing countries' legal systems, much of the first EIAs carried out were demanded from development assistance agencies as a condition of service rather than in-country demand for better environmental protection (Wood, 2003). However, the emergence of a sustainable development agenda by governments has been an influential factor in the EIA systems in many developing countries (Lohani, 1997).

The EIA policies and arrangements of development agencies remain important, especially in countries that have weak or non-existent domestic arrangements. Recently, the World Bank has introduced a number of changes to increase the systematic application of its EIA procedure, notably through its linkage to new environmental and social safeguarding policies (World Bank, 1999). Likewise, the United Nations Environment Programme has also developed a set of guidelines for developing countries (UNEP, 1988).

### 4. The EIA system in Lebanon

The legal basis for EIA and its 9 annexes is established in the **Environmental Law no. 444/2002** (Chapter 4, Article 21-23 [Annex 1]) and **Law no. 690/2005**. It is being implemented even though the EIA application decree has not been issued by the Council of Ministers (COM) yet.

The EIA decree was prepared over a decade ago in the framework of a regional project funded by the Mediterranean Environmental Technical Assistance Programme implemented by the World Bank.

The draft EIA and its annexes require that the project proponent hires a national consulting firm among the pre-qualified consulting firms of Council for Development and Reconstruction (CDR) (MOE decree No. 7/1 of 2003) to prepare either an EIA report or an Initial Environmental Examination (IEE) report.

The law and the decree also assign full authority to the Ministry of Environment (MoE) through its service of Environmental Technology to arrange the screening, review, control, and follow-up of the EIA process and its implementation. The approval of an EIA is a pre-requisite for any subsequent license or permit by any or all other relevant authorities that may be required prior to construction.

In recent years, the MoE has improved efforts to enforce EIAs in sectors and in the permitting procedures of line ministries such as the Ministry of Public Works and Transport, Industry, and Tourism.

All development projects, including wind farm projects, regardless of EIA classification, must adhere to the environment quality standards for air, water, and soil (MOE ministerial decision 52/1 of 1996) as well as to air emission standards and wastewater discharge (MOE ministerial decision No 8/1 of 2001).

## Chapter 2 - The EIA Process for Wind Farm project

The rationale underpinning EIA is that it is a means to help choose whether to move forward with an action or proposal based on an understanding of the environmental consequences of its implementation. The simplicity of this concept has led EIA to become one of most widely adopted environmental management tools by governments and development institutions throughout the world.

EIA possesses a distinct feature in that it is anticipatory, and thus aims to *predict* likely environmental effects of a proposal. In turn, this can provide a basis upon which developers and decision makers can respond appropriately to these effects. EIA, therefore, is an ideal environmental management tool that can sufficiently make reasoned estimates of likely significant effects of a proposal. Likewise, knowledge that there is a likelihood that the proposal may have an impact of a uncertain magnitude can allow changes and alterations to be made to certain aspects of the proposal early on in the process, or that the “precautionary principle” be applied and the proposal may not go ahead at all.

The EIA process considers the impacts of proposed developments on the biological, physical and human environments: air, land, fauna, flora, landscape, etc. Its scope includes a review of the effects that could bring adverse changes to the natural environment and the resulting short and long term effects that these changes could have. EIA frequently has a dominant focus on the environmental (biophysical) impacts however best-practice regularly takes social and economic impacts into account as well.

EIA can indicate when a project:

- Is likely to cause environmental damages;
- Causes adverse impacts on valued ecosystems, landscapes, and other environmental features;
- Could result in harmful health effects on a community;
- Could provide an opportunity for environmental or social improvements.

### EIA AS A DESIGN TOOL

One of the areas where EIA can be most effective is in influencing the design of the project during the planning stages. Early identification of environmental problems allows the opportunity for the project design to be altered thus reducing or eliminating that impact, and thus would avoid ‘end-of-pipe’ solutions that could prove costly. If carried out properly, it can potentially benefit all those involved in the planning process.

## EIA IMPROVES CERTAINTY OF DECISION MAKING

Projects that are subject to an EIA required by regulation will be subject to a consent system. If the EIA was effectively used as a tool in the design of the project, there is a higher prospect that planning consent may be granted. By identifying environmental impacts early on and designing the project to reduce or eliminate these, then the environmental reasons for refusing consent are also reduced or eliminated.

## THE EIA PROCESS

EIA is described as being an iterative process. Figure 1 below shows how EIA can be illustrated as a linear sequence of steps however it contains a number of feedback loops that are designed to revise the project proposal and reconsider the environmental effects of any changes that have taken place.

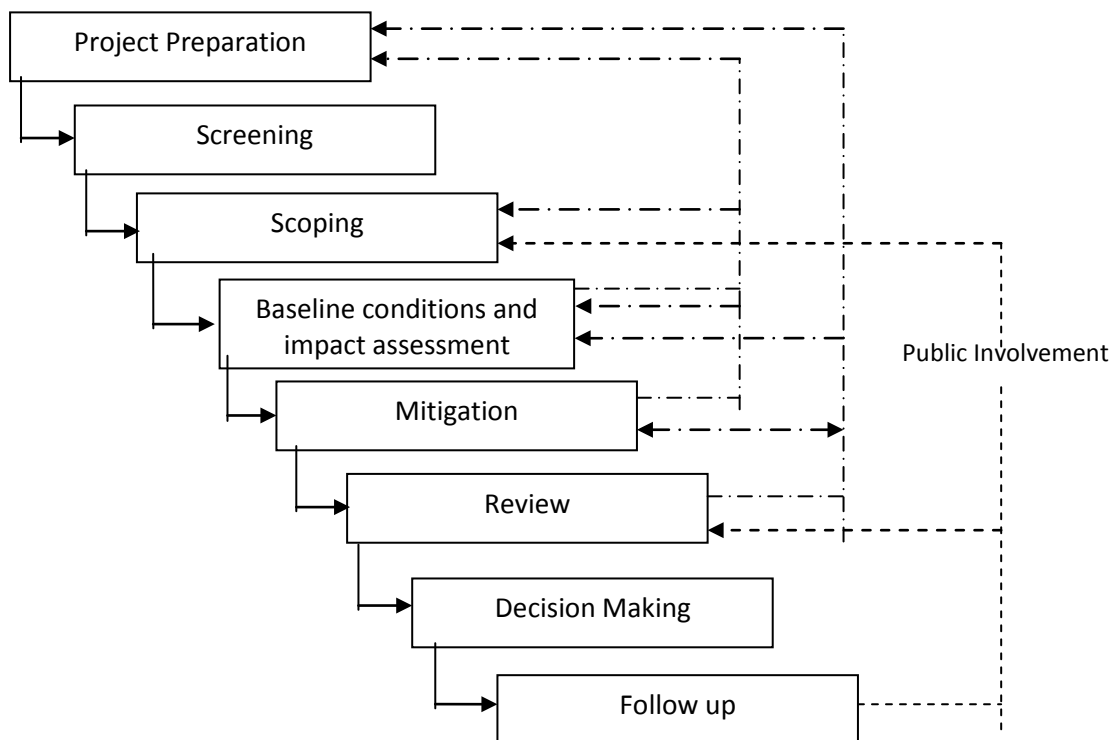


Figure 1: EIA process description

## WHO IS INVOLVED IN AN EIA?

EIA involves a number of different stakeholders and successful EIAs should try to actively involve all of them. Typical stakeholders involved are:

- Developers that are responsible to conducting the EIA, however will often employ consultants with full or partial responsibility;
- Consultants with a multidisciplinary team dependent on the type of project, or an EIA coordinator with a number of sub-consultants;
- The regulating authority that will evaluate the environmental statement and will ultimately make a decision on the project, but can also set the requirements of the EIAs and advise on issues to be addressed by the EIA;
- Non-governmental organisations (NGOs) provide inputs and can be involved in decision making;
- Affected or interested members of the general public may provide inputs and be involved in decision making.

### 1. Project Preparation

Consideration of environmental issues should begin at the project's inception, where EIA can be used as a tool for sustainable design and influence decisions on what is to be constructed and where it is to be located. This stage is regarded as one of the most important since this would provide the best opportunity to avoid significant environmental effects by steering clear of environmentally sensitive locations, as a first best option, and selecting designs that will have reduced impact if that impact is deemed acceptable. This will ensure a better proposal is prepared and saves time on going back and revising project designs later on in the process.

This step should involve:

- Options appraisal;
- Site selection;
- Project design and mitigation;
- Preliminary site walk-over;
- Preliminary environmental desk and field Studies;
- Consultation;
- Type of application.

It must be noted that the work initiated at this stage should continue throughout the duration of the project, particularly during the baseline study and beyond.

The preliminary site walk-over will provide an understanding of the project location and identify key environmental issues. The desk study will follow up and support the preliminary site appraisal and identify further key environmental aspects of the site. During this step, the Environmental Sensitive

Areas, the Important Plant Areas (IPA), Important Bird Areas (IBA), etc. will be identified in order to better understand the sensitivities of the site and the issues that those could bring out. The identification of regulatory and scientist zoning can highlight the ecological sensitivities and the measures and tools for environment protection. Information may be collected at this stage on potential issues (migration corridors, protected species). Consultations with relevant environmental and local groups, local experts, and NGOs will be a valuable source of information.

The data obtained from these studies will focus on identifying key sensitive receptors, preliminary impacts and opportunities for environmental benefits, and yet may also indicate possible technical constraints for the wind farm installations (radio easements, air corridors, pipelines, proximity of houses...etc.).

The preliminary scoping is also the opportunity to conduct a preliminary first survey of historic or/and cultural monuments.

## 2. Screening

Screening refers to the decision as to whether an EIA is required or not and is usually decided by the determining authority. The purpose of screening is to ensure that all development proposals likely to result in significant environmental effects are subject to an EIA. Part 4 of the MoE EIA Decree, the Lebanese Ministry of Environment will inform the concerned petitioner of the need to carry out an EIA or not. Annex No. 1 of the decree on EIA lists the projects with an immediate need for an Environmental Impact Assessment.

The criteria to consider the need of EIA for a project that should be considered include:

- Development characteristics;
- Characteristics of the location;
- Characteristics of potential effects.



Picture 2: Aumelas Wind farm project in South of Scoping

The purpose of the EIA is to focus on the significant effects of a proposed development and not on every single environmental effect that can be identified. The scoping phase aims to identify the effects that would most likely be significant in order to focus time and resources on the important issues. Identification of key impacts should be undertaken using a combination of professional judgement and other opinions, particularly government and regulatory authorities.

Scoping is normally carried out by those responsible for the EIA, i.e., the developer and their advisers as part of their project management when deciding on the work that needs to be done to inform decisions about the project such as location, design, treatment etc. The developer may also wish to consult the determining authority or government department, and present to them a scoping report covering the issues viewed as most important for them to review and amend accordingly.

To some extent, the scoping stage of EIA continues throughout the process. If an unacceptable environmental effect is identified, a redesign of the project should take place, which could lead to the main environmental effects of a project changing, and therefore the scope of the EIA will also change.

### 3. Determining the baseline conditions

#### 3.1. Identifying the zone of study

The boundaries of the study area are defined by the potential expected impacts that have significant repercussions on the environment. The visual impact is always considered for this purpose.

However, this does not involve studying each theme with the same degree of accuracy over the entire study area. It is therefore useful to define several areas of study (Table 1 and figure 3). These areas of study will vary according to the components to study, to the reality of the territory and to the main features of the project.

| Study Area                                | Features   |
|---|--|
| Furthest zone                             | The furthest study zone is the area that includes all potential impacts. It is defined on the basis of the physical components of the territory easily identifiable or noticeable (ridge, cliff, valley, etc.) that demarcate, or on bio-geographical boundaries (types of environments, hunting territory of the raptors, wintering areas, etc.) as well as on the human elements and cultural heritage components. |
| Middle zone                               | The middle study zone is the area where environmental studies are carried out. Corresponds to the area of wind farm potential implantation where several project alternatives will be considered. It is based on the location of the nearest residences, existing infrastructures, natural habitats. This is the area where environmental investigations and acoustic analysis are carried out.                      |
| Immediate study zone or Construction zone | The immediate study zones used only for a detailed analysis of the selected project and an environmental optimization of it. Geotechnical conditions, the natural heritage value and issues, archaeological heritage, etc. are surveyed.   |

Table 1: Study areas identification

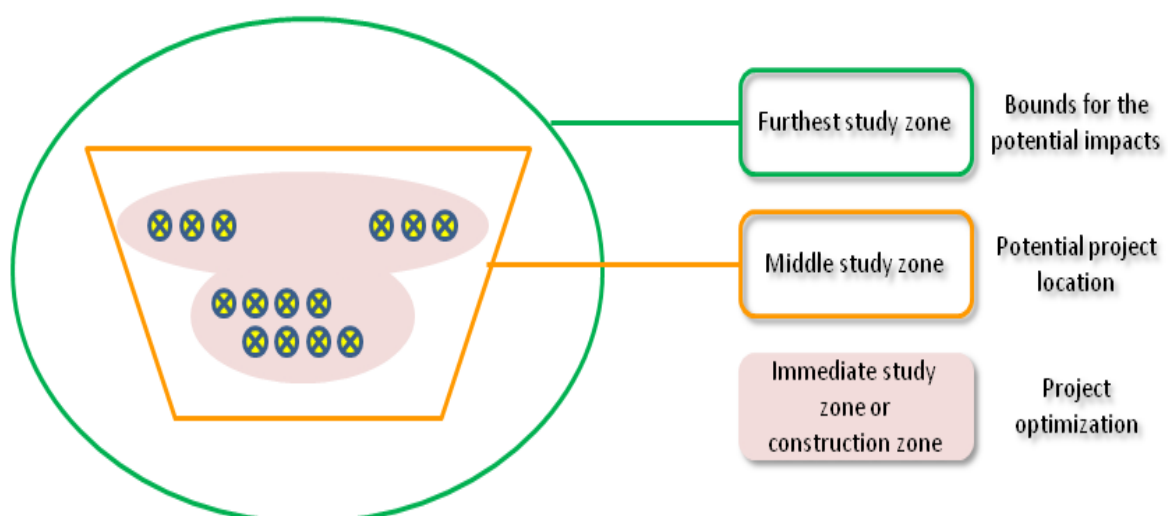


Figure 2 : Types of study zones for a wind farms project



## 3.2. Determining baseline conditions

### 3.2.1. Objectives

The evaluation of impacts and assessment of effects is dependent on a clear understanding of the existing environmental baseline conditions within, and associated with, the proposed development area. Baseline data have therefore to be gathered in order to characterize the existing environment and identify potentially affected receptors. Data collection has to involve:

- Review of existing published and unpublished data;
- Field surveys: often site's specific data is severely lacking in Lebanon, therefore field surveys will be needed to identify baseline conditions for the EIA. These should include: natural habitat, flora and fauna surveys, identification of protected species, intrusive ground investigations (to identify contamination), visual impact survey, landscape character survey (using landscape and visual impact assessment), land-use surveys, archaeological field survey, water quality survey, air quality survey, population demographic surveys.
- Desk surveys;
- Contact with relevant agencies and organizations;

The analysis of the environmental baseline is the document of reference for assessing the impact of the project once commissioned on the site and the restoration of the site at the end of the operation stage. It is performed by specialists, on the basis of scientific data and field observations. For this last one, the implementation of proven methods is recommended.

The environmental baseline;

- Provide the literature review data and results of field investigations for the environmental baseline of the site;
- Put these features in perspective with help of local, national and even international references to appreciate the rarity or abundance. As such, local politics must be taken into account.



Picture 3: Wind farm project in Morocco

### 3.2.2. Study methodologies

The completion of the environmental baseline analysis implicates both the literature and field studies. It focuses on four main components:

- Physical environment;
- Natural environment;
- Human environment;
- Cultural heritage and landscape.

Field studies implements the following techniques:

- Field observations;
- Sampling and on-site measurements;
- Meeting with population, local stakeholders and authorities.

The environmental baseline is illustrated by maps that can show several topics when the comparison makes sense (tourism and cultural heritage, infrastructure, easements and development projects) or when the quantity of information allows it.

### 3.2.3. Environmental components

#### **NATURAL HERITAGE AND BIOLOGICAL ENVIRONMENT**

The EIA should describe vegetation, flora at and around the project site, presence of wildlife in the project area and the value of the project area as a species habitat. Occurrences of rare species (fauna and flora) and habitats suitable for rare species should be identified. Field evaluations should be required to supplement existing information.

#### **PHYSICAL ENVIRONMENT**

Unique landforms, slopes, runoff characteristics and soil types should be described, as well as the proximity of the proposed undertaking to streams or watercourses. Groundwater and surface water resources should be characterized if the project has any potential to impact them. Baseline surface and groundwater quality should be described where appropriate, and field evaluations may be required to provide site-specific data.

#### **HUMAN ENVIRONMENT**

The EIA should address land use at and around the project area including information concerning existing infrastructure (roads, utilities), nearby residential and community features, any special land-use designations (e.g., parks, local zoning, etc.), significant cultural and heritage status, etc.

#### **LANDSCAPE AND CULTURAL HERITAGE**

EIA should describe landscape and all cultural heritage features. Field investigations, landscape surveys including photomontages should be carried to assess the potential effects of the wind farm project installation.

## 4. Assessing environmental impacts

The impact study identifies and describes direct and indirect, temporary and permanent effects of the project on the environment, particularly on the flora and fauna, landscapes, soil, water, air, climate, biological balance, on the protection of cultural heritage and , if any, on the neighbourhood (noise, vibration, light emissions) or on the hygiene, health, public safety and health.

As mentioned earlier, one of the main purposes of EIA is to predict the environmental effects (positive and negative) of a proposed project. There are three main elements in assessing environmental impacts:

### 4.1. Understanding the baseline conditions

The Baseline is often the current conditions on and around the proposed site, but can also involve the prediction of environmental conditions in the future; for example if a project will have a long lead time then long term changes to the environment should be taken into account. The environmental baseline analysis ends up by an assessment of the environmental sensitivity of the site. This assessment is based on a clear presentation of the criteria used and a good analysis of the data collected during the previous step. The on-site environmental issues at stake are assessed with regards to criteria such as quality, rarity, diversity, richness, etc. of the components of the environment.

Sensitivity expresses the risk that we have to lose all or part of the natural value because of the project installation. The synthesis of the environmental issues may be presented in a table folding characteristics of the study area with the sensitivity level, in order to better prioritize them. GIS represents an important tool to represent the sectors of the site that could or cannot be outfitted with wind turbines (Figure 3).

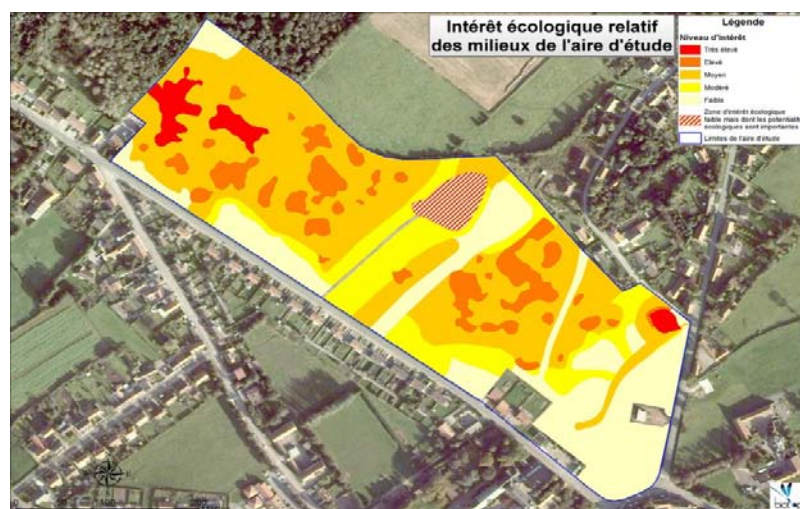


Figure 3 : Example of a Map of ecological sensitivities within the project's study area

## 4.2. Predicting the magnitude of impacts

Baseline data will allow for good quality predictions to be made of changes in the environmental conditions. Methods can include quantitative and qualitative data collection. Quantitative surveys could predict measurable changes as a result of the development (for example noise levels and air pollution) and should be used where possible. They rely on the ability to accurately measure baseline conditions and make accurate predictions with the development in place using models. The benefit of such a method is that it provides the ability to predict and subsequently monitor tangible effects. Other issues would require qualitative assessment techniques primarily using expert judgement or stakeholder consultations where changes in environment will be described or illustrated such as in landscape and visual impact assessment or in assessing expressions of opinions. In some cases a combination of the two may be necessary. It is pertinent to note that not all impacts will be predicted accurately and uncertainties must be taken account of.

## 4.3. Assessing the significance of impact

Once an understanding of likely impacts has been gained, it is then necessary to know how much this impact matters i.e. determine the significance of the environmental impact. This assessment will usually be determined on the basis of expert judgement and in order to minimise the risk of challenge by other experts, it is important to devise significance criteria related to change in environmental conditions or to the quality of the environment upon which to base the decision. Significance is broadly classified based on:

- The value of the resource (international, national, regional, local importance) and the risk associated to its loss or degradation;
- The nature of impacts (positive, neutral or negative);
- The magnitude and the reversibility of the impact;
- The duration involved (temporary or permanent change of site's features);
- The reversibility of the impact (quantification, spatial extension);
- The number and sensitivity of receptors.

Often scales of classification of the significance of impacts are used to communicate whether the impact is minor, moderate, or major, and this usually is presented in the form of a matrix along with the value of the resource. Figure 4 shows the significance of the environmental impacts for a wind farms project.

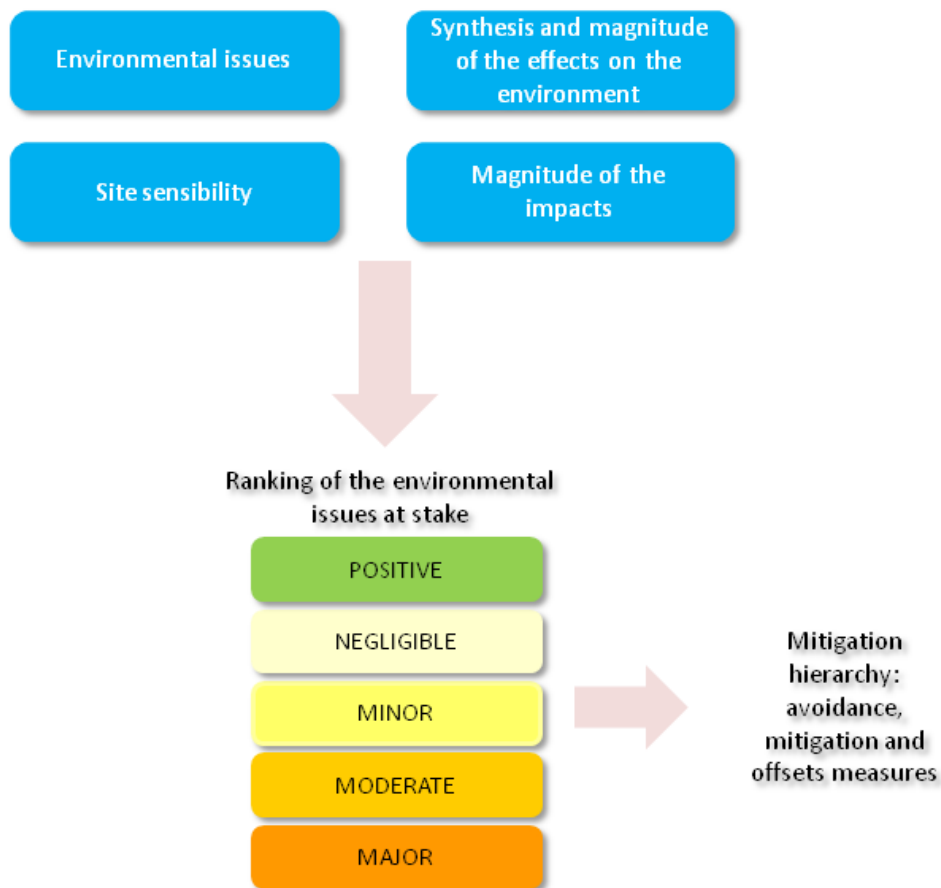


Figure 4 : Significance of environmental impacts for a wind farms project

The terms "effect" and "impact" don't have the same meaning. The term "effect" describes the consequence of the objective of the project on the environment: for example, a wind turbine will produce a noise level of 36 dB (A) at a distance of 500 meters. The term "impact" is the transposition of this consequence on a scale of values: the noisy impact will be major if residents are close to the wind turbines, it will be minor if the residents are far. The assessment of the effects on the environment consists in predicting and determining the significance of different effects (positive or negative): the effects over the time, the direct or indirect, temporary or permanent, and the cumulative effects. Some effects can be reduced, that is to say that appropriate measures will reduce them in time or in space; others cannot be reduced.

#### 4.4. The different types of effects

##### 4.4.1. Direct/indirect effects

The impact assessment cannot only focus on the effects that result directly from the planned projects. It also has to take into account indirect effects, in particular those resulting from other interventions led by the planned project. Those indirect effects are generally distant in time and location from the wind farm project.

#### 4.4.1. Temporary/permanent effects

Temporary effects disappear in time and are mostly linked to the construction and/or dismantling stages: construction site nuisance, lorry traffic, noise, dust, smells, pollutions, vibrations, disturbing fauna, flora destruction under a temporary storage area of material and machinery.

Permanent effects don't disappear during the project lifetime. They are for instance the visibility, effects on birds and bats, noise, shadow flicker, etc.... They can also be long term effects resulting from the site purpose changes: soil compaction, destruction of law walls or banks, tree or hedge felling, emergence of exotic species...

#### 4.4.2. Induced effects

Induced effects are not directly linked to the project but result from the project. They are, for instance, the increase of the site's public attendance which disturbs fauna or contribute to the deterioration of surrounding remarkable natural areas, even if protection measures were defined in the project development.

#### 4.4.3. Positive effects

Those projects produce positive effects on global pollution (avoid greenhouse gas emissions, avoid radioactive waste), or on local development and employment. The impact assessment, which aims at public information, can refer to those global positive effects of wind energy, ensuring to focus on the concerned project.

#### 4.4.4. Cumulative Effects

EIA regulations in most countries stipulate the consideration of cumulative effects. The European Commission defines these effects as "changes suffered by the environment due to an action combined with other past, present, or future human actions". The term "cumulative" refers to the sum of at least two different projects' effects. For example, an industrial plant may have relatively low predicted emissions to air, without exceeding national air quality standards. However, when the dispersion plume is modelled this may overlap with the dispersion plume of another development under construction over a sensitive habitat. The sensitivity of the habitat to cumulative levels of pollutant should therefore be assessed.

It is necessary to distinguish the same project effects that can be added from the cumulative effects of the interaction between two different projects.



Picture 4: Wind farm project in France

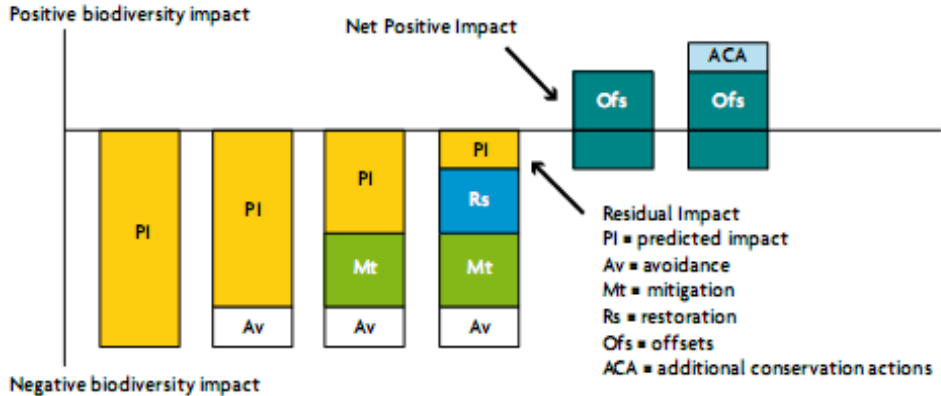
The studied cumulative effects particularly concern landscape and ecosystems. For instance, various wind farm sites built in the same landscape unit can break landscape continuity. On the other hand, if the projects are well designed, they can contribute to create a harmonious “wind farm basin”. A cumulative effect can result from the proximity to an electric line which represents a second barrier to birds’ displacements. In order to analyse cumulative effects, it is necessary to cross the impacts of the known projects (we will refer to their EIA if available or to globally expected impacts by project types) with the concerned wind farm project, and check that their sum is compatible with the environment.

It is not about conducting an exhaustive analysis but about going by “known projects” at the date of deposit of the wind farm project authorization request, that is to say the projects submitted to an authorization procedure and EIA’s legislation, and that have been subjected to an application to the competent authority in charge of authorizing and approving the project. The study area to be considered is the distant area for big projects (highways, high-speed lines, high-voltage lines, wind farms) and close area for other projects.

### 5. Mitigation

In the event that significant environmental effects are identified the developer and consultant may conclude that they are only likely to achieve project consent if the effects are eliminated or reduced. Mitigation of environmental effects should follow a systematic process attempting to avoid, reduce, remediate, or compensate for them. There can also be the opportunity to enhance positive environmental effects. According to the mitigation hierarchy (Figure 5), efforts should be made to prevent or avoid impacts on the environment, then focus on minimizing and reducing, and then repair or restore adverse effects. After these steps, any significant residual effects should then be addressed via an offset in order to achieve ‘no net loss’ of environmental components.

It must be noted that, while mitigation is routinely illustrated as being part of this stage of the process, in reality it is considered from the earliest stages of the project’s inception.



Sources: adapted from Rio Tinto and Western Australia EPA

Figure 5 : The mitigation hierarchy

Measures to avoid, mitigate or compensate impacts should be presented. If some mitigation measures have been included in the project description, they should be summarized in this section. Any impacts that cannot be mitigated should be identified. If impacts are not completely understood,



it may be necessary for the proponent to undertake additional evaluation and to prepare specific contingency plans to be implemented if the impacts occur.

It is possible to design measures to avoid environmental impacts from the stage of the project design (change location to avoid a sensitive natural environment). They reflect the will and the decisions taken by the project developer to design a project of lesser impacts.

Measures to mitigate or reduce the impact include, for example, the reduction or the increase of the number of wind turbines, modification of the space between wind turbines, the distance from houses, the regulation of wind turbines operation, etc.

Measures of compensation aiming at the conservation of the natural areas' initial value include, for example, reforestation of deforested plots to maintain the forest quality when clearings are necessary, buying parcels in order to restore biodiversity on them, implementing protection measures for flora and fauna species, etc. They operate on the residual impacts once other types of measures have been implemented. A compensation measure must be related to the nature of the impact but can be implemented outside the project site.

## 5.1. Project alternatives

The project's alternatives identification is clearly the first step in the mitigation process. It consists in two main steps: the identification and the assessment of project alternatives and foreseen variants

### 5.1.1. Identifying the project alternatives and foreseen variants

Several locations are compared in terms of technical, economic and environmental criteria during the project development and the environmental assessment.

These alternative locations should be as diverse as possible. At the end of this analysis, one of them is selected and undergoes the planning variant analysis. During this process, several variants can be considered and studied. The selected variant will be described in great details within in the impact assessment study (Figure 6).



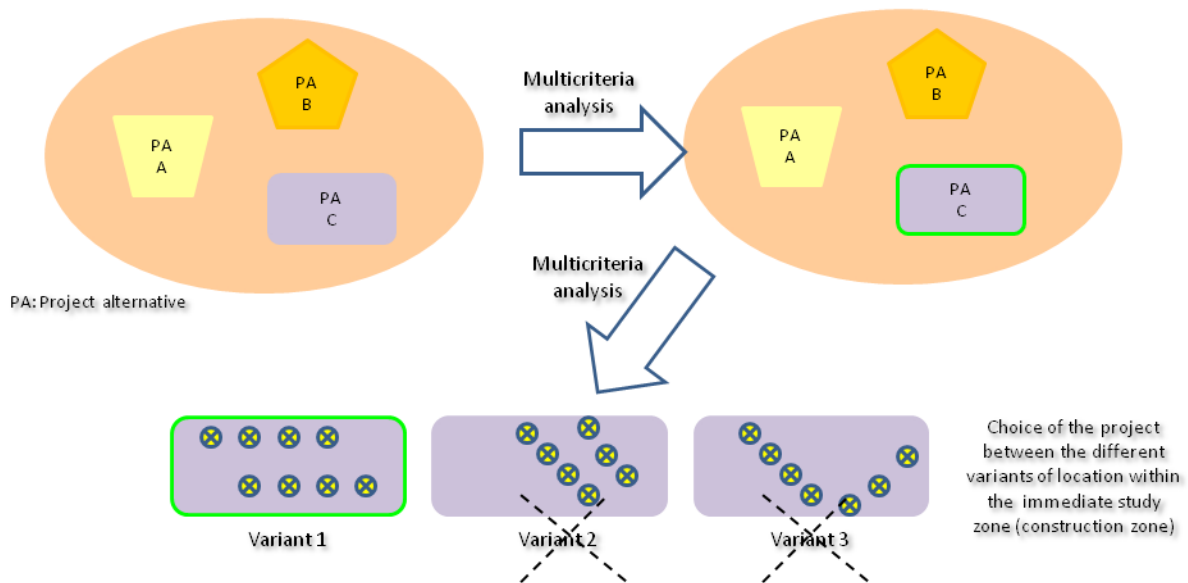


Figure 6 : Analysis of the Project Alternatives (PA) and variants, and project selection

The impact studies should present the variants analysis carried out that takes into account:

- Variants of number and location of wind turbines on the same site;
- Variants on the infrastructures related to the project: location, connection type and power grid layout, access location for the delivery of wind turbines, etc.
- Technical variants: type of wind turbine, foundation, grid connection, etc.

PA and variants presented must be realistic. This study approach presented in the impact study provides a critical view on the project, presenting the different options considered during its design. It facilitates the understanding of the choices made by the project developer and the justification of the alternative selected. The impact study presents then a detailed analysis of the variant selected.

### 5.1.2. Assessing the project alternatives and its variants

A multi-criteria analysis can summarize the different possibilities of the project design. This analysis takes place during the selection of the site (the study of alternative project) or the choice of location variant. This analysis involves consideration of several criteria:

- Technical criteria: wind potential, facilities necessary, grid connections and road networks, etc.;
- Environmental criteria: natural heritage value, level of rarity, threat or sensitivity of the natural environment, landscape features, proximity to riparian habitat, etc.;
- Socio-economic criteria: current uses of the site, local development projects, economic benefits, etc.

A summary table, as the one presented in Table 2, of the various project alternatives and their variants can be a tool for decision support by providing a global vision. This table can be presented jointly with a map showing the different project alternatives or variants analysed and should allow prioritization of impacts.

|   | Impacts of the project alternative or variants |           |           |                       |                       |
|---|--|-----------|-----------|-----------------------|-----------------------|
|   | Project alternative A                          |           |           | Project alternative B | Project alternative C |
|   | Variant 1                                      | Variant 2 | Variant 3 |                       |                       |
| <b>Technical criteria</b>                 |  |           |           |                       |                       |
| Energy production                         |  |           |           |                       |                       |
| Ease of access                            |  |           |           |                       |                       |
| Electrical connection                     |  |           |           |                       |                       |
| Land availability                         |  |           |           |                       |                       |
| Technical assessment                      |  |           |           |                       |                       |
| <b>Environmental and social criteria</b>  |  |           |           |                       |                       |
| Impacts on flora                          |  |           |           |                       |                       |
| Impacts on avifauna                       |  |           |           |                       |                       |
| Impacts on bats                           |  |           |           |                       |                       |
| Others impacts on the natural environment |  |           |           |                       |                       |
| Impacts on landscape                      |  |           |           |                       |                       |
| Proximity of habitations                  |  |           |           |                       |                       |
| Environmental assessment                  |  |           |           |                       |                       |
| <b>Socio-economical criteria</b>          |  |           |           |                       |                       |
| Competition with the uses of the site     |  |           |           |                       |                       |
| Local economic benefits                   |  |           |           |                       |                       |
| Socio-economic assessment                 |  |           |           |                       |                       |
| <b>Global final assessment</b>            |  |           |           |                       |                       |
| Rank                                      |  |           |           |                       |                       |

Table 2: Example of multi-criteria analysis of variants and project alternatives

The variant (or the project alternative) selected is not necessarily the one with the least impact on the environment. Indeed, all the technical, economic and environmental constraints must be taken into account. This should require a dialogue between the various stakeholders on the impact assessment (landscapers, naturalists or acoustic experts) to find the best compromise possible and to assist the developer in his choices.

## 5.2. Mitigation measures

### 5.2.1. Identifying measures

In order to identify the mitigation measures, the projects developers can rely on:

- The analysis of measures adopted in existing similar projects (case studies);
- The experience acquired by the developer;
- The results of consistent literature research ;
- The interviews of relevant stakeholders partners (government, local authorities, associations).

The measures are defined according to the chronological principle consisting in removing the impacts as early as possible, then reducing the project impacts and eventually off-setting the negative consequences which cannot be avoided or reduced.

Each of these measures should be associated with:

- Specific performance targets;
- The person responsible for their implementation (if known);
- A precise description of the methodology;
- The delay and the technical conditions for their implementation;
- An estimate of the administrative feasibility;
- An assessment of the costs that allows the project developer to verify that he can implement the measures without penalizing the project. The amount estimated by the project developer should be verified by the relevant administrative authority.

The proposed measures should be realistic because they represent a commitment from the project developer. Adapted to the expected impacts and proportionate to the issues identified, they are based on successful experiences and relevant protocols and have to be summarized in a table.



#### **Consideration of impacts induced by a wind project**

Experts' attention is often focused on the impact of wind turbines on flying animals (birds and bats).

The wind farm installation requires the setting up of access roads and assembling and lifting areas of wind turbines which can generate significant impacts on the environment (species and ecosystem functioning) and the landscape (visual impact).

If the project is located in an agricultural area as shown in the photo above, it is also necessary to estimate the impact in terms of loss of production for farmers affected. Measures should be proposed to enable an agricultural activity return for example.

Box 1: Consideration of impact induced by a wind farm project

#### 5.2.2. Monitoring and surveillance program

Follow up activities are regularly needed to ensure that the EIA results in improved environmental protection on the ground. This should involve monitoring and management measures to ensure that the mitigation measures are being implemented and effective and that impacts do not exceed certain levels or if any unidentified impact arises as a result of the project that were unforeseen.

Monitoring activities consists of all the analytical tools and measures necessary to control the impact on the environment of the actions undertaken during the construction, the operating and the decommissioning phases. Monitoring enables to verify the compliance with the commitments taken in the environmental field by a balance of initial commitments. It presupposes a baseline study of quality.

Monitoring can be achieved with the involvement of environmental professionals during the site construction and decommissioning phases, or during the operation phase to verify and refine the effectiveness of the reduction measures.

As required in the Lebanese legal basis for EIA, the monitoring and surveillance program include:

- Technical details of the surveillance means (standards of surveillance-surveillance methods-surveillance areas-measurements-save and analysis of information-emergency procedures-Required monitoring patrol);
- Reporting procedures;
- Detailed budget and equipment and supply acquisition program;
- The cost of the monitoring and surveillance program.

The results of the monitoring are made available for the administrative authority as well as the assessments carried out at predefined deadlines. The undertaken monitoring strategy aims to improve future projects and to verify the effectiveness of the avoidance, reduction or compensation measures.

## 6. Review and decision making

The finding from an EIA should be drawn together in the form of an Environmental Statement (ES) and presented to the determining authority and the general public for approval. This stage will involve an evaluation by the stakeholders of the quality of the EIA to ensure that their requirements have been addressed and that the information provided and its interpretation is reliable and sufficient to form a sound a basis for decisions.

The ministry of environment will thus determine if the mitigated project:

- Complies with legal requirements;
- Meets national and local policy goals and objectives;
- Requires conditions and legal obligations attached to the consent that deal with aspects of the detailed design and implementation of the project.

## 7. Keys to Success

### START EARLY

The 1985 EC Directive states that “the best environmental policy consists in preventing the creation of pollution or nuisance at source, rather than subsequently trying to counteract their effects” (EC, 1985). To achieve this it is important that environmental expertise is incorporated into the project planning at a point which it can influence the fundamental decisions about what is going to be built, why and where. This in turn would provide the opportunity for significant impacts to be addressed and dealt with through the design and location of a project.

### INVOLVE STAKEHOLDERS EARLY

Successful EIAs have often included early and effective consultation taking into account the concerns of affected communities, and ensures that the EIA has addressed these appropriately, and that redesign of the project has been allowed as a result of this process. Contrary to the traditional approach of a developer keeping their plans secret and until an appropriate time when they are prepared to defend them, early consultations with local communities could provide the developer or consultant with information that may not be accessible to them, and reduce surprises at late stages, and in turn avoid incurring unnecessary costs.

### RECOGNISE THE IMPORTANCE OF SCOPING

Research has shown that EIAs that tend to fail have often not given due attention to ensuring that the right issues were addressed and dealt with correctly. This is characterised by a lack time and resources being given to the scoping phase of EIA. Consultations with the determining authority and local communities can prove to be valuable sources of information that will enable the EIA the address issues which they believe are the most important. Moreover, it is an opportunity to make the EIA more cost efficient by focusing on key issues and ‘scope out’ those that are of less importance.

# Chapter 3 - Specific considerations in the frame of EIA for wind farms project

## 1. Monitoring birds

Due to its mobility and its ubiquity in natural areas, the avifauna is one of the most sensitive biological groups to the effects of the installation of a wind farm.

Depending on the species, the effects on birds are of two types:

- Disturbance, where the bird's population changes its natural flyway path due to the installations. This can result in a "barrier effect" and habitat loss;
- Direct mortality through collision with wind turbine blades;
- Loss or damage of habitat resulting from turbines and associated infrastructures.



The collision is the main risk. It is often linked to particular climatic conditions. However, a loss of habitat, which has a permanent feature, is a stronger issue in terms of population's dynamics and thus species conservation.

The avifauna study is about bird species' populations using the site and the behaviour of these birds particularly their routes and their flying height. If the wind farm has been selected to avoid sensitive areas for birds, and if the wind turbines locations have taken into account local sensitivities, the installation of a wind farm is not a strong threat for birds.

### 1.1. Preliminary studies during EIA's work preparation

A literature search is recommended at this stage as well as a first habitats sensitivity and ecological infrastructure assessment. The preliminary studies aim at:

- Assessing the migration activity magnitude on the site in order to cover the diversity of successive migratory patterns by the field visits;
- Assessing possible use by arboreal diurnal raptors, including sensitive species or with a high ecological value, and raptor nesting on the ground;
- Assuming the presence of nocturnal sensitive species, requiring nightly visits during adapted breeding periods (late winter, early spring for diurnal raptors);
- Locating the parking areas of migratory and wintering birds daily transits;
- Locating the wetlands that attract water species.

Consultation with associations of nature protection is useful to get historical data.

## 1.2. Protocols for birds baseline study

Field surveys should be undertaken over a complete life cycle (except in winter when the preliminary scoping does not show interest), so as to study the breeding birds, wintering stationing and migratory birds transits.

### STUDY OF THE MIGRATION

#### Bird migration issues in Lebanon

Middle East is a major migration crossroads between Central Eurasia and Africa. In both spring and autumn migrating soaring birds (storks and birds of prey) are funnelled by Bosphorus in Istanbul is the major concentration area of all birds breeding in Eastern Europe. A higher number of birds of prey migrate along the East Black Sea and cross East Turkey to South in autumn. Once across the Bosphorus, most birds continue SE, crossing Turkey and concentrated along the East Mediterranean Coast. During spring migration, most of the migrating soaring birds concentrate in Egypt, fly across Sinai and disseminate in North, North-East and East directions.

In Lebanon, spring and autumn migration present consequently differences also. In spring (below, left) the major route through Lebanon used by migrating birds of prey and cranes is along the eastern flanks of the Mount Lebanon mountain range and the western half of the Beqaa Valley.

In autumn (below, right), most soaring birds pass down the western slopes of Mount Lebanon while smaller numbers travel east of the mountain range ridge. These streams do converge at times and congregate in large flocks (Nabil Khairallah).

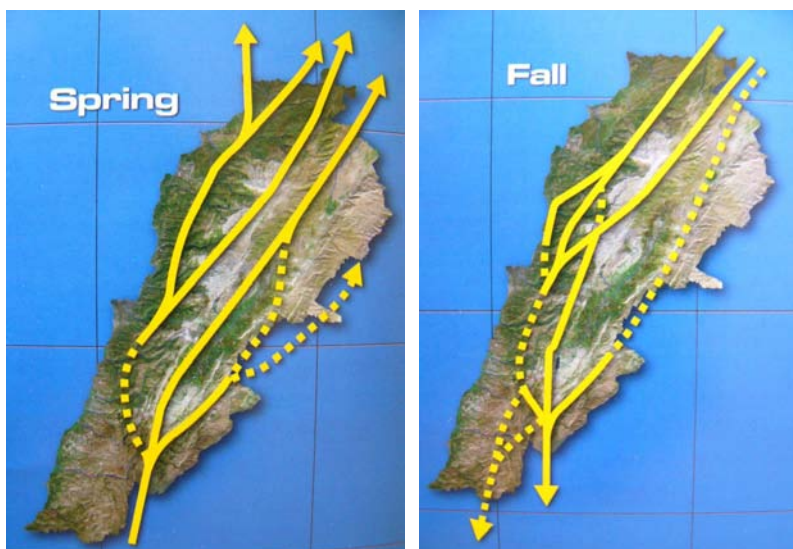


Figure 6 : Soaring birds main flyways in spring (left) and in autumn (right). Solid lines show established routes, dotted indicate those requiring further research (source Beale & Ramadan-Jaradi 2001).

#### Box 2: Birds migration issues in Lebanon

The understanding of the migratory phenomenon is relatively complex, because it depending on a multitude of factors such as weather, landscape, sources of disturbances, etc. In the frame of studies relating to wind farms, the objective is to understand the local migration functioning on the basis of a few 'test' days. The following information is sought:







## STUDY OF BREEDING AVIFAUNA

Monitoring of breeding birds aims at assessing the importance of the site as breeding, feeding, or transit zone for bird populations.

The PAI standardized protocol (Punctual Abundance Index), widely used in wind farms impact studies enables comparison with other test sites. The PAI protocol is particularly fitted for breeding birds. It consists of a census of birds seen or heard at a given point during a defined period. Sampling points are to be distributed over the area of possible wind turbines implementation (middle study zone), that is to say inside, outside and on the edge of the area, and be representative of the environmental diversity of the site.

The above methodologies are relevant for the breeding and common passerines study but are less relevant for other more mobile species (risk of double counting) and / or songbird. This is the case of raptors and water birds that are families particularly sensitive to the presence of wind turbines. Further investigations are thus required.

## STUDY OF WINTERING AVIFAUNA

It is necessary to conduct a wintering bird study in the case of proximity of the wind farm location towards known wintering areas; for example when it is close to wetlands, or in wide open plains and plateau attended by northern species populations. It is advisable to perform the investigations from December to January during the wintering period.

Direct observation from strategic points helps identify the species and assess the density of frequentation and use of the study area by these species.

## SYNTHESIS

After collecting raw data using spread-sheets and geographic information systems, cartographic and statistical processing enables the realization of one or more synthesis maps: they show the routes by species families (sparrows, pigeons, waterbeds ...) and the importance of the site for birds (breeding, feeding, transit, etc.).

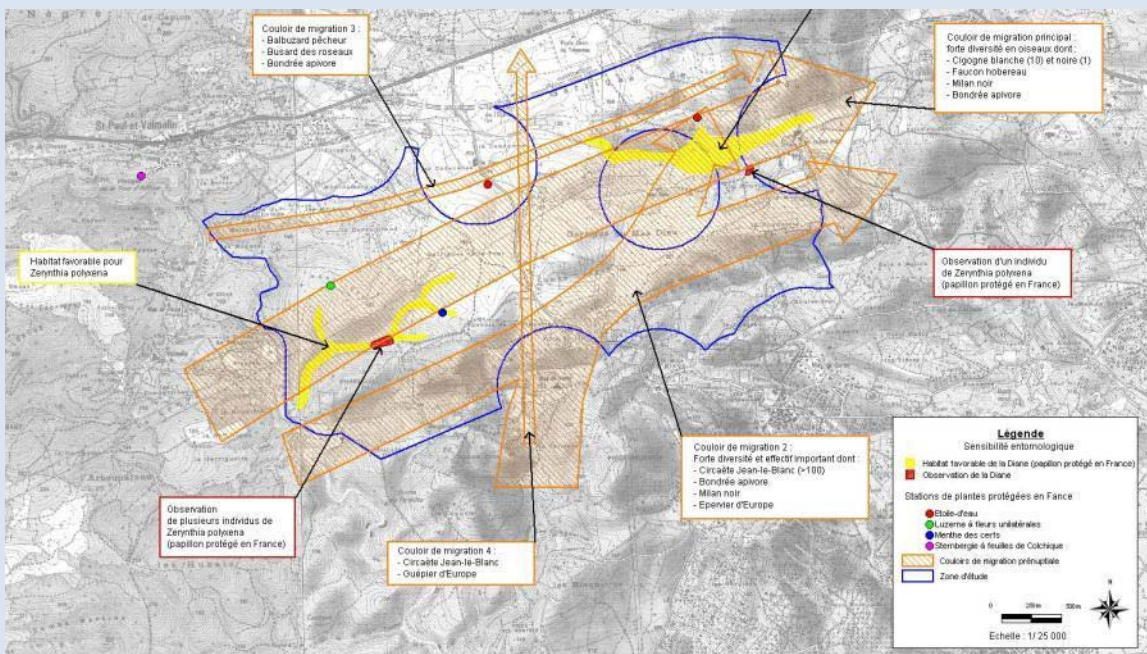
Taking into consideration of the use of the study area to find the best location for wind turbines

The monitoring carried out by experts in the study area of the project should have several objectives:

List the species present in the study area to identify the conservation issues related to the project. The expert should analyse the species' conservation status and their vulnerability regarding the wind turbines.

Find out how bird species use the site: breeding grounds, migratory stopping, wintering area, etc. The mapping of all observations in the study area will highlight areas preferentially used as a hunting area for raptors for example, or the flight corridors during the migration period. It is rare that the birds are spread uniformly over a territory.

The map below shows the results of an ornithological study in the South of France. The synthesis of all the observations carried out on the site has enabled the identification of the flight routes used by birds. Thanks to this map, the project manager knows where the best locations for the wind turbines are.



Box 4: Consideration of the use of the study area to find the best location for wind turbines

### 1.3. Assessing wind farm's impacts on birds

The effects of wind farms on birds, although very diversified (habitat destruction, mortality, "barrier" effect, disturbance ...) do result in impacts in certain conditions that are related to:

- The configuration of the study zone and the modalities of occupation by birds;
- The species sensitivity;
- The existence of other environmental constraints (other aerial infrastructure, weather conditions, various pressures ...);
- The characteristics of the wind farm(s).

The method for assessing impacts consists in comparing the issues of the baseline with the wind farm project features and the sensitivity of the considered species. Cumulative impacts with other wind farms or other types of development projects likely to affect the birds are also studied.

The use of geographic information systems enables an analysis by phenological stage because the impact risk on birds changes during the different biological cycle phases, or an analysis for different variants of the project.

The accuracy of this impacts risk analysis (area of habitat impacted, distance of disturbance, periods of risk for collisions, populations concerned ...) depend on the effectiveness, proportionality and relevance of the measures to eliminate, reduce or compensate. The foreseeable impacts once quantified, localized and prioritized must then be compared with other results of the ecological study.

#### The risk of collision

The monitoring carried out on some wind farms show that wind turbines can be a cause of mortality for birds. The number of birds affected in a year varies from a wind farm to another.

Indeed, a number of inappropriately located wind farms have caused a considerable numbers of bird collisions with the turbine rotor blades.

Some of the highest levels of mortality have been for raptors at Altamont Pass in California (Howell & DiDonato 1991, Orloff & Flannery 1992) and at Tarifa and Navarre in Spain (Barrios & Rodriguez unpublished data). These cases are of particular concern because they affect relatively rare and long-lived species such as Griffon Vulture (*Gyps fulvus*) and Golden Eagle (*Aquila chrysaetos*) which have low reproductive rates and are vulnerable to additive mortality.

Monitoring headed conversely for many other wind farms show very low level of mortality.

The rates of collision per turbine are very variable with annually averages ranging from 0.01 to 23 bird collisions.

It would seem from the evidence available from existing wind farms that there are two main types of sites that have collision problems:

1. Sites with soaring birds occurring regularly within the wind farm at the same height of the rotor blades. In Lebanon the main species that would fall into this category would be the Steppe

Eagle, Steppe Buzzard, Honey Buzzard, White Stork, White Pelican, etc. More than one million of soaring birds are crossing Lebanon twice a year during spring and autumn migrations (Nabil Khairallah – Annex 2).

2. Sites with very high densities of other birds flying at the rotor height. In Lebanon these could include seabirds along the coast and on any major migration routes (bottleneck and corridors).

Several factors condition the risk of collision:

- Site attendance by birds,
- Vulnerability of certain species,
- Wind farm site features (topography, vegetation, airstreams) that may favour certain pathways
- Adverse weather conditions (wind, fog).

#### 1.4. Mitigation

Among the main measures foreseeable to eliminate, reduce or offset the impacts of a wind farm project on birds, the following examples which do not constitute an exhaustive list can be listed. It should ensure the feasibility of the measures implementation and their proportionality vis-à-vis the wind farm project:

- **Site selection:** It is the main factor that enables the reduction or elimination of the majority of impacts on the birds;
- **Wind turbines location** to avoid the barrier or funnel effects. A park orientation parallel to the migration routes effectively reduces the negative effects on migratory birds. The development of an inter-wind turbine larger than the other in a line of wind turbines can sometimes be considered to reduce the barrier effect or collision risk. However, the feedbacks are deficient in this regard. Bird daily transits between resting, breeding and feeding areas should also be taken into account and incorporated into the project design. It's the same thing for the upper-air features of the site and use of updrafts by soaring birds or biological corridors for displacement (wood edges, hedges ...);
- **Choice of the construction works period and planning** regarding the life cycle of species, especially outside the breeding season of the most sensitive local species. Work period limitations must be determined according to the species phenology and the operations that have the strongest impact (for example the earthworks or excavations);
- **On site construction work inspection:** this bird monitoring is fairly easy to implement and effective to limit the disruptions and disturbances during the breeding period. When the time between the impact study and the start of the construction works is very long, this monitoring enables to take into account the evolution of the breeding populations baseline;
- **Replacement habitat creation** with, for example, the reconstruction of a hedges network, the creation of a land reserve away from the wind farm for the wildlife best conditions, etc. Such measures should be related to significant residual impacts identified and be proposed only when all efforts to remove and reduce the impacts were made.

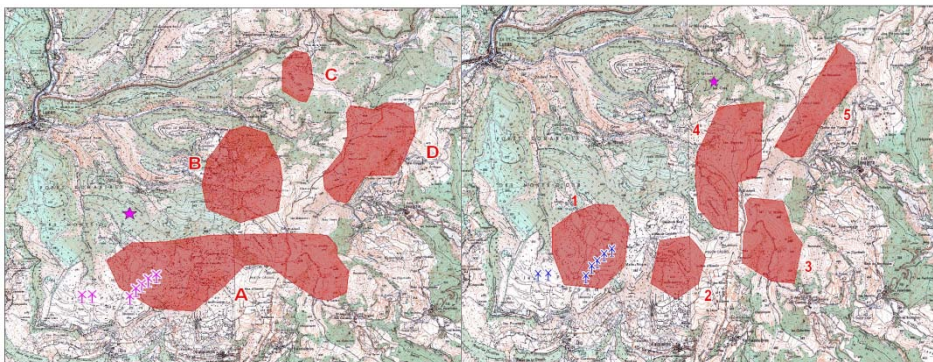
Targeted post implantation monitoring, actions to protect the nests of buzzards, the awareness of farmers may constitute such attendant measures.



### Nesting Snake Eagle Monitoring in the vicinity of a wind farm in Southern France.

During the EIA of a wind farm project in Southern France, a nesting couple of Snake Eagle was highlighted. A part of their hunting area was included in the project area. The EIA concluded on a medium risk for the Snake Eagle. Therefore a monitoring has been conducted before and after the construction of the wind farm.

The results of the monitoring show that the hunting area of those birds is still roughly the same after the wind farm construction, the birds don't avoid the vicinity of the wind farm. They have changed their nest's place for unknown reasons.



*Hunting ground and nesting place of Snake Eagle's pair before (left) and after (right) of the construction of wind farm.*

Box 5: Nesting Snake Eagle Monitoring in the vicinity of a wind farm in Southern France.

## 2. Monitoring bats



Knowledge about the wind turbines impacts on bats is more recent than the ones on birds. The main issue to consider is the risk of mortality. However, the causes of bats' mortality are multiple (pesticides, predation, road mortality, etc.). Unlike birds, it has become more evident that the indirect disturbances due to wind turbines ("barrier" effect or loss of habitat) are marginal.

The wind plays an important role in the bats activity. In general, the activity of these animals decrease significantly for wind speeds above 6 m / s (the activity level is then reduced to 95%). The activity focuses on periods of no wind or with very low wind speeds.

Bats study will enable the project developer to define a location for wind turbines that has no impacts on local and migratory bats populations, and in the case there are residual impacts, to take the appropriate mitigation measures.

The approach consists of a data collection phase (documentary and field surveys) and then an analysis phase (issues, sensitivities, magnitude and significance of impacts), which focuses progressively from a wide geographical area to an accurate settlement area.

## 2.1. Preliminary studies during EIA's work preparation

The literature research must consider a range of at least 10 to 20 km around the proposed sites for wind farms installation (which generally corresponds to the furthest study area), to take into account the scope of activities of most of the species, and ultimately focus on the construction zone or on the middle study zone.

The preliminary studies aim at determining how regional and local bat's populations use the site and surroundings (middle study area) and the methodology to be used during the bat's survey.

During this phase, the data to be collected are:

- Aerial photographs, detailed habitats maps;
- Maps showing species distribution, if existing;
- Data on caves and others bats' habitats (showing the number of animals and issues);
- Birds migration routes, since they can also give information bats routes in active migration;
- Data on the migration of bats in the region.

It is advisable to consult agencies likely to have inventory data on the study area considered, namely naturalistic associations.

The analysis of the data collected enables to state the main breeding and hibernation bat's colonies known, to identify a list of species potentially present on the site and to assess the issues at stake regarding these species locally. Determining if there are natural areas known for bats conservation close to the project area, enables to identify lists of important species and their ecology.

The different areas of the construction zone and its immediate periphery (middle study zone) are studied in order to assess the potential in breeding zones (trees, etc.), hunting territory and move corridors. This mapping measurement works with an aerial image of the site and the detailed natural habitats mapping.

If there are no issues regarding bats in a particular sector already studied by chiropterologists, the "pre-diagnosis" is sufficient to conclude that there is no risks associated the wind farm project implementation. In this case, a complete diagnosis is not necessary. However, this conclusion must be validated by a recognized local expert and by the competent authority. If there are ecological issues, the diagnosis will cover a full biological cycle to confirm and clarify these issues.

## 2.2. Protocols for bats baseline study

The bats monitoring or "diagnosis" is carried out on the potential construction zone and middle study zone. It aims to identify the species and sectors of this area presenting a potential risk, and the

modalities of site use by the resident and migratory populations, using acoustic surveys. Bats acoustic detection requires specific skills and appropriate equipment.

Foreign experiences have shown that most bats mortality linked to wind energy occurred in late summer and autumn and it frequently targeted migratory species. More recently, it appeared that local bats (sedentary) species were also affected, especially during mating and breeding. Therefore the field surveys should focus on both migration periods (autumn and spring) and the summer activity period. The sample of visits should be representative of the diversity of species, their behaviours and climatic conditions of the site.

| Monitoring target                       | Concerned study zone                      | Means to implement   |
|---|---|--|
| Quantify and qualify the bats' activity | Immediate study zone or Construction zone | Ultrasonic sound recording according to a technical protocol |
| Make a census of bats' habitats         | Middle study zone                         | Visit of bats habitats to validate the bats presence         |

Table 3: Objectives and means to monitor bats

The survey should focus on the sector concerned (table 3) by the future location of wind turbines, in which acoustic surveys should be representative of all the environmental conditions identified. The monitoring will enable to identify the ecological interest of the potential construction zone for the wind turbines installation and the type of activity recorded in each sector.

### INVESTIGATION MEANS AND METHODS

Among the tools available to assess the activity of bats (figure 8), there are:

- Acoustic detection tools: ultrasonic detection of heterodyne type, expansion of time, or by frequency division, made by manual sensors or with automated registration;
- Targeted investigations tools: night vision, infrared or thermal optics, radars, radio-tracking, net, etc.

Several methods can be used: points, transects, automated registrations. It is important to take down the weather conditions (temperature, wind speed, cloud cover, humidity), explain precisely the

methodology and equipment used for bats' activity data collection and the number of observations for each species (mapped by category and by area of the potential construction area).

The combined use of several types of methods and tools for field surveys is relevant. On the ground, transects with manual ultrasonic sensor are widely used for all bats activity phases. High up, the use of ultrasonic sensors with automatic recording is the subject of a growing interest.

Regarding a wind energy project, mortality is the strongest risks. For projects located in a forest, species to be studied are those that fly above the canopy.

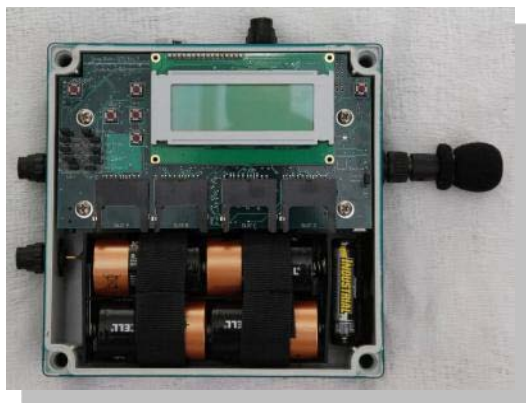
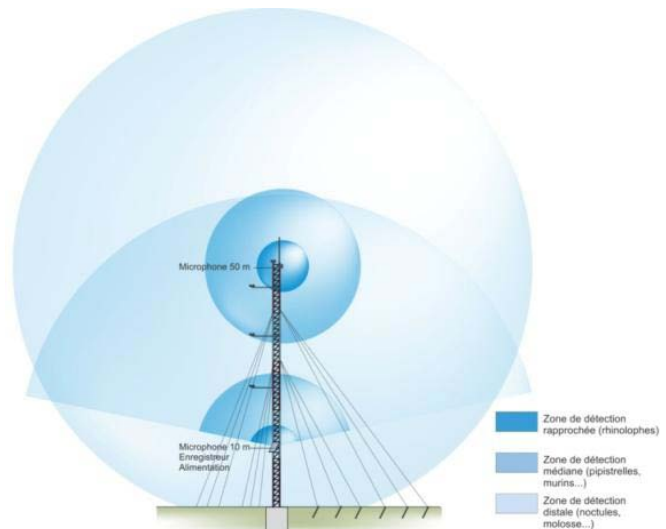


Figure 7: Types of acoustic tool: SM2BAT (left) and bats detection zones using acoustic tool (right)



## PRESENTATION OF THE RESULTS AND SYNTHESIS

The diagnostic results are diversified:

- Activity index for each habitat and each study area is defined by the number of observations per hour. An observation corresponds to an acoustic sequence that is attributed to a bat. When a sound sequence is continuous and when one or more bats are hunting in a restricted area close to the expert, every period of five seconds is counted as an observation. It is indeed a measure of activity level and not strictly of the bats' abundance;
- Diversity of species observed, including the presence of rare and sensitive species (depending on the protection status or conservation and ecology of the species);
- Privileged displacement routes;



- All clues that may clarify the site occupancy modalities (social cries, capture sequence, signals, etc.).

For each species, and for each sector of the study area, a level of issue (minor, moderate, major) is defined. The sensitivity of each species regarding the wind turbines is highlighted using ecological data of each species (hunting behaviour, flying height, migratory species, etc.) in relation to the wind turbines' features and knowledge of the impacts.

The interplay of this data enables to assess the risk for each species on each sector resulting from a wind energy project on the area. Risks by sectors are mapped across the potential wind turbines location area.

### 2.3. Assessing the impacts

During the impacts assessment the wind farm final design and the potential risks identified previously are analysed together. Each potential impact should be defined in relation to a species and / or a sector at risk. It will then be qualified (minor, medium or major impact) regarding to the consequences it can have on the population of bats concerned.

### 2.4. Mitigation

If moderate to major impacts are expected with regard to the location chosen, it's necessary to introduce measures to avoid, reduce or offset these impacts. It is important to remember the principle of proportionality used in the selection of the measures. Each measure is drawn up and justified in relation to a potential specific impact. Measures proposed by the consultant and set out in collaboration with the project developer must also be technically and financially feasible.

Currently, the primary mean to mitigate these impacts is the avoidance of sensitive areas where a large number of bats were recorded during the baseline phase. Recommendations of preventive distances from a given environment (for example edges or forest) cannot be generalized. Indeed, there isn't any scientific study that can propose an accurate distances scale.

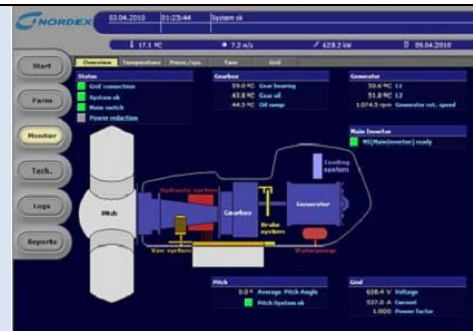
Other perspectives for reducing impacts on bats are currently being tested.

The regulation of the operation of the wind turbines according to the risk for bats (based on sensitive periods, wind speed, bats' activities) is a method under development. In France, the National Programme "Biodiversity Wind" is a partner of initiatives as the Chirotech© project. Such measures may be considered for special cases (when the implementation of measures to avoid and / or reduce the impacts is not possible or sufficient) with an assessment of their effects on energy production (it is estimated that the production loss due to the regulation of wind turbines is about 1%).

**The Chirotech© technology:** credible alternative reconciling the bats protection with the wind energy development.

In France, the consulting office Biotope in partnership with Nordex has developed a technology called Chirotech.

The new wind turbines setting up can lead to the destruction of sensitive species including bats. Some European governments suspend new wind farms to ensure their protection, where on the one hand, the risk of bats destruction is considered too high and on the other hand, when no mitigation measure is implemented.



Chirotech© enables to:

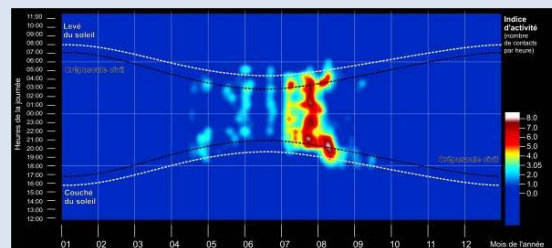
- better assess the actual risk of the project for bats[
- equip the wind farm with a device adapted to reduce up to 90% of the risk.

The Chirotech© system has been developed from behaviour modelling of small flying mammals to control the machines stopping during period of high activity periods. It ensures a significant bats mortality reduction while inducing low power generation losses.

In some figures:

- Mortality decrease up to 70 % \*
- Production loss in the order of 0.5 % \*
- Delay of study of about 1 year
- Low cost
- Entirely automated regulation system

\* Figures certified by the regulation of a wind farm in Vendée, 2009



### 3. Landscape and cultural heritage

The landscape is defined as a part of the territory as perceived by people, whose features' are the result of the action of natural and / or human factors and their interrelationships.

Cultural heritage is under the Code of cultural heritage "all real or movable properties, within the public or private property which are of historical, artistic, archaeological, aesthetic, scientific or technical interest."

### 3.1. Preliminary studies during EIA's work preparation

The four main objectives of the landscape and cultural heritage study are:

- Highlight the landscape qualities of the territory in the different study areas;
- Identify and prioritize the cultural heritage and landscape issues at stake regarding the wind turbines;
- Determine whether the landscape is able to accommodate wind turbines and how;
- Compose a landscaping integration project;
- Measure the visual effects produced and the effects on perception of the territory by the population.

The landscape and cultural heritage study approach is part of the process of the EIA and more broadly of the project approach. In this iterative process it is necessary to promote exchanges on the project during each stage of the project design in order to improve relevance of comments, proposals and recommendations.

All landscapes do not have the same capacity to accommodate wind turbines. The landscape ability to accommodate wind turbines is measured from its geographical and geomorphologic features, how it is perceived, and finally how it is operated, represented, used, constructed, protected, abandoned

and / or preserved. This accommodation capacity comes to the definition of a landscape alternative composition and to the wind farm design.

### 3.2. Landscape baseline study

#### 3.2.1. Objectives

The objective of landscape baseline is to answer to the following questions:

- What are the features and qualities of the studied landscape?
- What are the main landscape and cultural issues at stake regarding the wind farm project?
- What is the capacity of the landscape considered to accommodate wind turbines?

Landscape and cultural heritage sensitivities are assessed by crossing different approaches:

- **The visual approach of landscape context** consists in studying the visual sensitivity of the site on a given territory. It is carried out from perceived scales, protected or famous major landmarks, and fields of visibility. It brings an objective response for further analysis;
- **The social approach** concerns the collective recognition of landscapes by local people. It is apprehended by examining existing documents for the public (tourism books, publications, postcards) or by enquiries. A high density of sites recognized makes the collective perceptions sensitive and complex.

### 3.2.2. Landscape context

#### THE STUDY AREA

##### The furthest study zone

The furthest study area covers about ten to twenty kilometres of the project area: it is the potential impact zone of the project. It enables locating the project in its wider environment, in relation with elements of national or regional importance, such as sites and monuments. At this scale, the point is to show the "inter-visibility" with the cultural heritage elements and the place of attendance and major axes of movement (urban zones, roads and highways, railways, major tourist sites, etc.). The work on this scale is intended to ensure potential incompatibilities of land vis-à-vis the wind farm accommodation but it points more to locate the wind farm in its environment than to justify the choice of precise location.

Sometimes the visual impact of the project spreads over thirty or forty kilometres in mountainous areas for example, or from some particular sites with a high landscape or cultural heritage value recognized of national or international interest. In these cases, additional points beyond the study area and sometimes very far away from it can be useful.

##### The middle study zone

The middle study zone enables to study (up to about three kilometres around the project) the landscape elements concerned directly or indirectly by the wind turbines and facilities related

construction. It is also the study area of visual and social perceptions of the "everyday landscape" from inhabited and attended territories near the project study area.

##### The immediate study zone or construction zone

The immediate study zone is the construction area of the projects. This enables the description of how the project fits in the frame of the existing vegetation or green infrastructure, and the impacts of construction works and any potential landscaping facilities of the surrounding area (access roads, crane areas, delivery structures, parking, etc.).

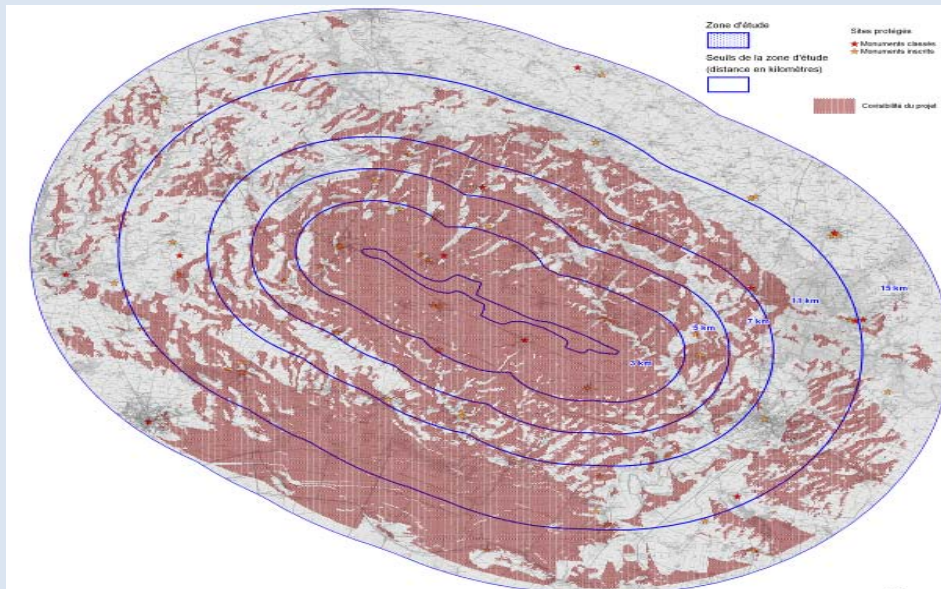


Picture 5: Non geometrical location of wind turbines may be a good choice in wild areas such this case in Morocco

### Study areas definition for the landscape assessment

The definition of the study areas for the landscape consideration is based on the expected perception of wind turbines. It is estimated that from 15 km, wind turbines do not have a significant impact on the landscape. They are clearly visible beyond that distance but are not likely to modify the landscape composition.

The example below shows the result of a calculation of the co-visibility area in the frame of a project in the Southwest of France. This map shows that the local topography severely limits the perception of the project in a large part of the study area. In this case, the landscape study focuses in the areas of co-visibility (in brown).



Box 6: Study areas definition for the landscape assessment

### 3.2.3 Landscape assessment

Perceptions of a wind farm are numerous and often linked to particular views, to “*pools of vision*”, to axes of perception, but also to the landscape composition (which offers screens, framings, perspectives).

The landscaper analyses the landscape context with the objective of determining how this territory is perceived. He/she identifies, prioritizes and maps the various points of view, axes and pools representing the landscape qualities of the territory.

To do so, the broader approaches to the landscape and the types of visual perceptions, the landscape components and the ways they induce the visual perceptions, and finally the existing wind farm environment (existing wind farms, in construction and in project) are studied.

#### THE LANDSCAPE COMPONENTS

The landscape consists of landscape units which are homogeneous areas in terms of their composition (relief, vegetation, urban development, buildings architecture, land use, agricultural practices, etc.) and of their perception (pool of visibility).

It is important to take into account the perception of these landscape units. Indeed, the same landscape will be perceived differently by an observer if this one is static: from a panoramic site, a monument, a place of residence; or if he/she is moving. Communication infrastructures are areas of landscape discovery. Perceptions are different depending on the speed of movement (highways, roads, and trains), types of movement (daily, occasional or touristy).

#### THE CULTURAL HERITAGE ELEMENTS

The notion of culture heritage includes the built heritage elements as well as the landscape and cultural heritage. It is considered as part of the heritage, buildings, sites and landscape elements protected by the State or local government, or listed as elements with high cultural value (gardens, trees, bridges and small cultural heritage such as fountains).

In every instance, the landscaper has to carry out a comprehensive inventory of all cultural heritage elements, protected or not, and map them to the extended scale of the furthest study area. He/she has to assess the issues at stake according to their degree of protection and recognition, of their proximity to the wind farm study zone.

The image that people return to their everyday landscape is shown in the representations (literary, artistic, social or touristy) of the territory. It is necessary to cross between them, these different representations, and compare them with the everyday perceptions of the landscape. These findings fuel the knowledge of landscape baseline and enable the final choice of points of views for the wind farm impacts study.

## STUDY OF THE COVISIBILITIES OF THE PROJECT

Besides the possible "co-visibility" in the protection areas of protected historical monuments, the landscaper will consider all other important "inter-visibility" from points of view representing the landscape and cultural heritage qualities of the territory. This work is particularly necessary in the landscape where the wind farm is already present and when the territory has many recognized social and cultural landscape landmarks (mountain peak, architectural buildings, religious building, military, landmark village, and natural heritage). In this case, the landscaper has to decide on the "inter-visibility" and especially on the acceptable ratio of scales between level of landscape elements or landscape structures and wind farm project by proposing recommendations on the height of the machines and their distance to landscape elements.

## TAKING OTHER EXISTING WIND FARMS INTO CONSIDERATION

The accumulation of wind farms built or planned is one of the new issues in the studies for the wind turbines installations. For the study, the landscaper must identify and map all the existing wind farms, under construction or planned, located in all the study areas. The existing wind farms are to be considered as elements of landscape. It is therefore necessary to analyse how they fit into the landscape structures, which scale ratio they have with other elements of the landscape and what is their influence in all the study areas. It would also determine which proportion of the horizon is occupied by the existing wind farms in the major field of vision to assess what is the possibility to implement new wind turbines, avoiding any phenomenon of visual saturation.

### 3.2.3. Landscape sensitivities synthesis

Landscape and cultural heritage sensitivities identified in the baseline study must be represented on the same map. Sensitivities are summarized in a table and classified according to their level: high, medium, low.

The landscaper must show their geographic reality, their distribution by study zone, how they interact and possibly overlap. This analysis leads to propose guidelines for the composition of the landscape and for the facilities of the project.

## 3.3. Assessing the impacts

### 3.3.1. Visual effects according to the setting up of the new turbines

To assess the visual effects of a wind farm and its possible variants, the landscaper shows the wind farm project with illustrations from the points of view he names as representative of the landscape qualities of the study area. All items selected to illustrate the project are shown accurately on a map.



For each selected point of view, the landscaper proposes, according to the landscape composition and graphically (photomontage, sketches from picture, retouched picture), one or more variants of

implantation. Graphs should show the addition of new elements in the landscape, and enable the impacts assessment on the observer and on the landscape structures that host wind turbines.

This stage of work is the most important part of the work of the landscaper. Indeed, the consideration of the landscape in the choice of the implantation scenario is the most effective in reducing the impact of a wind farm project on the landscape.



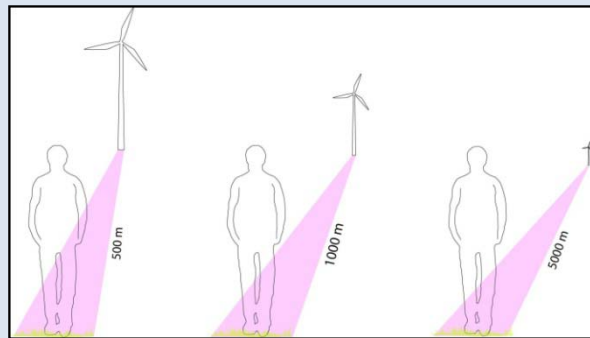
Picture 6: Photomontages for a wind farm project in France

Photomontages need to be realistic as possible into assess the visual impact of wind farm project



## Focus on the impact of wind turbines on landscapes

The visual impact of wind turbines must always be considered according to the potential viewers. The scale of wind turbines and their contrast to landscapes means that impacts on scenic and character values extend well beyond the wind farm site. Although the threshold distance for visual intrusion is debated, potential scenic and character impacts of wind farms extend to far greater distances than most other types of development in a landscape.



At a short distance (less than 1000 meters), wind turbines exceed 'human scale' and can be an overpowering and unacceptable presence to the viewer.



From 1 to 5 kilometres, we can consider that wind turbines may have impacts on landscapes, but these impacts are minor.

Farther than 5 kilometres, wind turbines are generally visible (occasionally they may be seen until 40 kilometres in "clear weather"), but they become insignificant in the vertical field of view.



Photomontages used to assess the visual impact of a same wind farm project at three different distances: 450m, 1.6 km and 6.7 km from the viewer.



Box 7: Focus on the impact of wind turbines on landscapes

### 3.3.2. Accumulated visual effects with the neighbouring wind farms, the « inter-visibility »

In landscapes already characterized by the presence of wind turbines, it is necessary to show how the new wind farm fits in the landscape taking into account the other existing wind farms. The issue consists in avoiding that the wind turbines accumulation comes to saturate the landscape, so that the machines are visible in all fields of vision.

### 3.3.3. Other effects of the landscape

Construction works have direct and indirect effects on the local landscape. Development or expansion of access roads, earthworks, trees uprooting, soil compaction, walls destruction have various consequences:

- Destruction of existing vegetation and opening of the landscape;
- Modification of the colour and the initial appearance of the site;
- Partial or total artificialisation of the site (roads, embankments, areas without vegetation, etc.).

The wind farm project installation may have other consequences on:

- An over-attendance due to the possible opening of new access or modification of existing channels;
- Conflicts regarding a new easy access for motor vehicles;
- Site abandon (Brownfield) by a part of its users after the installation of the wind turbines.

All these effects must be analysed in the immediate study area (construction zone).

## 3.4. Mitigation

Measures to eliminate impacts on landscape should be defined during the phase of design of the wind farm's project. However, for some time and in relation to particular points of view, measures of mitigation or reduction related to the project's impacts on the landscape may be necessary.

Equipment and associated infrastructure (road or track access and of wind turbines maintenance, transformer substation, supply terminal, etc..) are also sources of impact on the landscape perception. Reduction measures concerning them should be specified in detail in the impact study.

The impact study should also outline the measures taken for the rehabilitation after of construction and dismantling works completion.

## 4. Assessing the noise

### 4.1. Features of the noise impact related to wind turbines

When wind turbines are close together (until approximately 100 meters), three types of noise that result from two sources (blades and nacelles) are distinguished:

- A mechanical noise resulting from the nacelle and eventual gear boxes that increases upwind the turbine (and barely audible windward for distance up to 200 meters);
- A continuous aerodynamic noise located principally at the end of blades and that corresponds to the movement of each blade in the air;
- A periodic aerodynamic noise resulting from each blade passing in front of the windmill mat.

Those different noises tend to merge when we move back from the wind turbines. The mechanical noise quickly disappears, while an aerodynamic noise with a periodic noise corresponding to the blades passing in front of the wind tower remain. The noise level produced by the wind turbine, as well as the delivered electric power, depends more particularly on wind speed.

The wind turbine sound power (intrinsic value that characterizes the sound energy emitted by the wind turbine) follows closely the electrical power delivered by the same wind turbine. In low wind speeds, the turbine doesn't generate noise while in high speeds; the turbine operates at full power and generates noise.

The sound of the wind turbines changes according to the wind speed, as well as the residual noise levels (wind noise in vegetation and / or on obstacles) but not in the same proportions. When the wind speed is high for a given distance, the wind turbine sound can be inferior to the residual noise. Conversely when wind speed is low, the wind turbine noise may be superior to the residual noise. The critical area is therefore generally for low wind speeds, although this depends on the considered site.

The electrical power increase of wind turbines is not necessarily accompanied by a sound power increase. Indeed, the main sound contribution, over a long distance, is the noise of aerodynamic origin which is directly related to the blades rotation and the one of the wind speed. The bigger the wind turbine is, the more its blades rotate slowly (this is explained technically by the fact that the speed at the blade top has limits that should not be exceeded. This speed at the blade top is similar for all models).

Orders of magnitude can be given for information; those are valid for propagation in open space only (e.g., a plain without obstacles). For a 3 MW wind turbine with a sound power of 105 dB (A), the noise level at 100 meters from the turbine is about 55 dB (A).

## 4.2. Conducting the acoustic study

The acoustic impact outlining of a wind farm requires the accurate characterization of the initial baseline sound of the site where the machines are to be located. The emergence can be calculated from this baseline analysis.

The method for carrying out the baseline analysis requires a cross-analysis between the acoustic parameters (existing noise levels) and wind direction and speed parameters. Indeed, the sound of the wind farm depends on the wind (the machines sound level is a function of wind speed). Residences located on the shores of the wind farm are often located in rural areas with presence of vegetation. Sound levels measured can be influenced by wind speed in the vegetation (e.g. wind through the trees) and by the wind direction depending on the surrounding noise sources (e.g. road traffic).

Whatever the site, the methodology for carrying out the baseline conduct requires a preliminary scoping to define the study area and the representative observation period.

### 4.2.1. Preliminary works

The study area definition should take into account the residences likely to be impacted. It depends on the distance to the nearest machine but also of relief, prevailing winds, other sources of noise in the environment, etc.

The noise emissions impact of wind turbines should be studied from the most vulnerable residences, including:

- Closest residences to the site. Their identification is essential to identify the most sensitive of them regarding the type of occupancy, layout, etc. ;
- Residences under prevailing winds (particularly where prevailing wind direction is marked);
- Residences located in specific topographical patterns can locally lead to low residual levels, despite high wind speeds in the wind farm.

### 4.2.2. Acoustic baseline conditions: acoustic and aerodynamic measurement

The baseline characterizes the noise levels from the most vulnerable and / or sensitive houses. Acoustic measurements can be performed only outside of houses because of obvious difficulties in putting a measurement device inside a home, especially due to windows and/or doors being constantly opened and closed.

At the same time, aerodynamic measurements enable using an anemometer mast to measure the speed and wind direction. The mast is positioned at the wind turbines location and not at the nearby houses unless those are located at a similar altitude or topography configuration.

### 4.2.3. Impacts assessment

The impacts assessment of a wind farm is based on the sound assessment beside homes with a level sensitivity. The calculation of perceived noise levels at a given point is carried out from the sound waves propagation modelling. This prediction is carried out by specialized software.

The forecasting calculations are based on:

- Wind noise emission data (sound power);
- Sound waves propagation models.

#### **WIND TURBINES POWER SOUND**

The calculated sound power is a noise level inherent to the machine taking into account all the mechanical and aerodynamic noise of the wind farm. The wind turbine sound power is usually spread from 95 to 110 dB(A) according to the models and wind speeds. This power cannot be compared with the sound pressure levels at the bottom of the wind turbine nacelle which are rather close to 60 dB (A).

#### **SOUND WAVE PROPAGATION ASSESSMENT**

Sound waves patterns are then used to assess the noise impact based on standards such as ISO 9613-2.

The impact study should provide the calculation algorithm and the software used description, the description of the main parameters of the model calculations and retained values of acoustic, including the description of the input data.

#### **PROJECTED EMERGENCE ASSESSMENT IN DB(A)**

Projected sound emergences to be included in the impact study are calculated from the residual noise levels retained by wind class and from the calculated contributions for each receiver point by the acoustic model.

The impact study may eventually provide a long-term impact assessment which "includes levels corresponding to a big variety of weather conditions" (according to the ISO 9613-2 calculation standard).

## SPECTRAL EMERGENCE ASSESSMENT INSIDE THE HOUSES

Spectral emergences are only evaluated indoor. The most detrimental case is usually the one with windows open except in the particular case of houses with low soundproofing casements.

### 4.3. Mitigation

The impact study enables take into consideration the acoustic impact of a wind farm from the design stage. Different types of avoidance or reduction measures are thus possible to mitigate noise levels from the nearest homes and / or the most sensitive.

Acoustic modelling enables the location of the neighbouring areas most at risk but also identifies which machines are the sources of dominant noise at a given point and on what wind range. It is therefore a powerful diagnostic tool to guide the selection of the best scenarios at the project step.

Conceivable measures to reduce the acoustic impact of a wind farm are related with the choice of the scenario location, the choice of machines as well as the adaptation of the production means (table 4).

| Types of measures                       | Description   |
|---|---|
| Choice of the location and the machines | It is the main measures of reduction of the acoustic disturbances. This measure takes place during the project design enabling to find the lesser impact possible. It consists in choosing:<br>- the location (number, wind turbines location);<br>- turbines that meet the local requirements. |
| Adaptation of the production processes  | This measure aims at limiting the noise by the wind turbines.<br>The operator has the possibilities regulate their functioning according to the sound constraints.  |

Table 4: Examples of measures to mitigate the sound impact

### 4.4. Post-implantation monitoring and evaluation

The acoustic reception of a wind farm is achieved by acoustic measurements in the most vulnerable zone for the residents. To obtain residual noise and ambient noise samples over relatively homogeneous periods in terms of weather conditions, ambient noise and residual noise measurements are preferably carried out during wind farm on/off sequences during relatively short durations (according to the opportunities for the project developer).

## 5. Public health

Besides the noise, other impact factors affect local populations. The impact assessment should conduct an analysis of the effects on the neighbourhood convenience, health and public safety. This section analyses the potential wind farm effects on public health and the convenience of the neighbourhood. These items do not require further analysis in the impact study framework given the low levels of risk for residents; however they should be mentioned for information purposes.

## 5.1. Shadow flicker effects

### 5.1.1. Effects description

The shadow of the moving wind turbines' blades can create strobe effects with respect to the nearby houses (Figure 9).

Several parameters involved in this phenomenon:

- The size of wind turbines;
- The sun position (the effects vary due to the day of the year and the time of the day);
- The existence of a sunny day;
- The features of the font in question (orientation);
- The presence or not of visual masks (relief, vegetation);
- The rotor orientation and its angle relative regarding the concerned house.
- the presence or absence of wind (and thus the rotation or not of the blades).

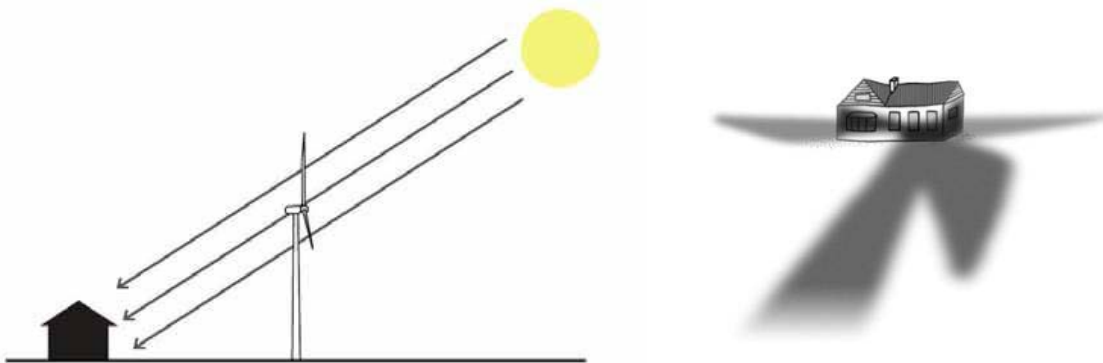


Figure 8 : Shadow flicker representation

The risk of epileptic seizures due to this phenomenon can be considered irrelevant. Indeed, a reaction of the human body can only occur if the flashing speed is higher than 2.5 Hz which corresponds to a 3-blade turbine at a speed of rotation of 50 rpm. Current wind turbines rotate at a 9-19 rpm speed, thus below these frequencies. The shadow flicker phenomenon can be perceived by a static observer, for example inside a home. This effect becomes imperceptible to an observer in motion, for example inside a vehicle.

### 5.1.2. Assessing the impacts

Considering the parameters involved in the shadow flicker phenomenon, only a statistical approach taking into account the sunlight fraction, the local features of wind and of the wind farm, can

quantitatively assess the probability of a perception of this effect and a possible disturbance for local residents.

The dwellings located at the east and west of the wind turbines are more likely to be affected by these phenomenon than the ones at the North or South. These disturbance phenomena decrease fairly quickly with distance (they decrease according to a hyperbolic curve). Appropriate software can specify possible disturbance period and produce maps showing the hours of darkness by year.

## 5.2. Electromagnetic fields effects

Electromagnetic fields are mainly related to the delivery station and underground cables of the wind farms. Radial field cables, commonly used in wind farms, produce very low or negligible electromagnetic fields when we are moving away from them.

The World Health Organization (WHO) considers that from 1 to 10 mA/m<sup>2</sup> (induced by magnetic fields above 0.5 mT<sup>82</sup> and up 5mT to 50-60 Hz or 10-100 mT to 3 Hz) minor biological effects are to be expected. As electromagnetic fields due to wind farms are usually in this range, they have no effect on health on populations' health.



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## Annex 1: Lebanese draft EIA procedures

| Stage                        | Activity   |
|------------------------------|--|
| Initial Filing and Screening | <p>-The Project Proponent completes a Project Screening Form (PSF) of the intended project in accordance to Annex 4 of the EIA decree and submits it the Ministry of the Environment for screening.</p> <p>Screening is made through the Service of Environmental Technology based on significance/severity of impacts determined as a function of impacts magnitude, type, nature, extent, timing, duration, likelihood and reversibility as per the EIA Decree. The service determines if the project is among:</p> <ol style="list-style-type: none"> <li>1. Annex I projects for which an EIA report is required</li> <li>2. Annex II projects for which an Initial Environment Examination is only required</li> <li>3. No further Environment Analysis is required.</li> </ol> <p>Duration of the MOE response is 12 working days</p>  |
| Scoping                      | <p>-Scoping is required for projects in Annex I and the EIA report</p> <p>- The proponent is required to inform the stakeholders, concerned ministries and NGO of the preparation of an EIA report and the municipality should post on her bulletin board, an announcement to that effect during 18 working days and requesting comments from the public (article 7 section 30). Also MOE could also receive comments from the public or stakeholders during 25 days (article 7 section 4).</p> <p>-The project proponent is required to submit a report on any EIA consultations and meetings with stakeholders (article 7 section 5).</p> <p>- The scoping report is available for consultation at the MOE by the public or by the concerned institutions (article 7 section 9).</p>   |
| Technical Evaluation         | <p>A technical committee comprised of 3 to 5 members of various background and expertise from the different services of the MOE is responsible for the review of the EIA and IEE studies. If need be, experts not available at the MOE can be subcontracted to assist with the review of the EIA studies.</p> <p>The technical committee used the methodology described the “MNA Guide for the Preparation and Review of EA reports of the World Bank” is being used under section 4 part B “reviewing EA reports.”<sup>73</sup> The methodology is based on ‘Review Checklists’ with corresponding scores (A-F). A total score of C is considered to be satisfactory despite omissions and/or adequacies.</p>   |
| Decision and Approval        | <p>-The Minister reviews the Committee’s report and notifies its decision to the Proponent and publishes it within 50 working days. This decision is transmitted to the concerned institutions and should be published on the municipality bulletin board during 12 working days. The decision could be acceptance of the EIA report, conditional acceptance and rejection.</p> <p>In case of conditional acceptance or rejection, objections and complaints from the proponent can be submitted to the MOE within 12 days from the announcement of its decision and a reply should be provided within 12 days from receiving the complaints.</p> <p>-In case the objection is related to a public or private project that has been approved without it being subject to an EIA or an IEE although it requires such a study, article 77 of the Council of State by-laws applies.</p> <p>-In case the objection is from a public authority against MOE decisions of screening, scoping and EIA approval, the COM will decide.</p> |
| Monitoring                   | <p>The Ministry of the Environment is required to follow up on the implementation of the Environment Management Plan and reporting the results of monitoring.</p>  |
| Disclosure of EIA            | <p>Section 12 of the draft EIA regulations states that the EIA and IEE available for examination at the MOE.</p>   |
| Penalties                    | <p>Article 58 of the Environmental Protection Law 444 dates that Shall be punishable by imprisonment from one month to a year and to a fine ranging between LP 50.0 million (US\$ 34,000) and LP 200.0 million (US\$ 134,000) or either of these two sanctions, every person who (a) did not prepare an EIA or IEE; (b) implement a project contrary to the EIA or IEE approved by the MOE; (c) execute a project for which EIA/IEE is not required but is not conformed to the national standards; and/or (d) opposes or obstructs the measures of control, inspection and analysis provided in the environmental protection law.</p>   |

## Annex 2: Study on the effect of wind energy & power lines on soaring birds in Lebanon by Dr. Nabil Khairallah

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### **Introduction**

Each year millions of soaring birds migrate between their breeding grounds in Europe and Asia, and wintering areas in Africa. Most of these avoid extended over water flights because of a lack of soaring conditions (thermals) and therefore avoid lengthy Mediterranean passages by funneling through the Iberian Peninsula, crossing the Strait of Gibraltar at the Mediterranean western edge. A smaller number do island hop across the central Mediterranean, while the great majority fly southeast across from North and Eastern Europe and along the western shore of the Black Sea then entering the Levant via the Bosphorus and Dardanelles. These then fly south along the eastern coast of the Mediterranean to be joined by trans-Caucasus migrants.

Lebanon being located at such a junction, with birds avoiding the inland arid lands to the east and the sea from the west, constitutes a migration bottle neck of global significance.

This was confirmed by Birdlife stating that soaring migratory birds depending on soaring and gliding between areas of rising hot air to aid their long-distance passage cannot fly over large water bodies or high mountains. This limits their potential routes and concentrates birds into corridors and through tight 'bottlenecks'. This congregation makes soaring migrants highly vulnerable to localized threats with many parts of the flyway undergoing a period of rapid development, creating hazards where no threats occurred previously. At migration bottlenecks, many soaring birds die as a result of collisions with man-made structures such as power lines and wind farms. The statement indicated that an estimated 69% of soaring birds which glide through the Rift Valley and Red Sea areas have an unfavorable conservation status.

RSPB (2001) recommended in its report "Wind farm development and nature conservation" that early consultation between wind farm developers and key national nature conservation organizations from the outset of the site selection process may enable avoidance or mitigation measures to be identified for sensitive locations.

## Migrating Soaring Birds

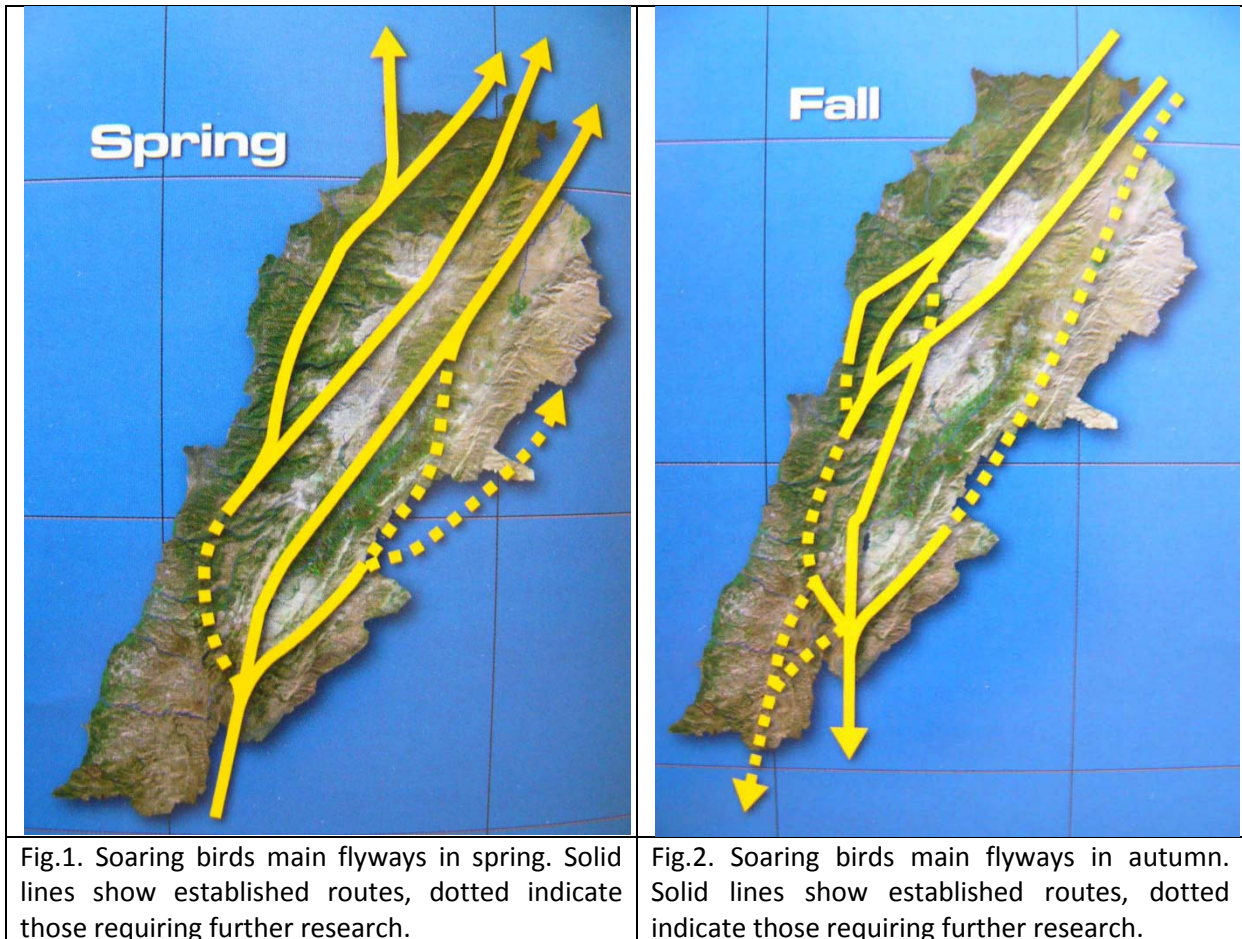
Porter (2010) listed 36 soaring birds species as migrating or resident in Lebanon (Table 1), while Ramadan-Jaradi (2008) listed 46 species as present or historically recorded in the country. Research carried out in autumn of 2006 over one spot, Bhamdoun (33° 48' 33" N 35° 39' 35" E) recorded 71910 individuals of 33 species (Khairallah & Conroy 2010); although 2 others are known to occur regularly, namely Griffon Vulture and Golden Eagle.

|    |                          |                                   |              |
|----|--------------------------|-----------------------------------|--------------|
| 1  | Northern Goshawk         | <i>Accipiter gentiles</i>         | Accipitridae |
| 2  | Eurasian Sparrowhawk     | <i>Accipiter nisus</i>            | Accipitridae |
| 3  | Levant Sparrowhawk       | <i>Accipiter brevipes</i>         | Accipitridae |
| 4  | Common Buzzard           | <i>Buteo buteo</i>                | Accipitridae |
| 5  | European Honey-Buzzard   | <i>Pernis apivorus</i>            | Accipitridae |
| 6  | Long-legged Buzzard      | <i>Buteo rufinus</i>              | Accipitridae |
| 7  | Eurasian/Common Crane    | <i>Grus grus</i>                  | Gruidae      |
| 8  | Booted Eagle             | <i>Hieraaetus pennatus</i>        | Accipitridae |
| 9  | Eastern Imperial Eagle   | <i>Aquila heliaca</i>             | Accipitridae |
| 10 | Short-toed Snake-eagle   | <i>Circaetus gallicus</i>         | Accipitridae |
| 11 | White-tailed Eagle       | <i>Haliaeetus albicilla</i>       | Accipitridae |
| 12 | Lesser Spotted Eagle     | <i>Aquila pomarina (pomarina)</i> | Accipitridae |
| 13 | Greater Spotted Eagle    | <i>Aquila clanga</i>              | Accipitridae |
| 14 | Steppe Eagle             | <i>Aquila nipalensis</i>          | Accipitridae |
| 15 | Bonelli's Eagle          | <i>Hieraaetus fasciatus</i>       | Accipitridae |
| 16 | Golden Eagle             | <i>Aquila Chrysaetos</i>          | Accipitridae |
| 17 | Eleonora's Falcon        | <i>Falco eleonora</i>             | Falconidae   |
| 18 | Eurasian Hobby           | <i>Falco subbuteo</i>             | Falconidae   |
| 19 | Lanner Falcon            | <i>Falco biarmicus</i>            | Falconidae   |
| 20 | Peregrine Falcon         | <i>Falco peregrinus</i>           | Falconidae   |
| 21 | Red-footed Falcon        | <i>Falco vespertinus</i>          | Falconidae   |
| 22 | Merlin                   | <i>Falco columbarius</i>          | Falconidae   |
| 23 | Montagu's Harrier        | <i>Circus pygargus</i>            | Accipitridae |
| 24 | Pallid Harrier           | <i>Circus macrourus</i>           | Accipitridae |
| 25 | Hen Harrier              | <i>Circus cyaneus</i>             | Accipitridae |
| 26 | Western Marsh-harrier    | <i>Circus aeruginosus</i>         | Accipitridae |
| 27 | Common Kestrel           | <i>Falco tinnunculus</i>          | Falconidae   |
| 28 | Lesser Kestrel           | <i>Falco naumanni</i>             | Falconidae   |
| 29 | Black Kite               | <i>Milvus migrans</i>             | Accipitridae |
| 30 | Red Kite                 | <i>Milvus milvus</i>              | Accipitridae |
| 31 | Osprey                   | <i>Pandion haliaetus</i>          | Pandionidae  |
| 32 | Great White Pelican      | <i>Pelecanus onocrotalus</i>      | Pelecanidae  |
| 33 | Black Stork              | <i>Ciconia nigra</i>              | Ciconiidae   |
| 34 | Western White Stork      | <i>Ciconia ciconia</i>            | Ciconiidae   |
| 35 | Egyptian Vulture         | <i>Neophron percnopterus</i>      | Accipitridae |
| 36 | Eurasian Griffon Vulture | <i>Gyps fulvus</i>                | Accipitridae |

**Table. 1. List of soaring birds passing over Lebanon**



It should be noted though, that during the 2006 study, 4 species accounted for 96% of the passage (Honey Buzzard, Levant Sparrowhawk, Common/Steppe Buzzard and Lesser Spotted Eagle). Also, studies carried out in other regions of the country, while impressive on their own account, did not show the same results, indicating clearly that although these birds can be found on migration almost anywhere in Lebanon during the spring and fall seasons, it is clear that certain routes are preferred over others. However, these routes are not exactly the same for all species or in the two migration season, as shown in Figures 1 and 2 (Beale & Ramadan-Jaradi 2001).



In spring, the major route through Lebanon used by soaring birds of prey and cranes migrating north, to their breeding grounds, is along the eastern flanks of the Mount Lebanon mountain range and the western half of the Beqaa Valley. Lesser number of birds, dominated by pelicans and storks pass up the western side of the country where sometimes can be seen in striking large flocks over the coastal strip.

In the fall, when birds are returning south to their wintering grounds in Africa, most soaring birds pass down the western slopes of Mount Lebanon while smaller numbers travel east of the mountain range ridge. These streams do converge at times and congregate in large flocks. Unlike spring, the autumn passage is dominated by birds of prey with storks and pelican heading on a more south easterly track with majority passing over Syria and Jordan.

Generally, the passage starts by mid August building up to early October to dwindle down with few stragglers by the end of November, however, the numbers do vary significantly throughout this

period, with daily counts peaks in the thousands offset by days with total absence of birds. Also, it should be pointed out, that the composition of the passage does vary, early migrants being nearly

exclusively dominated by a single species, while by early October counts of up to 18 species per day have been registered, this diversity too, will dwindle as the season progresses.

**Fig.1. Soaring birds main flyways in spring. Solid lines show established routes, dotted indicate those requiring further research.**

**Fig.2. Soaring birds main flyways in autumn. Solid lines show established routes, dotted indicate those requiring further research.**

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### **Threats of Wind Farms and Power Lines**

It is well documented that both wind turbines and power lines constitute a hazard to aerial organisms (Barrios & Rodriguez 2004), mortality caused by turbines being higher than that caused by the power lines. The main differences being while the former is mobile and point located the latter is stationary and extends over large distances; these facts in themselves require different approaches in their assessments as threats.

#### **Wind Farms**

Recently, interest in wind farm development has intensified, resulting in impacts on habitats and species particularly in upland areas. Wind turbines may affect bird populations in a number of ways; a review of the literature identified the main potential hazards to birds from wind farms to be:

- Collision mortality
- Disturbance leading to displacement or exclusion, including barriers to movement
- Loss of, or damage to, habitat resulting from wind turbines and associated infrastructure

Although it is widely accepted that greenhouse gas emission is the primary cause of global climate change (Huntley *et al.* 2006), and that moving to renewable energy sources will play a vital role in reducing emissions, the unprecedented rate and scale of development of wind farms raises questions about impacts on wildlife. Although generally perceived to be of low environmental effects, collision fatalities of birds and bats have been found at wind farms world-wide (Adam Kelly & Fiedler. 2008).

Therefore, potential for significant mortality of migrants at wind turbines continues to be a concern as these structures are being placed in new regions with different habitats, weather conditions, and topography, Lebanese mountain ridges being a case at hand. Unfortunately, understanding of the impending implications of large-scale wind energy developments, especially in ecologically sensitive locations, has not kept pace with the recent rise in the number of development proposals.

Migrating soaring birds often take advantage of an atmospheric phenomenon called thermals. Thermals are updrafts of warm air that rise from the ground into the sky. By flying a spiralling circular path within these columns of rising air, birds are able to "ride" the air currents and climb to higher altitudes while expending very little energy thus extending their range during migration. Where wind farms are planned exclusively on mountain ridges, such as in Lebanon, where thermals are very likely to develop attracting soaring birds and consequently increasing the chances of collision with wind turbines. Raptors seem to be the group with the highest risk of collision, not directly related to their abundance (De Lucas *et al* 2004).

Yet the absence of thermals in winter forced bird of prey to use slopes for lift, the most likely mechanism influencing both their exposure to turbines and mortality (Barrios & Rodriguez 2004).

An example of how complex an environmental assessment could be is presented in the following two cases; one of a resident bird of prey the other is of a migrant. Some of the highest levels of mortality have been for raptors at Altamont Pass in California (Drewitt, & Langston. 2006) and at Tarifa and Navarre in Spain (Barrios & Rodriguez 2004). At Altamont, Golden Eagles congregate to feed on the abundant prey. In the Spanish situation, extensive wind farms were built in geographical bottlenecks where large numbers of migrating birds fly through a relatively confined area due to the nature of the surrounding landscape, for example through mountain passes, or use rising winds to gain lift over ridges (Barrios & Rodriguez 2004).

The effect of birds altering their migration flyways or local flight paths to avoid a wind farm is a form of disturbance which could result in a displacement. This effect is of concern because of the possibility of increased energy expenditure when birds have to alter their flight path further while trying to avoid a large array of turbines, and the potential disruption of linkages between distant feeding, roosting, moulting and breeding areas otherwise unaffected by the wind farm.

The displacement of birds from areas within and surrounding wind farms due to visual intrusion and disturbance can amount effectively to habitat loss. Displacement may occur during both the construction and operational phases of wind farms, and may be caused by the presence of the turbines themselves through visual, noise and vibration impacts, or as a result of vehicle/vessel and personnel movements related to site maintenance. Here one should point out that the scale and degree of disturbance will vary according to site- and species specific factors and must be assessed on a site-by-site basis. The scale of direct habitat loss resulting from the construction of a wind farm and associated infrastructure depends on the size of the project but, generally speaking, is likely to be small per turbine base.

This might mean that the true effects of the intrusion on breeding birds will only be evident in the longer term, stressing the fact that for an assessment to be meaningful should include a minimum of 12-month field survey to determine the baseline numbers of birds present during an annual cycle

(Scottish Natural Heritage 2005). This survey should provide data on bird distribution and movements, including observations of bird numbers and diversity. Also, the effects of location, weather and flight behaviour on risk situations (passes within 5 m of turbines) should be analysed in any study

To put the whole issue in perspective, the proportions of the turbine are determined by the rotor blade length and tower height. The largest 2 MW machines onshore can have a tower height of 80 m

and a rotor diameter of 90 m, resulting in an overall height of 125 m. By comparison, a normal electricity transmission pylon is 52 m tall. In the case of these large turbines, the height of the rotor sweep above ground can be as much as 35 m.

### Transmission Power Lines

Mortalities caused by power lines is a global problem that has been aggravated by increases in the energy demand of certain regions and is particularly prevalent in natural areas where the introduction of power lines is a cause of significant disruption to resident or migrating species, for a review please refer to (Jalkotzy *et al* 1997). The most significant dangers being:

- Collision
- Electrocutation

Collision has an impact on the survival of birds, in particular those with wider home ranges, which include various species of soaring birds, many of which are listed as endangered species, stressing that the problem for Lebanon is more serious than previously thought.

The dilemma is that for most of their existence as a species, birds have not evolved in an environment where something like a power line could be in their flight path. Because of this, they mostly look down while flying, either to find their prey, nesting areas or places where they can roost or feed. If there's a tree or a mountain in front and the bird is looking down, it's going to see the trunk or the lower portion of the mountain; with power lines, unless it's right at the pylon, there's nothing under the lines to give warning, hence the increased chance of contact, leading to damages.

Collision with power lines could well be a lesser-known problem than electrocution and is harder to detect because it can occur at any point along the transmission line, whereby the bird collides with one of the wires, generally the earth wire, which is less visible (University of Barcelona 2010).

The results of a study based on a radio-tracking study of Bonelli's Eagle populations in the Barcelona and Tarragona area, suggest that collision risk is influenced by a number of factors, including the topography of surrounding terrain and the proximity of lines and pylons to nests and other areas used frequently by bird species (Rolland *et al* 2010), a fact particularly relevant to birds passing over Lebanon; a region foreign to the migrants with power lines extending across the numerous valleys they have to traverse.

Electrocution occurs when a bird comes into contact with two wires or when it perches on a conductive a metal structure; such as a pylon and comes into simultaneous contact with a wire. This is a major threat to many bird species across the world, but in particular species such as soaring birds, which show the greatest incidence of electrocution, simply due to their long wings which are a prerequisite for soaring flight. Although large raptors are more susceptible to electrocution, juvenile raptors lacking the experience and flight control of adult birds are known to be more frequently electrocuted than adults.



The Edison Electric Institute identified reasons why raptors are attracted to power lines: Poles increase their range of vision and attack speed when hunting; they provide good hunting and roosting platforms; they are favorable sites for raptors to broadcast territory boundaries; and usually a good prey base exists along rights of ways.

### **Mitigation Measures**

Wind farms and transmission power lines, although belonging to the same industry, by their nature require completely different mitigation measures and therefore, here, too would be treated independently.

#### Wind Farms

In order for wind energy to continue developing into a sustainable renewable energy source, it has become necessary to have mitigation measures that will address these issues and keep green energy “green” while minimizing lost generation time.

Review of the available literature revealed that mitigation measures fall into two broad categories:

- Detection
- Preventative

There have been a number of recent developments in the detection, assessment and monitoring of the effects of wind farms on birds, examples of which are the following:

#### Radar

Radars are now available that detect bird movements in both the horizontal and vertical planes and analyses and summarizes collected data using GIS tools and statistical techniques. The most important advantage of radar over visual observations is that it allows continuous and simultaneous sampling of bird movements over a large area, regardless of time of day and would provide early warning to the operators to take evasive action when strong bird movement is noticed.

The technology is not without its limitations, though, since it is impaired by prevailing weather conditions, and its effective range reduced by the topography, the latter factor being of particular significance in mountainous terrain as that expected in the Lebanese landscape.

However, the major drawback in the deployment of this equipment to assist wind farm environmental assessments could well be the high cost of available equipment and the required level of expertise.

#### Thermal Animal Detection Systems (TADS)

Researchers have been developing the use of remote Thermal Animal Detection Systems (TADS) using an infra-red video camera in an attempt to record birds flying in close proximity to wind turbines (Desholm *et al* 2006). This system has been piloted most recently at offshore wind farms and can provide valuable information on flight behavior, avoidance and collisions, especially in offshore areas where visual observations and the collection of corpses is not feasible, thus providing essential data to populate collision avoidance models. TADS can also function in conditions of poor visibility and at night. However, experience has shown that under normal circumstances there is a very low probability of an individual camera recording a collision event (Desholm *et al* 2006). This is, in part, due to the narrow field of view provided by the camera, with only a third of the rotors swept area observed, and because of the very limited number of birds passing the visible area. Although the system clearly has potential, but in order for it to provide more precise data on collision rates it

would be necessary to install many cameras on turbines throughout a wind farm a procedure involving addition expenses on the project.

Other remote sensing techniques are being investigated, including the use of pressure/vibration sensors within turbine blades to detect bird strikes and acoustic detection to monitor bird movements from their calls (Evans 2000).

#### Population modeling

As well as improving remote technology for observing birds collisions and displacement, the development of demographic and distributional models are being developed to predict population-level impacts attributable to the wind farm. Although this technique could be valuable for studies of displacement as well as predicting impacts, such research requires long timescales to verify model predictions and is therefore a costly and long-term process which will not be appropriate for all species nor for all wind farm proposals.

Munoz *et al* (2011) found that there were significant differences in mortality rates of adjacent wind farms, with fatalities concentrated around few turbines. Preventative measures such as the selective turbine shut down is a useful mitigation measure, especially when focusing on the most dangerous turbines during migratory period.

Other defensive directives listed through the literature could be as follows:

- Ensuring that key areas of conservation importance and sensitivity are avoided.
- Implementing appropriate working practices to protect sensitive habitats.
- Providing adequate briefing for site personnel and, in particularly sensitive locations, employing an on-site ecologist during construction.
- Implementing an agreed post development monitoring program.
- Increasing the visibility of rotor blades – research indicates that high contrast patterns might help reduce collision risk.
- Where possible, installing transmission cables underground.
- Marking overhead cables using deflectors and avoiding use over areas of high bird concentrations, especially for species vulnerable to collision.
- Timing construction to avoid sensitive periods.
- Implementing habitat enhancement for species using the site.

#### Transmission Power Lines

Thorough survey of available material on bird electrocution and collision mitigation techniques showed that realistically, there is not a practical way to permanently keep birds off transmission structures. Knowledge of bird behavior and interactions is essential in understanding the effectiveness of the deterrents; yet again one method suitable for one species might not be as effective for others.

However, the following recommendations or attempts have been suggested as helpful;

- Reconfiguration, altering the shape of pylons could be advantageous at times.
- Retrofitting existing structures as in markers deployment.
- Perch guards and insulator shields of various designs are available and have been used with mixed results.

- Scare tactics such as boom guns, ultrasonic sirens, gel repellents and visual scare devices (plastic models of hawks and owls) have been shown to be temporarily effective, until the birds become accustomed to the devices.

Perch management was found to be the most successful method of removing ospreys and storks from transmission poles where a nearby alternative platform was installed near the existing nest site and the birds were seen to adopt the new structure.

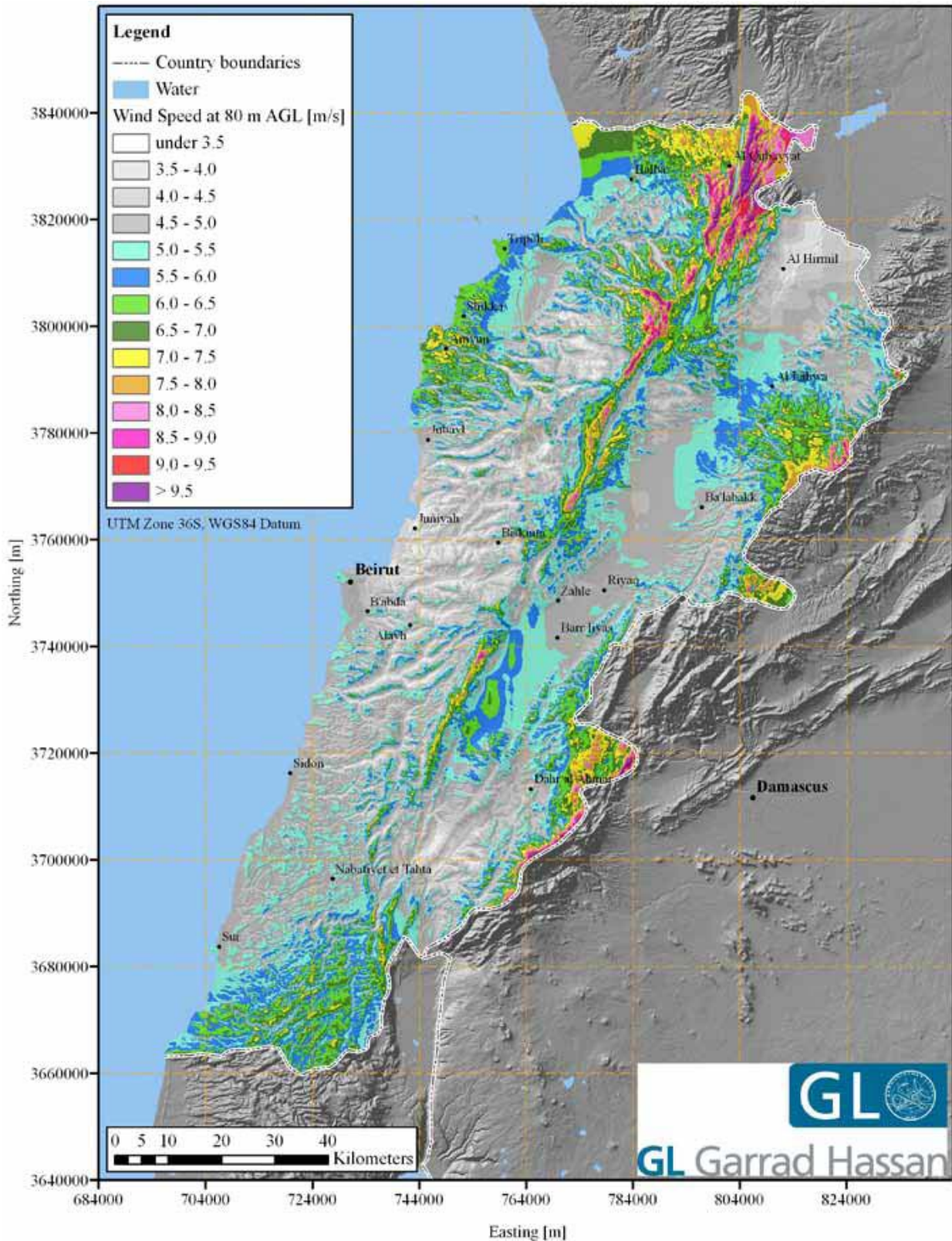
### **Conclusion and Recommendation**

The development of wind-energy is a vital component of the Lebanese government objective to increase the proportion of energy derived from renewable sources, with a set target of 12% of renewable energy by 2020.

However, wind energy developments are themselves not without its bearing on the environment, and the current pace and scale of development proposals, combined with a poor understanding of their effect, is a cause for apprehension. As shown above, one of the main areas of concern is the potential impact of wind farms on birds.

Discussions with technical personnel involved in the renewable energy industry, defined the wind speed of 8 m/s as considered to be the lower economic limit of electrical energy production, since the power available from the wind is a function of the cube of the wind speed. Therefore if the wind blows at twice the speed, its energy content will increase eight-fold. For example turbines at a site where the wind speed averages 8 m/s produce around 75-100% more electricity than those where the average wind speed is 6 m/s. However, the production curve levels off at about 13 m/s, with a storm protection shut down at 25 m/s. (BWEA 2005).

Based on the above and the information presented by CEDRO (2011) demonstrate that north east Lebanon and a narrow strip south east adjacent to the Syrian border are the most favorable locations for wind farms installations (please refer to Figs. 3 & 4) in the country. Now if we compare Figs. 1 and 2 depicting the major defined flyways for soaring birds over Lebanon with those maps illustrating the wind speed, we would see that the most suitable region for wind turbines coincides with the flight path of migrating soaring birds during both seasons. Indeed a predicament requiring a very careful and thorough assessment. However, our situation is not as dire as it may seem, we are much better placed than the similar situated Californian or Iberian Peninsula examples discussed above simply because we have the instruments and the information to address these threats before they metamorphose into reality.



**Fig 3 Central estimate wind map of the Republic of Lebanon at 80 m above ground of The National Wind atlas of Lebanon (CEDRO 2011)**



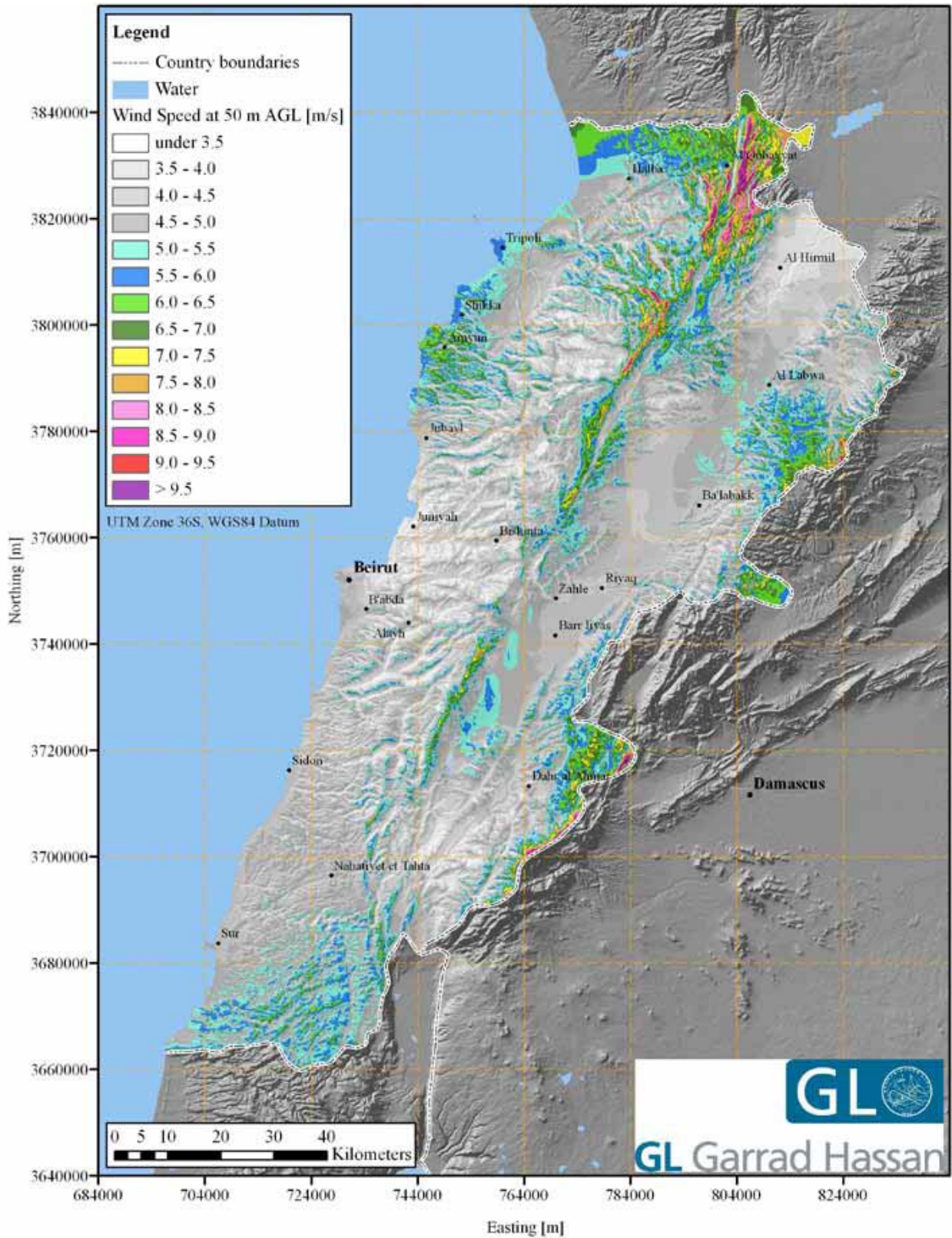


Fig.4 Central estimate wind map of the Republic of Lebanon at 50 m above ground level of The National Wind atlas of Lebanon (CEDRO 2011).

What's to be done?

- Bird vulnerability and mortality at wind power facilities reflect a combination of site-specific, species specific and seasonal factors, therefore, once specification and location of the proposed project are at hand, a detailed survey of the migration, preferably for 4 cycles (2 springs and 2 autumns), should be undertaken covering the main routes followed, the composition and numbers in each season.
- Despite the expected large number of migrating birds in the projected areas, only a small fraction of birds on migratory flights might actually be exposed to the turbines. So, the new wind installations must be preceded by a detailed behavioural observation of the recorded birds, as to roosting and feeding habits; activities when birds are most exposed to the alien structures.
- Based on the findings of the study, the most unobtrusive season for construction should be selected and adhered to.
- Once the works are operative and commissioned, remote sensing equipment manned by trained personnel should be deployed, if at all within budget, failing that, at least one member of the staff with ornithological qualifications should be in attendance at all shifts to assess the size, state and structure of the migrating flocks or birds in the surrounds to advise on the action to be taken.
- The passage being seasonal and variable intra that period, the most appropriate mitigation measure should be a plant shut down during the comparatively few days of intense birds presence.

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