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Workshop Proceedings

Assessing and monitoring the impacts of wind energy on birds in South Africa: the next steps

30 September – 1 October 2013

Kirstenbosch Research Centre Seminar Room, Cape Town

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Minimising the impact of
renewable energy on birds

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Background

We are entering an exciting new phase in the development of wind energy in South Africa. The first wind farms in the Renewable Energy Independent Power Producers Programme have begun construction and should become operational soon.

Birdlife South Africa hosted a two-day workshop which brought together local and international bird specialists, environmental consultants, industry, government and NGOs. The aims of the workshop were to reflect on lessons learned so far in assessing the impacts of wind energy on birds in South Africa, to discuss post-construction monitoring approaches, and to consider future projects, research needs and opportunities. The workshop was attended by approximately 60 participants.

Day 1 (30 September): Impact assessment and mitigation

Lessons learned assessing impacts on birds

Summary of key lessons

1. Collision Risk Modelling requires a large amount of data, without which statistical confidence in the model's output will be low.
2. It is essential that avifaunal specialist spends time on site to orientate themselves and develop of monitoring protocols.
3. It was suggested that criteria to assess the "acceptability" of impacts be developed.
4. Mitigation proposed prior to the issuing of environmental authorisation, is received better by the developer than that suggested post authorisation.
5. Curtailment as mitigation is mostly not well received by developers as it implies a financial risk.
6. There is uncertainty around post-construction monitoring requirements and how this might link to enforcement. This needs to be clarified.
7. The impacts of associated infrastructure should be taken into account.
8. Identify a suitable control site can be challenging, but it is important to use one if possible.
9. It is critical that there is good communication between the avifaunal specialist, developers, consultants and landowners.
10. It is challenging to balance the economic realities and need for adequate data.
11. Climatic (inter-annual) variation should be kept in mind as monitoring is usually only done over one year (four seasons).
12. While international case studies are useful, it is important to take into account region-specific circumstances.
13. Sharing of data between different projects would be greatly beneficial. However it will take time to set up the necessary structures and agreements.
14. The stance taken by the Department of Environmental Affairs on the Best Practice Guidelines have improved over the past years.

15. The availability of observers can be a challenge. Observers must have good bird identification skills as well as local and regional knowledge of the area where the development is proposed.
16. It was debated whether time spent per vantage point should be reduced if there are many vantage points to cover.

Bird Monitoring at Proposed Wind Farms: Lessons Learned 2011-2013 (Andrew Jenkins, Johan du Plessis, Robin Colyn and Penny-Jane Cooke, Grant Benn and Rhonda Millikin.)

Andrew Jenkins has worked on 45 wind energy projects. Of these one was fatally flawed, 15 were frozen or abandoned, and 29 received environmental authorisation. To date, eight of the approved developments have been selected as preferred bidders. Avian impact studies do not appear to be a significant barrier to responsible wind energy development.

There is a huge amount of data captured during monitoring and this information could make a significant contribution to ornithology in South Africa. It is sometimes suggested that monitoring requirements are too excessive, but experience has shown that significant changes are often required based on monitoring results, indicating this is not the case. It was highlighted that current monitoring protocols do not account for inter-annual variation.

The current regime is adequate to filter bad or potentially bad projects from the neutral or good ones. Problematic projects will usually require more work to fully address sustainability and mitigation. Experience with Collision Risk Modelling showed that large amounts of data were needed otherwise statistical confidence would be low.

It was noted that it is essential to spend time on site. This is important for orientation and to develop protocols. An adaptable approach is also required and the protocols should not be followed blindly. Communication within the team and between teams working on different projects is important.

A recent incidental observation of a Jackal Buzzard killed at the Darling Wind Farm is a reminder that the risk of bird collisions is real.

Birds and Wind Farms in SA: Lessons Learnt (Jon Smallie)

Initial scoping assessments give an indication of which birds *could* be on site, whereas pre-construction monitoring allows one to monitor which birds *are* actually on site. The challenge is how to use this information to determine the acceptability of a proposed facility. At the moment this is subjective and it was suggested it may be useful to develop criteria for “acceptability” of impacts. There is often limited information on which to base these judgements, both in terms of population size and susceptibility to mortality. Similarly, cumulative impacts are challenging to incorporate into the assessment. This is an important issue to resolve as the level of acceptability/significance of impacts informs the level of mitigation required.

Experience with different mitigation options is that re-siting of turbines is often well accepted by developers, particularly if this is recommended early on in the process. Sensitivity mapping can also be effective, but the challenge with this is that it can be site-specific; an area identified as high sensitivity on one site, may not be recognised as highly sensitive on another.

Using curtailment as mitigation is not well-received by developers as it brings in financial uncertainty. Mitigation proposed before environmental authorisation issued is received much better than if mitigation is proposed after authorisation has been granted. In the latter scenario (i.e. when environmental authorisation has been granted without pre-construction monitoring being completed), it appears to be up to the specialist to negotiate with the developer and there is little external review.

There is a lot of uncertainty around what will happen with enforcement of post-construction monitoring; who will do it and how will it happen?

More emphasis is required on avoidance, as per the mitigation hierarchy. This should be possible in South Africa where there is a lot of space.

Challenges experienced with pre-construction monitoring include the very large areas sometimes involved, difficult access, rough terrain, and sometimes dense vegetation. The turbine layout is often not available at the time of designing the programme and it can be difficult to balance the need to gather sufficient data and the cost of doing this. The impacts of associated infrastructure should also be taken into account.

There are also challenges around identifying a suitable control site. It can be hard to identify a control site without knowing what factors will be most important on a particular wind farm site. It can also sometimes be hard to find a nearby site where a wind farm has not been proposed. The diversity of species and broad goals of monitoring can mean that monitoring does not focus on the critical issues.

The need for good communication, particularly with the developer, was highlighted. It was noted that landowners where wind farms are proposed expect to receive large amounts of money if the project reaches operation, and this has resulted in very different attitudes towards the EIA team compared to an EIA for a power line. This has both positive and negative implications.

Lessons learnt so far (Chris van Rooyen and Albert Froneman)

The size of proposed development areas is a major challenge. There is a need to find innovative ways to cover large areas. Logistics can also be challenging, especially where sites are inaccessible and it can be hard to balance the economic realities and need for adequate data.

Climatic variation (inter-annual variation) is also a potential problem if monitoring is only done over one year. Changes in the proposed layout as the assessment process proceeds can mean that monitoring protocols must be changed mid-process to ensure the right area is covered and time is not wasted monitoring an area where there will be no turbines.

If monitoring is only completed after authorization was granted (early projects), it can be challenging to resolve any new issues should they arise. This can result in conflicts with the developer and it is not clear how issues should be resolved.

Finding suitable monitors can be difficult and the projects require a great deal of project management and data analysis skills.

Sharing of data between different projects would be greatly beneficial, however this can be difficult to arrange, particularly since it is a very competitive environment.

While international case studies are useful, it is also important to take into account region-specific circumstances. Home-grown solutions may sometimes be the most appropriate. Professional judgement is important and will continue to play a major role in the evaluation of risks.

There is scope for interpretation of the Best Practice Guidelines, which could lead to different approaches by different specialists. Environmental Assessment Practitioners do not always support the implementation of Best Practice within the EIA and there is some uncertainty with regards to the Department of Environmental Affairs' (DEA) stance on the Best Practice Guidelines (although this is changing).

Wind Farm Monitoring: Lessons Learnt to Date (Andrew Pearson)

One challenge is that specialists are not always given time to quote accurately. The time required for data analysis and report writing should also not be underestimated.

Bird identification skills are crucial and monitors and specialists must have local/regional knowledge of the area in question. The availability of observers can be a challenge. Observers come in different forms; they could be private individuals, family teams or companies. Observers must be self-sufficient and independent, but they do require management.

There is no set formula to setting up monitoring on a site. This should be addressed in scoping and ideally monitoring and impact assessment should be done by the same specialist. The specialist must be on site and involved with the set-up of monitoring protocols. The primary step is to determine the number and location of vantage points. Access can be challenging and a 4x4 is usually essential. It is important to record priority species as incidentals.

The challenge with vantage points (VPs) is that one is often dealing with very large sites (e.g. 40 000ha) and monitoring these sites takes a large amount of time. VPs should be set up to cover as much of the proposed wind farm as possible. A decision must be made as to how much is observed at a time (180 vs 360 degree observations). Consideration must be given to the accuracy of observations; one can usually see accurately up to about 1 km. Determining distance and height can be a challenge, particularly in poor weather. Existing structures (e.g. meteorological masts), can be useful in determining the height of birds, or a kite could be used. It is best to use two observers; this is better for safety, it increases coverage and reduces boredom.

A big question is how long each VP should be monitored. It is recommended that three hours are spent observing per session, with four sessions per VP per season (i.e. 12 hours per VP per season). One should strive for a maximum of two sessions per day (covering different VPs), although in summer it may be possible to do three. A question is whether the time should be reduced if there are many vantages points to cover and whether there should be a trade-off between spatial coverage and time spent on site. One needs to balance the need for certainty and statistically defensible data with economic realities.

At least one or two drive transects should be done (ranging between 4km – 15km). These should be conducted twice per season and ideally located between VP's.

Most focal sites have been dams or wetlands, although they can include existing power lines and nest sites (e.g. Black Harrier/Secretarybird/Verreaux's Eagle). These can be variable, changing from season to season. While incidentals observations are useful to included, they are difficult to analyse and draw firm conclusions from. They can, however, point to issues that warrant further investigation (e.g. lek areas or nest sites).

It can be challenging to identify the height and distance of birds in flight. Managing poor weather conditions is also a challenge. It was questioned whether sites should be monitored if conditions are poor and not necessarily representative of normal conditions.

Observers must make hard and electronic copies of data and data must always be thoroughly checked and "cleaned". It is useful to produce hazard maps using grid cells and based on flight characteristics. With analysis, relatively accurate sensitivity of the site can be determined and used to inform turbine micro-siting.

There is a lot of uncertainty surrounding the timeframes for post construction monitoring, specifically with regards to how long this should be done for.

Determining what is acceptable risk is difficult, particularly when deciding if mitigation is required or when making recommendations as to whether a project should or should not proceed.

The main species encountered that are likely to be vulnerable to the impacts of wind energy include Jackal Buzzard, Rock Kestrel, Martial Eagle, Black Harrier, African Marsh Harrier, and Denham's- and Ludwig's bustards.

Discussion

There was some debate around the quality and qualifications of monitors/observers. One suggestion was that the specialists should be doing the monitoring, while another suggestion was that there should be some standards set or registration process for monitors.

It was agreed that there is uncertainty around post-construction monitoring and clarity is needed on this urgently.

Assessing and monitoring the impacts of wind energy on birds in South Africa: The next steps (Alvaro Camiña)

Alvaro Camiña is from Spain and has worked on approximately 950 wind farms (between 16 000 and 17 000 turbines). A major difference between the Iberian Peninsula and South Africa is the large size of South Africa and low (human) population density.

There are a number of different stakeholders involved in the development of wind energy, including the developer, financiers, environmentalists, government, landowners and local interested and affected parties. They sometimes have competing needs and these must be integrated and balanced.

It is important to follow the mitigation hierarchy and efforts must be made to first avoid impacts. Avoidance can involve adjusting the development or changing the timing of construction so it does not take place during particularly sensitive periods. Pre-construction assessment is necessary to predict and avoid impacts. This can include visual observations, collision risk models, and use of radar and/or satellite tracking. Without adequate pre-construction monitoring it can be challenging to predict and avoid impacts.

There are a number of different factors that affect the mortality rates of birds at wind farms, including the species' biology, environmental variables, the characteristics of the wind farm itself and external factors not related to the wind farm. It was highlighted that a distinction must be made between the number of collisions and the "quality" of collisions. In other words, one should not simply look at the number of birds killed, but the type of bird affected and the significance to the population should be considered.

Various Spanish examples were discussed:

1. Bonelli's Eagle was used as the first example (this species is similar to the African Hawk Eagle). Almost all nest sites of this species are known and there is a large overlap with wind farms. However there have been very few collisions recorded. At one particular site a wind farm was proposed on the edge of a pair's territory. These eagles were fitted with satellite tracking devices and it was observed that birds were displaced. The birds excluded the wind turbines from their territory, but they adapted to the new conditions. This was deemed to be "acceptable disturbance" and did not appear to have affected the birds breeding success. However, there are other examples where disturbance and barrier effects on Bonelli's Eagle have been observed when turbines are placed too close to the nests. Wind turbines placed within 1km of the nest has resulted in nest abandonment. A buffer of between 1 and 1.8km appears to be necessary for successful breeding.

   The example of Bonelli's Eagle highlights the value of satellite tracking birds at wind energy facilities. It was noted though that using different methods of Kernel Density Analysis to interpret the results can result in different (possibly wrong) decisions. At least one year's pre-construction monitoring should be done and, if possible, both the male and female should be tagged. The frequency of data recording should be at least once an hour (preferably every 15 minutes), from dawn to sunset. It was noted that the lack of GSM coverage in some areas is a challenge.

2. Migrating Wood Pigeons were used as the second example. These birds appear to experience a barrier or avoidance effect. After construction of a wind farm the birds changed their movement patterns to move through the area where there was the biggest gap between turbines.

3. In the example of Golden Eagles, once again almost all nests sites are known and there is a large degree of overlap between the birds' territories and wind farms. Golden Eagles appear to be very adaptable and fly between the wind turbines. There have been five collisions recorded in Spain, three of which were not near nests. There appears to be no difference in breeding success of birds near wind farms.

4. In Spain more than 1000 Griffon Vultures are killed by turbines every year. Collision rates vary from 0.002 – 0.420 vultures per turbine per year. The higher collision *rate* occurs in the south, but in terms of *numbers* more birds are killed in the north where there are more birds and more turbines. No collisions have been recorded at approximately 51% of the turbines and only a small percentage of turbines are responsible for high levels of mortality. Approximately 60% of the total mortality is caused by just 20% of the turbines. Most of the birds killed (73%) were adults.

   In Spain mortality rates of Griffon Vultures differ according to the time of year and region. In the north of Spain mortality rates peak during chick rearing and drop in summer after fledging. However, the opposite pattern is observed near the Straits of Gibraltar as birds move though this area in great numbers when migrating. In order to reduce collision rates during the migration period observers are placed in the field every day during this time. The observers alert the wind farm operator if birds are at risk of colliding and curtailment is required. This has reduced mortality rates by 39%.

   In Northern Valencia, measures against "mad cow disease" resulted in changes in the availability of food for vultures. Collisions of Griffon Vultures increased, with 393 birds killed between 2006 and 2010. As a result, thirty-three turbines were shut down resulting in economic losses and a subsequent court case. To resolve the conflict, feeding of the vultures near the wind farm was stopped and a rubbish dump near to the turbines was closed. Two vulture restaurants where established to provide the vultures with food well away from the wind farm. Transmitters were fitted on the vultures and 500 birds were tagged. The combined measures were effective in changing where the birds moved and this subsequently reduced the collision rates. There is still some uncertainty though, as collision rates do not always correlate with the number of birds crossing per turbine, or the number of birds at risk.

Improving Avian Environmental Impact Assessments with Radar (Rhonda Millikin, *Andrew Jenkins, Grant Benn and Johan du Plessis)*

Based on experience in North America a significant portion of wildlife mortality at wind farms occurs at night. This is mainly bats, but also includes nocturnal migratory birds. Ninety percent of the mortalities occur during dispersal, as animals move in search of food, water or breeding sites. Movements of birds and bats at night are not detectable by human observers. We also do not know what the drivers for this dispersal are in South Africa and landscape-scale surveys can be used to answer this.

EIAs usually require wildlife activity to be measured at the scale of individual turbines, but visually based observations are ineffective in low light and poor visibility. Even in good visibility visual observers are inaccurate in gauging height and distance. This can result in questionable accuracy in estimating risk. Radar can help with this.

EchoTrack's team in South Africa includes experts in radar technology, South African bird biology, GIS and field operations. The objective of radar surveys is to augment observer-based surveys to:

1) include night movements,
2) provide reliable, absolute counts, round-the-clock, in all-weather conditions,
3) free the biologist for focused study,
4) provide 3D spatial accuracy beyond the human observers' capability, and
5) provide more options for effective mitigation with quantitative data at the scale of the individual turbine.

The radar system is automated and mobile, as it is housed in a trailer. The radar observes a large area (approximately 2km) and covers 360^{o} (dependant on the topography of the area). The system is augmented by microphones set up in field which simultaneously record night flight calls. Through co-observations (linking visual and radar observations), it should be possible to identify a species' "radar signal". Once this is done, the radar data can then be searched for that particular signal and data on a priority species can be obtained.

Radar data are quantitative and repeatable. Flight activity is defined as flight paths/km^3/hour and birds can be located explicitly in terms of height, direction and location. The sample size is massive with an average of 703 flight paths/day recorded. The system can record 10-13 hours per day or night, and there is no risk of observer bias. The data are analysed digitally and flocks can be grouped in time.

Radar can capture far more data than visual observations, although it does not eliminate the need for field observations. Field observations are necessary to develop a database of flight behaviours and calls so species observed can be identified. Radar can, however, provide more accurate information on the distance and height of birds. The number of birds at blade height can also be more accurately assessed than when using observers. Conditions affecting risk can also be assessed. Radar also facilitates the improved understanding of night movement patterns, which is not possible with visual data.

In the first example of how radar has been used in South Africa it was suspected that there was large-scale movement of coastal and wetland birds at night at a site on the West Coast. The daytime movement of Kelp Gulls pointed to a possible flyway. Radar plots were set up to intercept potential routes. A protocol was established to conduct diurnal co-observations to confirm species identification. Radar monitoring took place over a full night. The results of the study indicated that

21% of bird activity occurs in the first two hours after sunset and then again at sunrise. It was confirmed that birds were moving along a valley and this information could be used to improve the turbines layout.

In the second example, radar was used to detect the daytime movement of pelicans. By using radar changes in height of the pelicans could be detected and it was possible to distinguish between two types of flight behaviour. This has implications for the time spent at blade height. By freeing up the biologists' time, the use of radar allowed for more focussed assessments (e.g. investigating where pelicans are commuting to).

Discussion

It was agreed that radar does not replace the work of a biologist, but rather augments it. Species identification can be achieved if there is enough acoustic data and if the species has characteristic flight patterns. This is a process that will, however, take time.

It was asked whether EchoTrack's technology could identify bat species at hub height. It was confirmed that this was possible.

Topography can affect the area covered by the radar. It is therefore important for the operator to understand the landscape.

It was noted that EchoTrack is not the only radar technology in use. Merlin is another example. One difference between the two systems is that Merlin has two antennae and this data is combined to give a two-dimensional image, whereas EchoTrack produces a three-dimensional image. EchoTrack can, however, only be used post-construction to pick up if there is any change in behaviour, unlike Merlin which can be linked curtailment.

It was pointed out that the huge discrepancy in flights recorded by observers compared to that recorded by radar may be due to the observers only recording flight activity at risk height and only recording priority species' movements.

Rhonda noted that the intention is to train locals to use the technology and to interpret the data.

Collision Risk Modelling (Mike Armitage)

Birds flying through a wind farm are at risk of collision. Collision risk modelling assesses the probability/frequency of birds colliding. Collision risk is influenced by a number of factors including the species, season, turbines, topography, visibility and lighting. The risk to birds should therefore be assessed on a case-by-case basis; one solution does not fit all.

Good survey design is essential for collision risk modelling and information needs should be identified during scoping. Target species should be decided on (i.e. rare and threatened species that are species vulnerable to collisions). The size and sensitivity of the site should inform the survey design and survey effort (duration and frequency), but this should always meet the minimum requirements of the Best Practice Guidelines. In South Africa the guidelines stipulate a minimum of four visits over at least 12 months. This is lower than the minimum usually required in the United Kingdom (i.e. 2 years). The purpose of surveys is to gather sufficient information to determine impacts occurring over the lifespan of the wind farm. This should therefore ideally take into account annual variation.

The frequency of surveys should be sufficient to provide a representative sample. In the UK a minimum of 36 hours per VP per season over four seasons is required (once again more than is required in the South African guidelines). For sensitive sites this frequency should be increased. Samples should be stratified and efforts should be focused on the most sensitive areas.

It was noted that flexibility is required and the surveys should be able to respond and, if necessary, adapt to new information.

Vantage point watches measure flight activity and focus on target species. VPs should be positioned to cover most of the proposed wind farm. Terrain models and viewshed analysis can be used to help identify suitable locations. In the UK it is recommended that a maximum of three hours without break is spent observing at a vantage point. Monitoring should be done under conditions of good visibility, but should cover a range of conditions. Observers should make an effort to be inconspicuous.

The Band model is used to calculate the potential number of bird strikes. This is calculated based on the number of transits through rotors (stage 1) multiplied by the probability of being struck (stage 2).

Stage 1: The number of birds flying though the rotors is based on the flight activity survey data. This can be predictable movements (e.g. geese) or random activity (e.g. raptors).

For predictable movements the risk window is defined (e.g. a 200 meter buffer around the turbine area). The mean number of birds moving through this risk window per hour, the number of hours for flight activity per season, the number of birds potentially in the risk window in a season, and the potential number of birds moving through the rotors are all calculated.

For random movements the calculations are more complicated. The visible area from VPs, the average flight activity per visible hectare, the proportion of time in the risk area at risk height, the hours per year/season flying in the risk area, the volume of air swept by the rotors, and the bird occupancy of the rotor swept volume must be calculated. The occupancy of swept volume is then translated into number of transits per season.

Stage 2 looks at the probability that a bird moving though the rotors would be struck by a moving blade. Scottish National Heritage (SNH) has a spreadsheet to aid this calculation and uses input variables based on characteristics of the turbine and characteristics of the birds. The spreadsheet calculates the number of potential collisions, assuming the birds do not take any avoidance action.

However, birds do avoid collisions and this must be taken into account. The general avoidance rate previously accepted by SNH was 95%, however 98% is now the default. Avoidance rates can be calculated for different species and can be as high as 99.8% (e.g. geese).

Predicted collision rates alone are not enough to inform decisions, one needs to assess the significance of these impacts on the integrity of the population. UK guidance is based on the principle of integrity (i.e. the integrity of a population should not be compromised). Adverse impacts would be those that compromise the favourable conservation status of a species.

Discussion

It was noted that collision risk modelling must be based on adequate and sufficient data if the results are to be meaningful. The SNH guidelines suggest a minimum of 36 hours per vantage point (VP) per season. However, the amount of time required would be influenced by the levels of activity (i.e. low levels of activity may require more data). It must always be kept in mind that the model results are only as good as the data used.

It was also noted that there are different collision risk models available, the Band Model is just one example.

A challenge is that observers usually estimate the height of birds in bands, defined according to the height of the turbines to be used. Data can be lost if the dimensions of the turbines change.

The importance of avoidance factors was noted. It was suggested that since there is no data for South African species, precautionary rates should be applied and avoidance rates for similar species should be used (if available).

There was a lot of discussion around how much effort should be put into monitoring VPs and whether this effort could be reduced on large wind farms, as this can be very time-consuming and costly. In the UK wind farms are treated the same, regardless of the size. It was noted that the UK market is different; South Africa's market is more competitive and there is less certainty of a successful application. As a result funding for bird monitoring at an early stage is not as forthcoming.

It was noted that there is normally a focus on the risk of bird collisions at wind farms, but the impacts associated with avoidance and displacement should not be overlooked. It was highlighted that a control site is necessary to confirm if displacement occurs.

It was suggested that habitat management plans can be a useful tool to offset impacts, particularly if the offset involves restoration of natural habitat.

Wind Energy and Migratory Soaring Birds (Ibrahim Al Hasani)

Installed capacity of wind energy in the Rift Valley/Red Sea Flyway is set to grow, but the wind energy resources overlap strongly with one of the most important flyways for migratory soaring birds. The Migratory Soaring Birds Project is working to resolve this challenge. They are doing this by mainstreaming conservation into the wind energy sector using pilot projects, capacity strengthening and engagement with the different stakeholder groups (BirdLife partners, donors, financiers, governments, developers and consultants).

Guidance documents have been produced, highlighting the mitigation hierarchy and outlining monitoring requirements. These guidelines include the recommendation that each vantage point be monitored for a minimum of 36 hours per season. The importance of site selection and strategic environmental assessment has been highlighted and a sensitivity mapping exercise is underway. This map will eventually be available as a web-tool where the public can access information on sensitive sites. The use of temporary shut-down of turbines is also considered a mitigation option during operation, although engineers are often not keen to shut down turbines.

The project has already achieved recognition for the regional guideline and this has been customised for the national context in Jordan and Egypt. Formalised agreements have been entered into with government agencies. Sensitive bottleneck sites have been protected from wind development and turbines in sensitive areas have been relocated. It was noted that part of their success was due to the project adopting the language of business.

Capacity is a challenge in the region, with few ornithologists available to do the monitoring. There are also data gaps that need to be filled.

Future plans include reviewing EIAs and Strategic Environmental Assessments, including sensitivity mapping in the decision-making process, developing further guidance material (e.g. on post-construction monitoring and shutdown on demand), and on-going engagement with key stakeholders.

Discussion

There was much discussion around shut-down on demand. It was questioned who would/should pay for the loss of income when the turbines are not operating and it was noted that the engineers and financiers do not like this option. It is also not clear how long it takes to shut down the turbines and what the implications of curtailment are for the manufacturer warrantees. It was suggested that it may often be better to avoid impacts altogether than to rely on mitigating impacts this way.

Day 2 (1 October): Impact assessment and mitigation

Feedback from DEA

Muhammad Essop from the Department of Environmental Affairs shared that they have received and processed 923 renewable energy applications, of which 109 were for wind energy. Eighty-six of these have been finalised. 25 503 MW of renewable energy has been authorised, 10 838MW of that has been for wind energy. He indicated that while only a few applications have been refused, a number have lapsed or are on hold.

Muhammad also confirmed that the Department is requiring 12 months of monitoring. This is communicated to developers on submission on the Scoping Report. The Department now also requires the layout to be finalised before authorisation is granted.

Post construction monitoring: insights and experience from Europe (Alvaro Camiña)

Post-construction monitoring must be considered in light of the mitigation hierarchy. The first step is avoidance, which falls within the EIA/preconstruction monitoring phase. Avoidance involves adjusting the development or altering the timing of work so disturbance does not occur during sensitive periods. Mitigation includes measures to reduce adverse impacts, both during development and operation. This should be followed by rehabilitation or restoration of disturbed habitats. Finally compensation may be necessary where avoidance or mitigation measures are not sufficient.

Post-construction monitoring includes monitoring of fatalities (or injured birds), as well as data on birds' use of the site. Post-construction monitoring is necessary to confirm the predictions of the environmental impact statement. If necessary, this data can be used to inform an adaptive management plan. The outcomes of post-construction monitoring should therefore be properly analysed and reported.

Key issues that must be considered for post-construction monitoring include:

1) The duration (i.e. how many years). In some regions of Europe monitoring is only required for the first three to five years of operation. In other areas monitoring must cover the lifespan of the project.
2) How often the site visits should take place (number of visits per season). This should be informed by searcher efficiency and scavenger removal trials. This can range between 12 visits per year to 36 or more visits a year. There is a strong correlation between the frequency of mortality searches and the number of (uncorrected) mortalities. Large carcasses also tend to remain longer than those of small passerines.
3) Whether the entire wind farm should be sampled or a stratified sampling approach should be adopted (large wind farms).
4) The skills of the observers (there may be a need to train people).

It should be noted that the number of fatalities may differ in different seasons. For example, mortalities may increase during migration, or during mating seasons if the birds engage in mating displays. The frequency of surveys should therefore be increased during these periods.

It is possible to use dogs to aid carcass searches. Dogs are much more effective than humans at detecting carcasses, but they need special training and can only work for short periods at a time. One would also need a team of dogs. Large distances between the turbines and/or wind farms may be a problem and the cost could prove to be prohibitive.

Consideration must be given as how to deal with carcasses (e.g. where the carcasses will be stored and how the findings will be reported). Government officials may need to be alerted and there may be regulations that place restrictions on the movement and storage of the carcasses. If a database of mortalities exists, the data should be recorded in this.

Another thing that must be considered with mortality searches is what area will be searched, or how far from the turbine the carcass searches should extend. The majority of carcasses are found within 100 meters to the turbine, but they can be found as far as 200 meters away. One survey method adopted is to search a circular area, with the distance from the turbine to the outer edge measured as the distance to the tip of the blade, plus 25 meters.

Sometimes the terrain that must be searched can be a major challenge (e.g. when crops are high). In such cases it may be more effective to wait until after the harvest. The difficulty in locating carcasses should not be underestimated.

Photos of mortalities in situ should be taken and details of any observable injuries and, if possible, the cause of mortality should be recorded. It should be kept in mind that mortalities can result from factors not related to the wind farm (e.g. harvesting or collision with vehicles).

It was noted that one of the challenges in South Africa is the distance between turbines; in Europe turbines tend to be closer.

Methods and tools to estimate bird fatality at wind farms (Joanna Bernardino)

The significance of the impacts of wind energy on birds depends on the location of the facility, the size of the wind farm, the layout, the species ecology and the status of the habitat/species affected. It is important to understand and quantify bird and bat mortalities so that the appropriate mitigation or avoidance measures can be implemented. A challenge lies in estimating *actual* mortality rates.

The Candeerios Wind Farm in Portugal is an example where, although experimental design and analysis was done in accordance with the best practice, the estimated mortality of kestrels turned out to be more than 200% of the actual population. The fatality estimates used were therefore likely to have been biased.

Mortalities are quantified using carcass searches. Searches should be regular (for example at seven day intervals). In Portugal the plot sizes are determined based on the size of the turbine and the area is searched using transects or zig-zag searches. It usually takes between 20 and 90 minutes to search a single turbine.

The observed mortality is not the same as the actual mortality. One needs to account for carcass removal by scavengers, natural decay, as well as the chance of observers overlooking carcasses. These factors are influenced by the size of the carcass, the season, the vegetation cover and the topography.

Carcass removal trials are used to determine how fast carcasses are removed in the field. Trials are done by placing carcasses under the turbines. These turbines are then checked over a period of time.

These trials should be done a number of times a year, ideally every season, to account for seasonal variation. Different sizes and different types of carcasses should also be used, with at least ten carcasses of each size used. Care must be taken to avoid scavenger swamping, which could artificially lower the removal rates. The turbines should be checked every day, for the first five days and then day 7, day 14 and day 21. This data are used to determine the removal correction factor.

A new statistical approach has been proposed by Bispo *et al.(2010, 2012).* Survival analysis factors in that the carcass removal rates will change over time. Different parametric models can be used for this to identify the best fit.

In addition to scavenger removal trials, searcher efficiency trials should be conducted to assess the percentage of carcasses found by the searchers. This can be done by using carcasses or dummies placed under the turbines. These turbines are then searched by different observes. Once again these trials should be conducted a number of times a year and carcasses of sizes and types should be used. The sample size would vary according to whether real or dummy carcasses are used.

Human observers are generally not very good at locating mortalities and this can bias the mortality estimates. Dogs can be useful to increase carcass search efficiency. In Portugal there has been collaboration with the Portuguese Public Security Police and two dog handler teams have been trained to do carcass searches.

Trials suggest that dog-handler teams are far more accurate in detecting carcasses than human observers. Dog-handler teams detected over 96% of carcasses, as opposed to 10% with human observers. The detection rate using dogs is not influenced by decomposition. Dog-handler teams can therefore be a powerful tool in improving estimates. They are most effective in the early part of the day when the scent is carried by moisture.

There have been many different formulas proposed to estimate mortality. Bio3 has developed a free online application to help users to apply the existing methodologies and estimate the mortality. This tool can be accessed at www.wildlifeestimator.com. The application is divided into three sections: 1) carcass persistence, 2) searcher efficiency (this is still in development) and 3) fatality estimation.

Future challenges with mortality estimates are optimising field methodologies to maximise the cost-benefit, improving data analysis, and finding the most effective mortality estimator.

Discussion

It was noted that a potential problem with using dogs is the cost (approximately 10 000 Euros per year for 10 dogs). Dogs can also only work for around 2.5 hours and this must be in the early (moist) part of the day. This could be a challenge in South Africa's dry regions. The large distances between turbines in South Africa may also pose problems. It takes two months to train a dog and they need to be retrained every week and must be motivated regularly. Logistics of handling the dogs could also be challenging. However, dogs can search a turbine much faster than humans can. It takes about 10 minutes for a dog to search a turbine, while it takes a human around 40 minutes. It was suggested that organisations that use dogs for mine clearance may be able to provide some valuable insights into the feasibility of this option in South Africa.

In Spain, large bird carcasses (for example vultures) have been known to persist for over a year. This is not the case for smaller species. If the affected species and/or priority species are large, the search intervals could be refined over time. It is, however, important to first identify what the impacts are and which species are affected.

There was some discussion around combining the mortality searches for birds with those for bats. This makes sense in terms of efficiency, but specialists in both fields should always be involved. There was also discussion as to who should do the carcass searches. One proposal was that this be done as part of the general wind farm operation (i.e. by employed staff), although concerns were raised about independence as the staff may have a perceived incentive not to report all mortalities. It was noted that in the United States the wind farm technicians conduct the searches with no noticeable difference in the results. There was some concern raised about how many specialists will be required for post-construction monitoring and where they would need to be based. Another option would be to hire locals to do the searches and to get the specialists to do the species identification etc. It was noted that the additional man-power should not be seen as a negative, but could be considered as part of the socio-economic benefits of wind energy.

There was also some debate as to whether the developers have budgeted for post-construction monitoring and to what extent they understand the monitoring effort that will be required. There is a lot of uncertainty around the post-construction monitoring requirements in South Africa. It was suggested that while the Best Practice Guidelines currently recommend a minimum of one year, this is too low, especially where there is a large amount of inter-annual variation. Most environmental authorisations are not clear on the requirements with regards to the length and intensity of post-construction monitoring. It was agreed that the post-construction guidelines need to be more specific with regards to timeframes.

It was noted that in some parts of Southern Africa (e.g. Kwa-Zulu Natal, the Eastern Cape and Lesotho) there are plenty of feral dogs and carcass removal is likely to be a real issue.

It was highlighted that it is critical to be able to place the levels of mortality observed in context of the broader population (to answer the “so what?” question). This requires an understanding of the population size, mortality rates etc., which is often limited.

It was also noted that monitoring of a control site is important to determine if displacement is a real issue, or if there is just natural variation in abundance. It was cautioned that the focus should not only be on large species, as some priority species may be quite small. Similarly, impacts of wind farms on habitats should not be overlooked.

There were a lot of questions around how many/ what proportion of turbines should be sampled, particularly for large wind farms. It was also questioned whether sampling should be random or stratified (were only a proportion of turbines are sampled). It was suggested that stratified sampling was most appropriate if all of the turbines are not searched. In Portugal, if there are less than 70 turbines, all turbines should be searched; if there are more than 70 turbines at least 30% should be searched.

It was also asked when post-construction monitoring should begin. In Spain it is started as soon as the wind farm is operational.

The use of remote devices to detect bird collisions (e.g. dtBird or sensors on the turbine blades) was discussed. The challenge is that these devices only cover one turbine and can be costly. However, it was suggested that costs should decrease if there is widespread buy-in to these devices.

It was asked which model is best for survival analysis and fatality estimates. The response was that all the models have pros and cons. The results will depend on the assumptions of the model. It is best to consider a combination of the results of different models, as this should give a range of possible results.

It was asked what the Department of Environmental Affairs' plans are with regards to recording mortalities and if and how this information will be used in compliance and enforcement. While he was not able to answer the question as this falls under a different department, Muhammad Essop from the Department committed to follow up on this.

National Strategic Environmental Assessment for Wind and Solar Energy (Cornelius van der Westhuizen)

The intention of the National Strategic Environmental Assessment for Wind and Solar Energy project is to facilitate the efficient and effective rollout of wind and solar energy in South Africa.

The objectives of the project are as follows:

1) Identify geographical areas (Renewable Energy Development Zones (REDZs) where medium to long term (5 – 20 years), large-scale development of wind and solar energy will have the lowest negative impact on the environment, while yielding the highest possible social and economic benefit to the country.
2) Decrease the risk of development in these REDZ by undertaking regional level assessments and obtaining wide authority and private sector buy-in.
3) Streamline the environmental authorisation process in the REDZs by replacing the legislated Environmental Impact Assessment (EIA) process with a more focused and streamlined legislated process. (The regional level SEA would focus subsequent assessments by highlighting issues that need to be addressed. The process would be streamlined through inter-departmental agreement and cooperative governance).
4) Enable strategic planning and investment that would facilitate efficient and effective development in the medium- to long-term (e.g. strategic investment on Eskom's behalf to enable the development of high potential areas, lower the cost of grid access, and provide timely grid access for renewable energy facilities).

Study areas were identified using a process of positive and negative mapping. These study areas will be refined to identify the REDZ. Positive mapping was used to determine the development potential. Positive mapping criteria used for solar energy included the DTI's proposed renewable energy related Strategic Economic Zones, industrial ports, social need, and network capacity. Because solar resources are adequate over much of the country, areas with most suitable resources were identified across four provinces. Wind energy is more restricted to specific areas. Areas with the best resources were identified across the Western Cape, Eastern Cape and Northern Cape.

Negative mapping was also used. This involved the identification of no-go areas (areas not suitable for large-scale wind or solar energy development). These included protected areas, irreplaceable Critical Biodiversity Areas, rivers, wetlands, areas identified by BirdLife South Africa (e.g. buffers around Bearded- and Cape vulture nest sites, Important Bird Areas (or parts thereof) and likely flyways), areas important for agriculture, and areas with a slope of more than 10 degrees. These no-go areas were combined to produce an "exclusion mask".

Study areas were identified by combining the positive and negative mapping and then identifying the largest areas with good potential for wind or solar energy development. The intention is to identify large areas, as these will need to be refined in the next phase. The idea was also to ensure that there are many portions of land within the REDZ so that landowners do not artificially increase their rates.

Fifteen study areas for wind energy have been identified, covering over 34000 km^2. This area has an indicative potential of almost 90 GW (assuming 2.5 MW per km^2) Eight study areas for solar energy have been identified, covering almost 70000 km^2.

The next phase of the project will prioritise the study areas and conduct environmental screening in each study area to refine these areas. The gazetting of the REDZ will probably follow a phased approach and would be reviewed every five years. Inputs from developers is being sought to identify preferred areas for development.

There is also an opportunity for provincial inputs. An interesting example of this input relates to the Stormsberg area of the Eastern Cape. The wind resource is good in this area, but buffers around vulture colonies have excluded it from consideration. The Eastern Cape Province is therefore sponsoring a PhD project to better understand the areas used by the vultures and refine the buffers.

Bird studies will be commissioned for the next phase of the SEA process (i.e. the refinement of the study areas). These studies will follow a similar methodology to that of scoping, as outlined in the Best Practice Guidelines. A finer scale sensitivity map for each REDZ will be developed and inform what type of authorisation process would need to be followed. Development protocols will be drafted for each study area.

Project information and data produced so far are available for download and comment at www.csir.co.za/nationalwindsolarsea/

Discussion

It was noted that wind and solar energy development would not be excluded from areas outside of the REDZ. There may be pockets of good development potential that cannot be identified with national scale studies and competition in the industry must be encouraged.

One of the main aims of the SEA process is to guide Eskom's spending on grid infrastructure and coordinate various departments' inputs. A question was raised around how permitting will be streamlined as applicants would still need to comply with provincial legislation/permitting procedures. The actual legal processes that will be followed are unclear, but the relevant activities may be delisted.

It was also noted that the DEA is in the process of identifying a custodian of the bird monitoring and mortality data. There is still a lot of discussion that must take place as to what this database should look like and what questions it should be designed to answer, but it was agreed that the database was essential. It was also agreed that there is value in standardising monitoring and data capture, and that most specialists are already capturing data in a similar way.

Spatial Analysis of Bearded Vultures (Timothy Reid)

(Note the details of this project have been omitted as the study is still being finalised).

One of the primary ways of mitigating impacts of wind energy on birds is to place wind turbines in areas not frequently used by vulnerable species. While the known distribution of a species is a useful starting point, unfortunately this information is usually only available at a very coarse scale. On way to address this information gap is to use Species Habitat Use models, which can help provide smaller scale information on areas potentially used by a species. To use these models one must have detailed information on the distribution and habitat use of the species.

Bearded Vultures are one of the species most vulnerable to colliding with wind turbines in southern Africa. There are between 2 000 and 10 000 individuals worldwide and the species is listed as Least Concern by the IUCN (although the numbers are decreasing). In contrast, the population in southern Africa is Critically Endangered. There are an estimated 109 pairs in southern Africa and the numbers are declining by 32-51%.

Over the last four years, Bearded Vultures have been tracked by Sonja Krüger using GPS trackers. She tracked 21 individuals (three fledglings, ten juveniles (post-fledging to 2 years), two immatures (2-4 years), one sub-adult (4-6 years) and five adults (> 6 years)). The position and altitude of each bird was recorded hourly. Adult birds predominantly spent time in the Drakensburg Escarpment and eastern Lesotho. Using Species Habitat Use modelling, this data was used to predict the distribution of the species.

Species Habitat Use modelling uses data from loggers to provide information on where birds were present, but it is also useful to have data on where the birds do not go (pseudo absence data). By linking use/non-use points with environmental data (for example topography or distance from the nest), predictions can be made for the entire population based on the tracked individuals.

Predictive models give useful insight into areas and habitat use of a species and this information can assist in informing the placement of wind turbines. This approach could be extended to other collision-prone species.

Discussion

It was suggested that it would be useful to have a meeting with the Lesotho Government to share the results of the model, as this information could be critical in guiding the placement of wind farms.

Research Priorities (discussion lead by Rob Simmons)

The following priorities for further research were identified (top five priorities are in bold).

Species focused studies:

- **Species specific research:**
    - Satellite tagging priority species to determine habitat use, patterns of movement and any changes in this brought about by wind energy facilities.
    - Revisit BAWESG list of priority species (e.g. by including flight mode (soaring vs powered), size and updated Red Data Book status).
- **Determine buffer distances for nest and roost sites** (including adults vs. juveniles).
- Investigate ecosystem level effects of species disappearance (e.g. effects of losing common species such as Jackal Buzzards, effects of losing keystone species).
- Determine population size and demography of priority species.
- Determine avoidance potential for different species (using satellite tags).
- **Population Viability Analysis for priority species.**
- Consider impacts of displacement vs. direct mortality on specific species.
- Determine if there particularly vulnerable individuals in population (e.g. age groups)?

Spatial studies:

- Additional research in the Renewable Energy Development Zones (as identified by the National Strategic Assessment for Wind Energy).
- Improve spatial guidance.
    - Identify and confirm flyways and buffers to these areas.

Studies of impacts at operational wind farms:

- Active research on the impacts of existing turbines on birds.
- **Summarise species mortalities at operational wind farms.**
- Research best methods for assessing and estimating mortalities.
- Improve understanding of predator-prey interactions in operational phase (e.g. how does this influence species abundance and risk).
- Confirm vulnerability of priority species to collision and displacement.
- Inform collision risk models with South African data (e.g. determine avoidance rates).
- Assess cumulative impacts of wind energy across subcontinent.

Impact assessment, monitoring & mitigation:

- Test effectiveness of mitigation measures.
- Study patterns of carcass removal in different habitats.
- **Develop framework for determining what levels of impacts are acceptable.**
- Monitor movements of migrants and nocturnal species; determine if this is linked to seasons and wind patterns.
- Investigate potential of biodiversity offsets for birds at wind energy facilities.
- Assess the impacts of associated infrastructure and effectiveness of mitigation measures (e.g. powerlines and bird-diverters).

Other:

- Quantify levels of mortality from other factors (e.g. birds, cars, other energy sources) and compare with wind energy.
- Local technology development (e.g. tracking devices and mitigation).
- Investigate the potential use of radar to collect data used in collision risk models.

Possible sources of funding:

- REEEP.org
- Wind Energy Industry
- GWEC (Global Wind Energy Council)
- Government (DoE, DEA, DTI)
- NRF Bilateral funds
- Global Change Grand Challenge
- Global Environment Facility

Conclusion

Speakers and participants were thanked for their contributions to the workshop.

The outcomes of the workshop will be discussed in the next Birds and Wind Energy Specialist Group meeting who will endeavour to take forward the relevant actions and recommendations of the workshop.

Appendix 1: List of participants

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