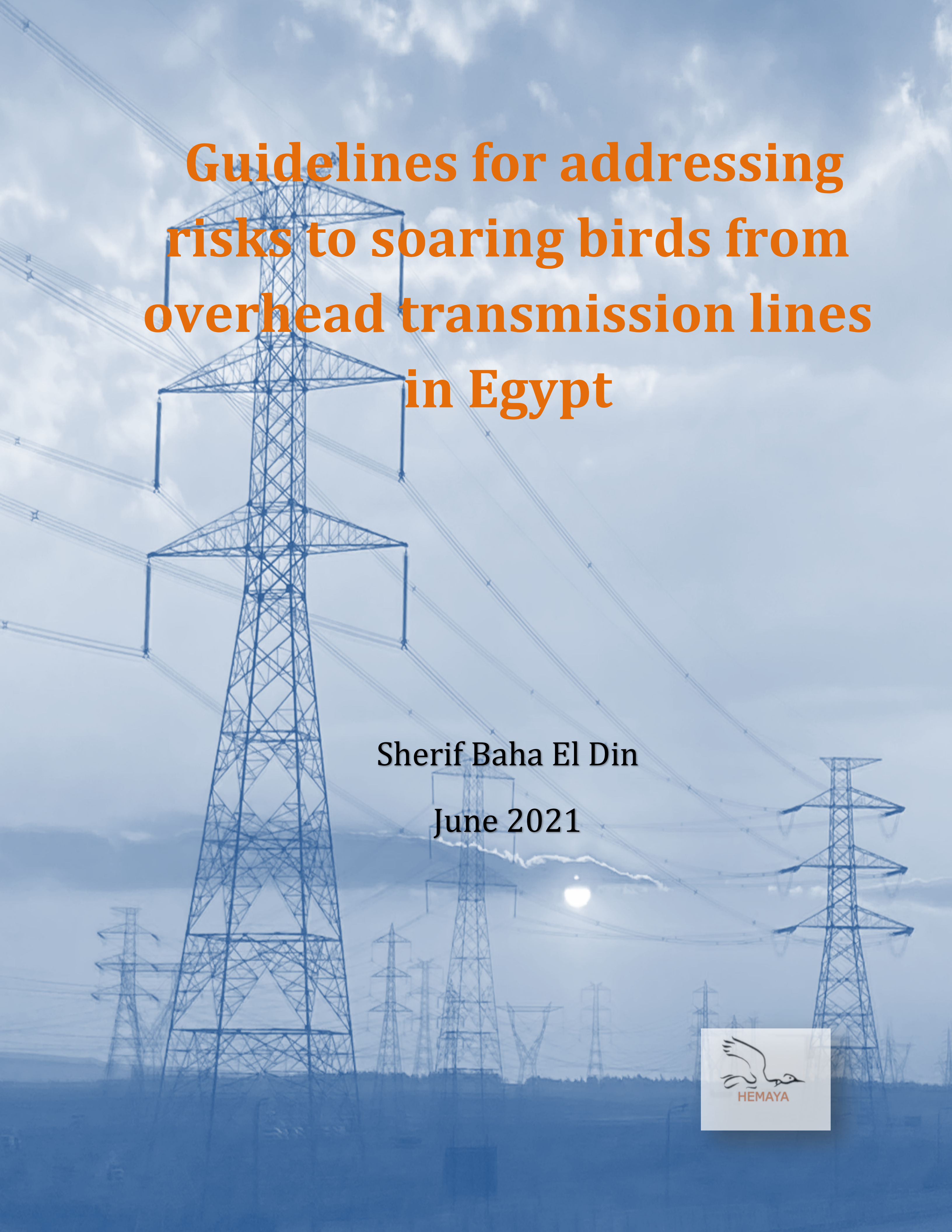

Guidelines for addressing risks to soaring birds from overhead transmission lines in Egypt

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HEMAYA

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1 Introduction

Electric transmission and distribution grids are expanding rapidly worldwide, with significant negative impacts on biodiversity and, in particular, on birds. The electric power distribution network in Egypt as in other nations is the backbone of economic development. The total overhead power transmission network in Egypt is estimated at about 50,000 km, including a low and medium distribution network of about 25,000 km. At a global scale this network is fairly modest when compared with that in the USA, where the electrical grid is the largest on Earth, with 321,869 km of high-voltage transmission lines and 8.9 million km of local low and medium voltage distribution lines.

Egypt is seeking to be a hub for electric power generation in the Middle East region; in six years, Egypt has been able to jump 68 ranks in terms of electricity production from the 145th rank to the 77th (Karima 2021). This increased power generation capacity needs a larger transmission and distribution capacity. Indeed, in recent years the power distribution network has undergone unprecedented growth in Egypt, particularly with the establishment of a number of new power stations and the increased power generation from renewable sources, this has increased the need to connect and redistribute the electric load through the erection of new or retrofitting existing power lines, specifically high tension Over Head Transmission Lines (OHTL).

In order to evaluate and mitigate the potentially extensive environmental and social impacts of OHTLs on the landscapes they pass through Environmental Impact Assessment or Environmental and Social Impact Assessments have been carried out for all major OHTL projects in Egypt in recent years.

Recognising the potential negative impacts of OHTL has lead national and multinational lending agencies to require careful assessment of the wide range of impacts the power lines could have across vast regions. Impacts ranging from construction disturbance to soils and waterways; to landscape scarring; to health risks to local populations living close to such OHTLs; to loss of arable lands; to damage to biodiversity resources. The loss of biodiversity resources, most significantly includes damage to bird life through either collision or electrocution.

This report seeks to examine the current national and international regulations for the assessment of risk to the avifauna from OHTL, specifically as they may relate to direct harm from collision and electrocution.

Reducing avian mortality rates from power line collisions is dependent on finding the factors that influence and circumstances under which birds fly at collision risk altitudes (Bernardino et al., 2018). These conditions could be the basis for the identification and development of appropriate management strategies that could be implemented by OHTL companies and conservation agencies, in order to reduce the potential where birds fly at collision risk heights in the vicinity of power lines. However, there is still relatively little scientific information available for power line bird interactions, particularly in the Asia, Africa and South America regions, particularly in the arid Middle East region. The complex and region-specific interactions between collision drivers and bird ecology continue to limit the ability to predict impacts and the success of mitigation measures.

Figure 1 Dead White Stork under the El Tor - Sharm El Sheikh OHTL. August 2021 (photo NCE).

2 Assessment of the risks to birds from the OHTL network in Egypt

Distribution of the OHTL infrastructure in Egypt

Much of the OHTL infrastructure in Egypt is found in the eastern part of the country along or parallel to the Nile Valley in the Suez Canal region and along coasts of the Mediterranean and the Red Sea. For the most power generation has been centred around the Nile Valley, with a major input from hydroelectric sources at the High Dam, with power being transferred from the Valley to the Red Sea and Sinai and to the Western Desert and North Coast. In recent years there has been a rapid growth in renewable energy generation mostly from wind energy; this energy production has been based in the western side of the Gulf of Suez, which required linkage to the national grid.

Table 1 Growth in OHTL between 2009 and 2014 (km)

Voltage	2009	2010	2011	2012	2013	2014
132 kV	2,504	2,484	2,484	2,484	2,485	2,485
220 kV	15,647	15,970	16,157	17,020	17,001	17,341
400 kV	33	33	33	33	33	33
500 kV	2,479	2,479	2,479	2,670	2,863	2,966
Total	**20,663**	**20,966**	**21,153**	**22,207**	**22,382**	**22,825**
Annual growth rate (%)	-	1.5	0.9	5	0.8	2.0

Source: EETC

Properties of the OHTL network in Egypt

Overhead transmission lines are responsible for the transmission and distribution of electric power from the generation sources to the end users and consumers, and for the export of energy to neighbouring countries. Generally power lines carrying > 70 kv of current are considered transmission lines, while those carrying <70 kv are considered distribution lines. Transmission lines require thicker wires, larger towers, longer insulators and usually traverse long distances; while distribution lines are used extensively for shorter distances, utilizing smaller towers, thinner lines and shorter insulators.

As of December 2020, Egypt had about 50,000 km of OHTLs (Karima 2021); of which the Sub-transmission lines (or distribution lines) of 66 kv or less are the most extensive covering an estimated 27,000 km, followed by the 220 kv transmission lines, covering an estimated 17,341 km. The OHTL network in Egypt has an annual growth rate of about 2% (source Global Transmission).

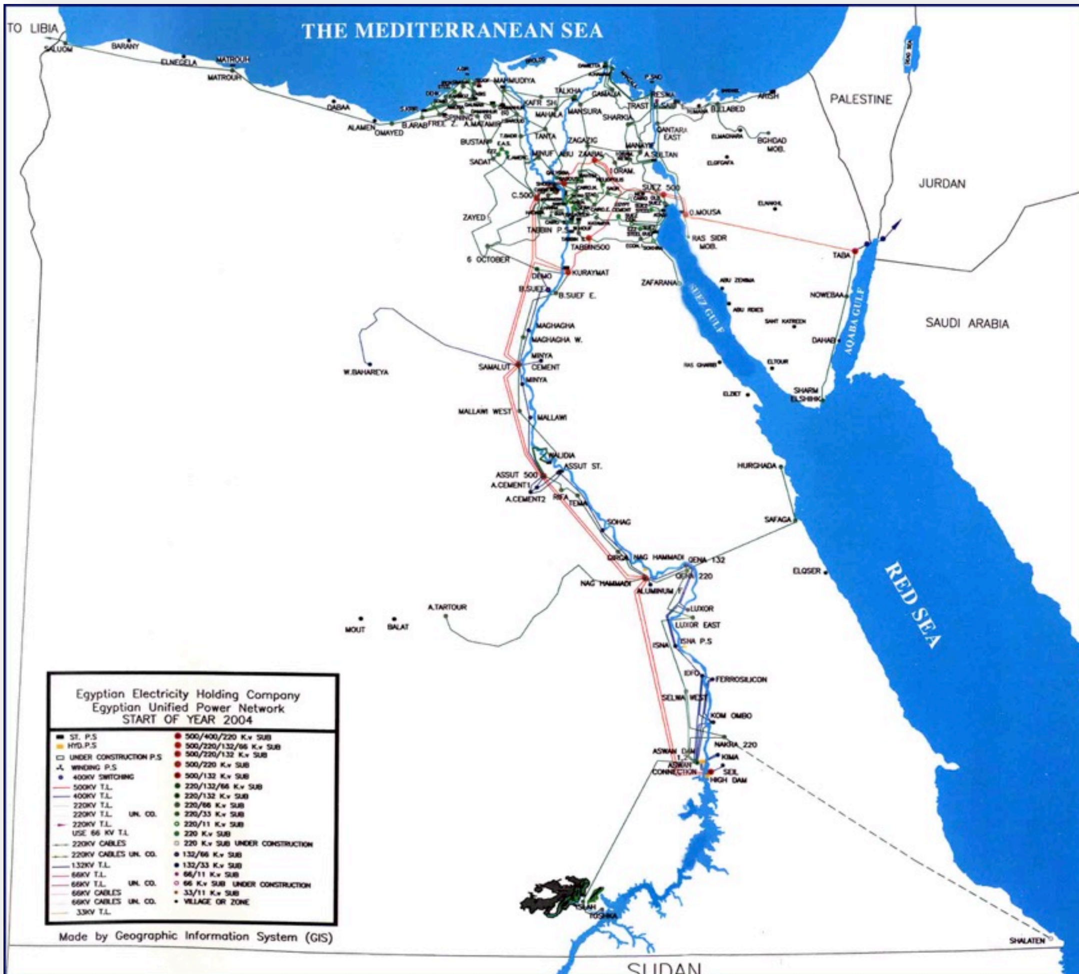

Figure 2. Map showing the power transmission lines network in Egypt (Source: http://www.eetc.net.eg/).

High voltage transfer network

Main distribution

The high voltage transmission network is mainly distributed along the Nile Valley in the Suez Canal zone and along Mediterranean and Red Sea coasts; with the highest density of power lines occurring between the Delta and the Suez Canal and Gulf of Suez.

Figure 3. The region between Cairo and Ain Sukhna and Suez has very high density of OHTLs coming in close contact with important flyways for soaring migrants

Physical properties of the high voltage OHTL network in Egypt

Various designs and sizes of power line towers and power line arrangements are used in Egypt, but the most common tower design is the metal lattice tower with three cross bars and suspended insulators, carrying the 220 kv double circuit lines, with a single ground line connect the tops of each of the pylons above the power transmission lines. (75% of all HOTL infrastructure in Egypt to date, as shown in Figures 3 and 4), The height of the most common 220 double circuit power line is about 40 meters (at the top ground wire). The power lines are stacked vertically, with 6.5 meters separating each of the lines (vertically), with lowest line at about 24 meters above ground.

Figure 4. The commonest high voltage power line design in Egypt, accounting for some 75% of all high voltage OHTL in the country. Here the power line passes over a waste water treatment plant in upper Egypt, where it cases regular bird casualties

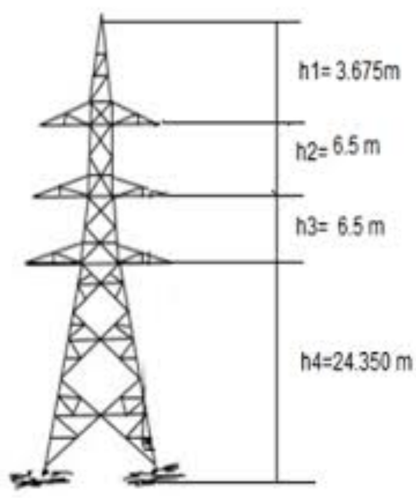

Figure 5 Dimensions of the most common Egyptian 220 kv double circuit multistory tower (source Abd-Allah et al, 2016)

Main impacts of power lines on birds include

- Collision with power lines or associated masts leading to death or injury;
- Electrocution due to contact with live energized components;
- Displacement/Barrier along migration routes or to suitable habitats/feeding grounds;
- Habitat impacts such as fragmentation of habitats at landscape level.

Issues

Collision is the main risk from high voltage power lines, as the proportions of this infrastructure are larger than the largest soaring birds known in the region, thus incidents of electrocution are hitherto unknown in Egypt.

Much of the collision incidents are said to take place with the ground wire that is stretched on the top of the towers above the power transmission lines and is used to conduct any potential lightening strikes to the ground. Because the ground wire is much thinner than the power lines it is less visible to birds and appears to cause much of the bird collision incidents. However, it is ikely that other power lines can cause casualties, particularly in species that fly in large flocks, like storks and pelicans.

The typically large distance between energized lines and grounded components of the towers make electrocution of birds unlikely or very rare by the high voltage transfer network.

Medium and low voltage distribution network

Main distribution

Medium and low voltage power lines are widely distributed in the countryside, in the Delta, the Nile Valley and Canal Zone; in most arable lands and industrial zones.

Tower design

The most widespread tower design is metal power tower with a lattice construction and a top cross arm with short upright insulators. This design is widespread throughout the Egyptian landscape particularly agricultural areas.

Figure 6. This is the most widespread low voltage distribution OHTL setup in Egypt, with short upright insulators. This line was photographed in Fayoum

Figure 7. The typical distribution power poles throughout Egypt, have metal lattice structure and a cross bar with very short insulators that are about 40 cm high. These

upright insulators expose any birds larger than 45 cm in length, including this Hooded Crow and species like Steppe Buzzard to potential electrocution risk.

Issues

Electrocution is the main risk associated with the typical design of low voltage distribution network in Egypt. The short upright insulators secured on metal frame is the most dangerous of all power poles. The electrocution risk could potentially be affecting any bird species with a body length (bill to tail tip) length of over 30 cm, which regularly perches on open perches, particularly large ad medium birds of prey. The number of casualties from these poles is likely to be high and affects a wide variety of both migrant and resident species and might be contributg to the long term decline of local breeding populations of birds of prey and other medium and large birds, including species like herons and storks.

Collisions are also known with the low lying distribution power lines, particularly in coastal areas, where migratory soaring birds are likely to fly at lower altitudes. The most notable example of distribution line causing significant collisions is the local distribution power line just north of Ras Shukhier, which takes dozens of White Stork every year, particularly in the autumn.

Risks of the OHTL network to avifauna in Egypt

OHTL have several potential impacts of birds, some of which are large landscape scale issues affecting habitat use and fly way utilization (Box 1); Power lines that are inappropriately placed across a landscape can lead to displacement of bird populations, and can have habitat impacts. The effect on the flyway could be significant as impacts are long lasting and cumulative. We are mostly concerned here with impacts that lead to the direct mortality of birds through either collision or electrocution.

The potential impacts of OHTL on birds varies greatly depending on location, type of transmission line and also the species of birds. For instance, power lines positioned in areas where migratory soaring birds fly at low altitudes are likely to cause much greater damage than where birds fly at high altitudes. Birds of prey are more likely to suffer electrocution from power lines than collision incidents, while storks, pelicans and cranes suffer more from collisions.

Collisions

Birds collide with power lines when they are unable to detect them during their flight. The thin ground line placed higher than the energised (thicker) lines is often the culprit. Nocturnal migration (mostly be small non-soaring birds), bad weather conditions and flight behaviour contribute to increased accidents.

There is evidence from Egypt that there are potentially significant casualty levels from OHTL in some regions and and in certain seasons.

There is mostly scattered and scant data on bird mortality caused by OHTL in Egypt, with Baha El Din and Ezzat (2020, in prep.), being the only research specifically investigating the issue. By in large the great majority of observed mortality from the available data indicate that collisions with power lines cause a much greater number of casualties than electrocution.

Most concerning is the construction of power lines near to the coast, which could lead to avian collisions, especially in the spring when birds tend to fly at low altitudes as they come to shore after crossing the Gulf of Suez. Many high-tension power lines are placed close to wastewater treatment plants, where they can cause considerable damage.

Known locations of high risk to birds from collisions

There are several locations where high-tension power lines are already known to pose a danger to migratory soaring birds in Egypt. One location is near Gebel El Zeit north of Ras Shukheir, where a local distribution line placed near the Gulf of Suez, takes a regular toll on low flying White Storks. Another is associated with recently established wind farms in the region. High-tension power lines are numerous in the Suez region and pose a potential serious threat to migratory soaring birds. An exceptionally hazardous power line it was built across the Suez Canal in 1998, suspended about 220 m over the Suez Canal some 15 km north of Suez., and carries It is for two 500 kV circuits.. Because the required clearance over the Suez Canal is 152 metres (499 ft), the overhead line has two 221 metres (725 ft) high pylons (one on either side of the crossing) in spite of its small span width of 600 metres (2,000 ft). The pylons each have four cross arms: three for the conductors and one for catching the conductors in case of an insulator string failure. This power line stands immediately in the flight path of the majority of migratory soaring birds concentrated at Suez particularly in spring, and during unfavourable weather conditions, such as sand storms that occur in that season.

Factors affecting OHTL collision rates

Location: OHTLs near coasts, waterways and other points of attraction to birds are most likely to cause problems.
Season: Seasonal changes in migration direction will affect where and when certain species would be most susceptible to collide with OHTLs.
Weather: Conditions of low visibility and strong winds contribute to increased collisions with OHTLs.
Species: Larger soaring birds are more likely to collide with OHTLs due to their limited manoeuvrability and flocking behaviour, which can lead to the collision of multiple individuals in the same time.
Infrastructure: The type of OHTL, height, wire configuration, orientation, etc. can affect the risk level to birds.

Electrocution

While high voltage power transmission lines are usually associated with collision risk, while medium and low voltage power lines or distribution lines (like the 66 kv power lines widespread in many areas of Egypt), are more likely to be associated with electrocution due to their short insulators, and short distance between live wires, where even medium sized birds can make a connection between two live components.

Almost all the 66 kv pylons have very short insulators on metal lattice body (as the one shown above), which is a design that carries a high risk from electrocution to medium and large birds that might land on the pylons. It is suspected that the populations of many birds throughout the Egyptian landscape where these power lines pass have been affected to a large extent, however this has not been documented to any degree.

The full impact of electrocution from distribution OHTLs is difficult to assess in arable areas as the land scape in such regions is complex and accessibility is difficult.

Figure 8. Steppe Buzzard electrocuted when landing on a 66 kv pylon with short upwards insulators at Ain Sukhna. There are at least 17, 500 km of such power lines in Egypt, making it the most common component of the power transfer network in the country.

Figure 9. Steppe Eagle that struck a power line near Ain Sukhna

Figure 10 Juvenile Egyptian Vulture that collided with power lines near Lake Burullus.

Table 1. List of species with documented collision and electrocution mortality in Egypt

Species	Collision	Electrocution
Black Kite		X
White Stork	X	
White Pelican	X	
Egyptian Vulture	X	X
Honey Buzzard	X	
Steppe Buzzard		X
Steppe Eagle	X	
Eastern Imperial Eagle		X
Marsh Harrier		X
Bonelli's Eagle		X
Moorhen	X	
Purple Gallinule	X	
Gargany	X	
Grey Heron	X	
Spotted Crake	X	

Figure 11 Part of a flock of Great White Pelicans that struck a newly established power line in the Gebel El Zeit region (photo by Bassim Rabia)

Habitat disruption

Power lines and their pylons make prominent disruption of the natural landscape, especially in open arid habitats, such as the deserts of Egypt. Besides the visual impact on the land scape, OHTL construction involves extensive earth movement and physical scarring of habitats, for access, establishing of bases for pylons, as well as building material extraction and movement.

The construction and maintenance operations can result in significant loss and fragmentation in desert habitats, including the introduction of predators, predator perches (for birds of prey) and nesting sites of predatory birds such as Brown-necked Ravens *Corvus ruficollis*, facilitating their existence in habitats where they would not occur under normal conditions; thus further contributing to the disruption of local avian communities.

Documented avian / OHTL interactions in Egypt

Generally, the documentation of wildlife management issues in Egypt is rather poor and sparse; this is partly due to the lack of maintenance of systematic data base on bird casualties from various causes including power lines. This can be contrasted with the situation in the USA and Europe, where fairly good data exists on the levels of casualties from power lines.

In recent years bird fatality monitoring has been established in wind farm developments and associated infrastructure including power lines. These studies have resulted in establishing some back ground information on rates of casualties with wind farms in the Gebel El Zait with the application of Shutdown on Demand (SOD) procedures, and more importantly have produced some data relevant to OHTLs in this critical region. The general conclusion from the initial data collected is that OHTLs probably cause more damage to migratory soaring birds than wind turbines. In the mean time OHTLs are not amenable to direct management interventions, such as SOD and in fact cover much larger areas of the landscape, and have little day-to-day monitoring or management inputs; thus they can act as “silent killers” distant from detection, but constantly taking a toll on world bird populations.

Anecdotal observations and initial studies indicated that there is bird mortality to be anticipated along the entire length of the OHTL network in Egypt, however more systematic surveys are needed to provide a more robust understanding of bird mortality along power lines in Egypt. But spontaneous and casual observations reported in various reports and by field workers can be of great value in illustrating the nature and scale of the issue in Egypt.

The only systematic efforts made in this respect are assessments of bird mortality from power line on both sides of the Gulf of Suez region were conducted in the autumn of 2019, the spring of 2020 and spring of 2021.

In 2019-2020 car-based survey were conducted on the west side of the Gulf of Suez (Baha El Din and Ezzat 2020, in prep.) along a total of 76 km of selected power lines segments in three representative and separate areas in the region. In total 1200 km of power lines were surveyed throughout the duration of the study of the two seasons. Forty per cent of the casualties found (within each season) belonged to about 14 species. The most common casualty was the White Stork (16 individuals), and most casualties were documented during a single weeks at the end of August 2019, and the third week of April 2020, coinciding with the peak migration of the White Stork in both seasons.

An overall average casualty rate of 0.26 bird/km/season is assessed for the studied segments over the two seasons. When this rate is applied to an estimated total length of 1200 km (of the target power lines for only two seasons), a total casualty level of 312 birds in one year is estimated. This is a very preliminary assessment, due to the yet limited data at hand.

Baha El Din and Ezzat (2020) suggested that distance from the coast is a primary factor affecting the level of casualties, with the orientation of power lines in relation to dominant migration direction as another potentially important factor.

In spring 2021 NCE carried out a carcass survey (NCE unpublished data, Baha El Din and Ezzat in prep.) of a 76 km stretch of the power line between Sharm El Sheikh and El Tor in South Sinai, resulting in 107 casualties during an 8 week season. The most common casualty was White Stork (23 birds), while 57 were unidentified soaring birds. The casualty rate was significantly higher than on the western side of the Gulf of Suez, with a preliminary rate of about 1.4 birds / km / season (NCE unpublished data).

Bird sensitive regions and locations

The risk to birds from power lines is heightened in areas where high volume of birds pass through at a risky altitude, or where certain species might use the OHTL infrastructure as roosting locations or as a perch or an outlook from which to hunt.

Risk varies along the length of any power line according to proximity to migratory routs, and distance from potential risks and points of attraction to birds.

Risks are heightened in regions of high bird migration volumes, particularly of MSBs, and also in coastal regions, along waterways and near wetlands.

Baha El Din (2014) identified regions around the Gulf of Suez and Aqaba as being of very high sensitivity for migratory soaring birds, while regions along the southern Nile Valley and the Red Sea coast were identified as being of high sensitivity.

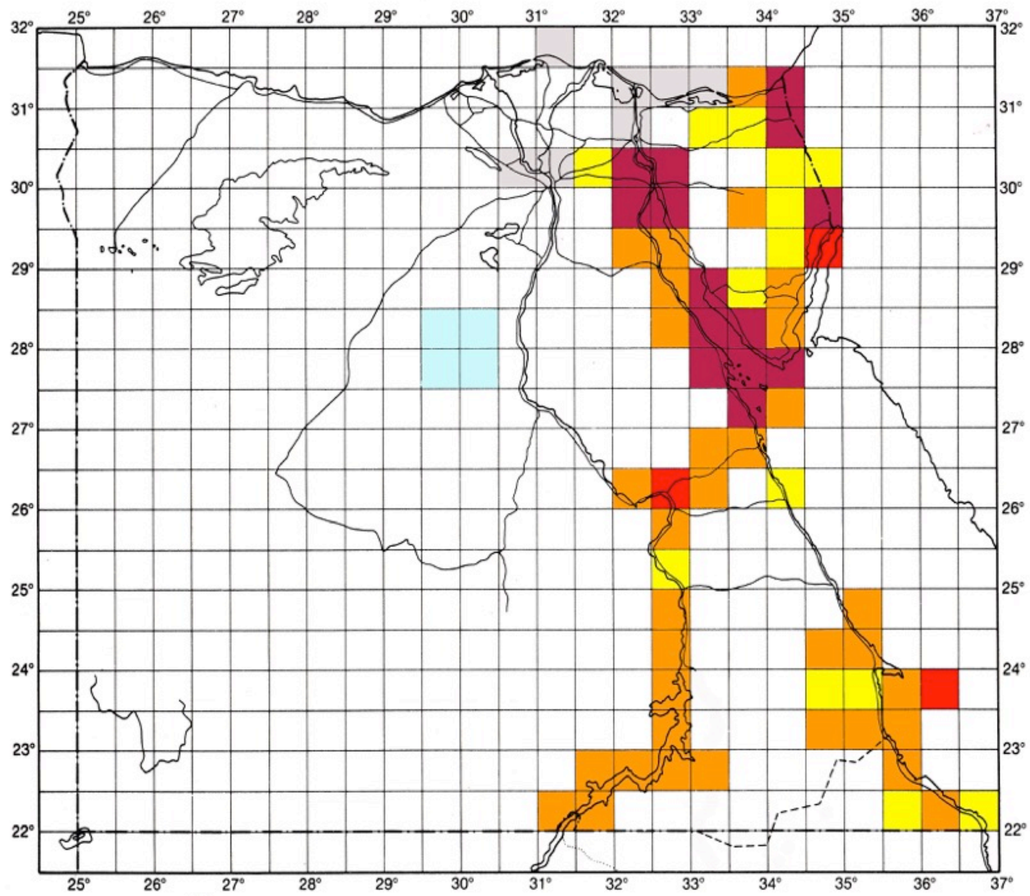

Figure 12. Migratory soaring bird sensitivity map of Egypt developed by Baha El Din (2014), and shows regions of greatest significance for MSBs (dark red), to the least important (light grey).

Future anticipated risks to birds from OHTLs in Egypt

With the rapid increase in demand for energy, and the huge spatial expansion of development across many parts of the country that have been devoid of human activity, the continued expansion of the power transmission grid is most likely to continue its rapid growth.

This growth is particularly notable in coastal regions, where future development and dense human populations are planned both on the Mediterranean and the Red Sea. The increased demand for desalinization in these coastal developments will require significant energy inputs. Agriculture and land reclamation projects also require significant energy sources and power transmission capacity. Power sharing links with neighbouring nations and the dream

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of having Egypt as a regional energy exporter (in the form of electricity) also require expanding the power transmission network.

The growing number of renewable wind and solar energy sources in remote regions along the Red Sea and in the Western Desert will require long power transmission lines to consumption centres.

The anticipated sustained growth in the OHTL network in Egypt will continue to pose a growing silent and under recorded threat to avian life in the country; unless a greater effort is made to first address known hot spots of risk (in the Gulf of Suez area in particular), then establish better understanding of the nature and scale of the issue and provide clear modalities to properly and sustainably manage the risks from OHTL to birds.

3 Local regulations for Over Head Transmission Lines and birds

Currently there are no local regulations that define clearly how and when avian concerns are to be addressed in Egypt. There are a group of legislation that address the EIA process at large and the requirements for EIA related to OHTL development, but nothing addresses the specific case of risks to birds. Until today avian concerns were dealt with in a peace meal fashion, depending on the knowledge of the individuals involved in the process (from both the developer and regulator sides). To date there has not been any field assessment of risks to birds from OHTLS, and much of the risk evaluation is based on desk top studies.

The Egyptian regulations also include a variety of legislation offering legal protection to a number of species of birds from hunting and killing and from habitat destruction.

Nature Conservation Legislation

According to Law 4 for 1994 and its executive regulations issued by Prime Ministerial decree 338 for 1995, Prime Ministerial decree 1095 for 2011 all wild bird species found in Egypt are protected, with the exception of 21 species which are considered as game species (mostly water fowl), of which hunting are allowed according to annual quota and regulations to be issued by the EEAA. Any violations of the law and unpermitted taking of birds (by any means) is illegal and punishable by law. Technically this applies to bird mortality caused OHTLs.

Egyptian regulations regarding the evaluation of environmental impacts of OHTL

The main environmental regulation in Egypt is Law 4/1994 for the protection of the environment, amended by Law 9/2009 and Law 105/ 2015; along with its executive regulations and multiple amendments. The collective body of these laws and regulations is known as the Environmental Protection Legislation.

Environmental Impact Assessment (EIA) is the main tool used to assess environmental impacts of future and proposed developments, according to guidelines that are outlined in articles 19-23 and 70, 71 and 73 of Law 4 / 1994. Law 4/1994 requires that, for establishments requiring licenses, an Environmental Impact Assessment (EIA) must be prepared and submitted to the Egyptian Environmental Affairs Agency (EEAA) for review.

The Executive Regulations relating to Law 4/1994 identifies activities which must be subjected to an Environmental Impact Assessment. Activities are classified into three groups or classes reflecting different levels of assessment required for their anticipated environmental impacts according to the severity and extent of these impacts, as follows:

1. Category A. list projects for projects with minor environmental impacts
2. Category B. list projects for projects which may result in substantial environmental impacts.
3. Category C. list projects for projects with potential significant impacts, which require complete ESIA.

According to the latest EIA regulations (EEAA 2017), most power lines are included under the "B" list of projects and activities that require an EIA. Both OHTL and underground power lines are considered as infrastructural projects that need to have full EIA due to their potential substantial environmental impacts.

In practice, only OHTLs of 220 kv and above have been required to have an EIA of any kind (Eng. Eman Rashed, EETC). Further more, power lines combined with substations as well as trans national OHTLs are considered to fall under "C" list of projects (Eng. Mohamed Abdalla, EIA Department, EEAA), due to their greater and more widespread impacts.

The "B" list includes projects and activities that need be screened for modest and localised environmental impacts. Projects are categorized by activity type, quantity of production or size. Proponents have to fill out Environmental Screening Form "B". The procedure consists of two stages: a screening (filling out Form B), followed by a scoped EIA on certain identified impacts/processes. The "C" list, which includes projects and activities that are anticipated have major environmental impacts requires a full EIA or ESIA.

According to the EEAA EIA classification, OHTLs, classified as Category "B" Projects are not required to submit a full ESIA study including consultations and disclosure. However, according to International requirements (e.g. WB and EIB guidelines, see below) a full ESIA study including public consultations and disclosure processes is required for all OHTL, thus many of the power line developments which are financed by international funding agencies have been subjected to the ESIA process.

After the preparation of the EIA study its presented to the EETC as the relevant competent administrative authority. The EETC in turn forwards the EIA to the EEAA for assessment, comment and eventual approval (articles19 through 23 of the Law and 10 through 16 of the executive regulations). Based on this approval a license to proceed will be issued. No additional environmental or social clearances are required other than the EIA approval to advance with the project activities. The law requires that any new project should comply with all the relevant articles pertinent to environmental attributes, which could be impacted from project activities.

For both "B" or "C" category projects, there are no specific guidelines for EIA studies dealing with OHTLs in Egypt. Specifically there are no guidelines on matters relating do avian risk management. According to Eng. Eman Rashed (pers. com. EETC), its only about 15 years ago that OHTL EIA studies started addressing potential avian concerns.

As a priority, most past EIA and ESIA studies dealing with OHTLs pay attention to human health impact, land tenure and right of way issues; while biodiversity is given a variable level of importance and coverage, and sometimes only a cursory mention. In all examined EIA and ESIA studies biodiversity issues are addressed in the form of descriptive accounts of likely fauna and flora found in the general project area, with most emphasis given to the foot print of the towers supporting the power lines.

The treatment of birds and bird migration issues in all OHTL EIA studies examined was based on general knowledge derived from the literature, with no apparent verification from the field. Even in bird migration hotspots, such as the Gulf of Suez, bird risk evaluation was based on desk work and predictions. No field work was requested or performed.

The potential cumulative long term effects of the OHTL infrastructure introduced into the environment are generally not addressed. Also the indirect impacts of OHTL development, such establishment of service and access roads (which involve extensive landscape adjustments as well as major soil movement), as well as the source of raw materials (rocks and soil) used in securing OHTL towers. Soil movements in desert environments can lead to the disruption of natural surface water movement and drainage, which is a critical issue in arid desert ecosystems. These secondary activities can have far reaching negative impacts on local environments and ecosystems.

In all OHTL EIA or ESIA studies examined there were no recommendations for re-routing power line for biodiversity or bird related considerations. In most cases there were no avian related issues flagged as being of concern, even in known bird sensitive regions. Some mitigation measures were proposed in some cases, mainly a broad recommendation to use power line tags and other visual deterrents at unspecified locations. It is not clear if there was any follow up and monitoring of implementation.

In all cases the evaluation of risk to birds was based on reviews of published materials and available general data, but no field investigation of this potential risk was requested or performed.

Protected area legislation

Law no 102 of the year 1983 provides the legal instrument for the declaration of protected areas in Egypt. Today there are about there are 30 protected areas covering 15% of the terrestrial area of Egypt. Law 102/1983 states that it is "forbidden to erect buildings and establishments, pave roads, drive vehicles, or undertake any agriculture, industrial, or commercial activities in the protected areas except with the permission of the concerned Administrative Body and restrictions specified by the Prime Ministerial Decree". These restrictions include the establishment of OHTLs. In theory any OHTL to be established within any protected area should be subject to the EIA process, and the mitigation hierarchy. The avoidance step being the preferred option to start with, but then any parts of the power line found to be unavoidable within a protected area should be subject to detailed pre and post construction monitoring, regardless of the risk zone it falls in.

Electricity Law No. 63 of the Year 1974

Electricity Law 63/1974 discusses in article 6 the limits of distances, which should be maintained away from other infrastructures and development areas. This is to be measured from the axis of the OHTL routes as well as any underground cables, as follows:

1. 25 meters in case of Ultra High Voltage OHTL
2. 13 meters in case of High Voltage OHTL

3. Five meters in case of High Voltage underground cables
4. Two meters in case of Medium and low Voltage underground cables

This might be of some relevance from the perspective of risk reduction to birds in situations where power lines might approach high risk locations too closely.

Gaps in current Egyptian regulations with regards to OHTL impact evaluation

Although Egyptian environmental regulations require that high and medium power lines should be subject to EIA process, there is currently no specific requirements for bird impact assessment, and the current assessments only provide general statements on potential risks to birds based on desktop studies, but there are no requirements for field assessment and no criteria for qualifying power lines as being of high risk to birds, and thus should not be approved or be modified accordingly. Most available OHTL EIA statements make clear reference to avian concerns from power line interactions with birds, there are no systematic effort made to investigate and evaluate these risks to birds in the field. To date all evaluation made as part of the EIA process has been desktop based. The EIA process should require pre construction systematic avian risk evaluation of future OHTLs, particularly in high collision risk zones.

More over, the EIA process is required for High and Medium voltage power lines, while low voltage distribution lines are not subject to these requirements. From an ornithological point of view the construction of distribution lines in high collision risk regions (see below) should be subject to the EIA process. Also the erection of distribution lines in all other regions of lengths greater than 10 km should also be subject to the EIA process.

OHTLs that are already in existance, or that have been constructed prior to EIA regulations in Egypt are not subject to any post construction evaluation in terms of impacts on the avifauna. It is suggested that a systematic evaluation of fatalities should be conducted along all existing OHTLs in Egypt, in order to evaluate existing "high risk hotspots" and help mitigate them, and to help build a better understanding of bird / power line interactions across the Egyptian landscape at large.

In a number of OHTL EIAs the BirdLife soaring bird sensitivity tool was used to indicate the likely risk to birds. However, using the migration routs of satellite tagged birds (see Fig. 1) to indicate the potential risk from OHTL is over simplified and potentially misleading as most of the satellite tracks are of White Stork, which has a specific migration rout that does not reflect the rest of soaring bird species. Also there is an assumption that OHTL only impact migratory soaring birds by means of collision, while in fact many waterbirds and resident species can be impacted also through electrocution.

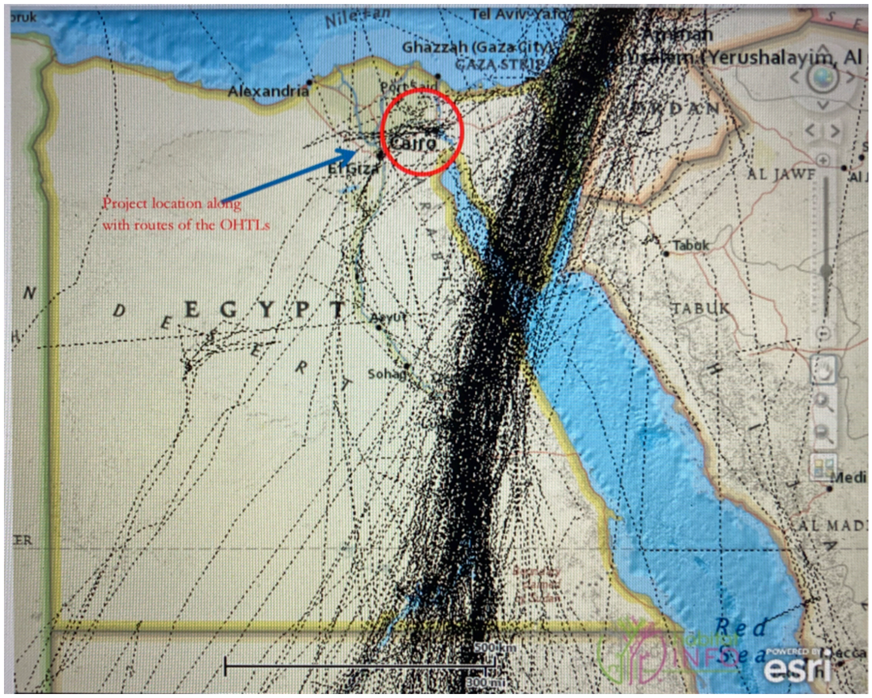


Figure 13 Map from the Birdlife Sensitivity Tool used by Ecoconserve (2019) to illustrate RISK from proposed OHTL in the eastern Nile Delta margins. The use of such regional tools is useful in illustrating general patterns of risk, but should not be a substitute to field assessment

4 International guidelines for managing OHTL risks to birds

Donor regulations regarding the evaluation of environmental impacts of OHTLs

Most large OHTL developments in Egypt are funded through loans from international lending institutions and donors such as the World Bank (IBRD/IDA) and the other major Multilateral Development Banks (MDBs), who have their own environmental and social safeguard policies that seek to ensure that the activities they support have minimal adverse impacts on the environment, biodiversity and human health. These safeguard policies have been deliberately harmonized amongst the lending agencies (Himberg 2015).

These regulations encompass the erection of OHTLs and their associated infrastructure. Much of the power grid in Egypt has been financed with loans from the IBRD or other MDBs, thus the regulations of these institutions is very relevant to Egyptian power line development policies and procedures, and the corresponding environmental safeguards that are applied within the country.

Developers seeking financing from the World Bank are required to comply with the Bank's applicable environmental safeguards, Operational Policies (OPs). The World Bank Environmental Safeguards framework consists of six separate OPs, of which OP 4.01 "Environmental Assessment", acts as an “umbrella” policy used in part to identify other OPs that may apply to a particular project. When proposed activities trigger OP 4.01 the Bank requires environmental and social impact assessment (ESIA) of the proposed project for Bank financing to help ensure that they are environmentally sound and sustainable. Other MDB environmental safeguards tend to be have similar two or three separate operational policies, standards or requirements.

During initial screening, proposed projects are grouped into one of four categories with respect to potential environmental impact. These categories determine the extent and nature of the Environmental Assessment process (EA) for that project. Category A projects have the most extensive environmental impacts and require the most extensive EA process. Category B projects have more limited impacts and require a more limited EA. Category C projects are deemed to have negligible environmental impacts and do not require an EA. OHTL projects usually fall into Category

Projects under Category B in general could have potential adverse environmental impacts on human populations or environmentally important areas including wetlands, forests, grasslands, and other natural habitats. The impacts are site-specific, reversible and temporary in nature.

The host country, and not the World Bank, are responsible for conducting the EA. The EA must ensure that the project meets the relevant environmental laws and regulations of the host country. The World Bank task team, however, provides oversight to ensure that the EA is conducted properly and that Safeguard Policies are fulfilled. For all projects the World Bank policy requires public consultation and disclosure to be undertaken as part of the assessment process. The Policy sets out requirements to comply and report on implementation of any environmental management plans.

The World Bank’s OP 4.04 outlines policy on biodiversity conservation taking into account ecosystem services and natural resource management and use by project affected people. Projects must assess potential impacts on biodiversity. The policy strictly limits circumstances under which conversion or degradation of natural habitats can occur and prohibits projects, which are likely to result in significant loss of critical natural habitats.

The European Investment Bank's (EIB) adopted an Environmental Statement in 1996 to underline its commitment to protecting and improving the natural and built environment according to EU policy. A revised Statement was issued in 2002 and again in 2004. Beyond the EU-27 countries, the environmental standards of the Bank are also subject to local conditions. EU environmental principles, practices and standards are described and explained in a large body of EU law and other official documents, notably the sixth Environmental Action Program (6 EAP) and its Thematic Strategies, as well as the mandates of the Bank. Moreover, The EIB applies a number of core environmental and social safeguard measures that reflect international good practice to all its lending activities. It requires that all its projects:

All projects funded by the EIB are screened and categorized according to their potential environmental and social impacts. The screening is carried out as early as possible in the process and considers potential negative environmental and social impacts whether direct, indirect, regional or cumulative in nature, of the operation and of its associated facilities relevant to the project's successful operation. In addition, this initial screening should identify the extent and the complexity of potential impacts and risks in the project's areas of influence, thereby determining the appropriate environmental and social assessment or due diligence requirements for the project.

Relevant International conventions

Egypt is party to several relevant international conventions with implications for the conservation and management of birds particularly migratory birds, including most importantly the United Nations Convention on Biological Diversity (UNCBD), Ramsar Convention on Conservation and Wise Use of Wetlands (Ramsar), Convention on the Conservation of Migratory Species of Wild Animals (CMS), Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) and the Raptor MOU under the CMS.

The CMS and its two subsidiaries AEWA and the Raptor MOU have direct relavance to the proection of migrant birds as a trans boundary resource that all countries have a shared responsibility to protect and provide safe passage. Egypt is bound to provisions of these agreements and has since established local legislation that reflects these international commitments.

The CMS has produced specif guidelines with regards to the establishment of OHTLs and issued a number of resolutions with regards to the impacts of power lines on avifauna and other wildlife.

The CMS / AEWA guidelines on power lines (Prinsen, et al. 2012), observe that from a strategic point of view, our objective should be to minimize the erecting of OHTLs. This would reduce costs and save resources, as well as, reduce the impact of OHTLs on birds and other wildlife. In order to do this (minimize the need for OHTLs) there needs to be a strategic approach at the national level to power generation and distribution planning, well into the future. This can be achieved through efficient network planning and dispersed power generation options, keeping power production close to end user (Prinsen, et al. 2012).

AEWA Guidelines on managing Impacts of HOTLs on Birds in the African-Eurasian Region

AEWA (2012) identified six steps to minimize the effects of power lines on birds, which each country should adopt. These steps are addressed in various ways within the current report.

Step 1: Develop and support strategic long term planning of nationwide electricity grid networks, including putting low to medium voltage power lines below ground. Apply appropriate Strategic Environmental Assessment (SEA) procedures for decisions on the need of power lines on a national scale and apply similar appropriate Environmental Impact Assessments (EIA) procedures on the construction of a power line once it has been decided that such a power line is needed. Aspects of the risk for bird collision and electrocution should be integrated into the EIA procedures (which are detailed below in this report).

Step 2: Develop and support collaboration between all stakeholders (utility companies, conservation organizations, governmental organizations, landowners) through voluntary agreements or if necessary, impose obligatory cooperation of utility companies for strategic planning and mitigation of negative effects on birds through legislation.

Step 3: Develop accurate databases and spatial datasets on the presence of key bird areas and presence of susceptible bird species, including flight routes of these species between breeding, feeding and resting areas as well as important migration corridors. These datasets enhance strategic planning and help define priorities.

Step 4: Routing new OHTLs should avoid key areas for birds, taking into account the presence of protected areas, abiotic factors that influence the bird/power line conflicts and the susceptibility of relevant bird species.

Step 5: Develop lists of key conservation areas and species in order to identify priorities for mitigating sections of new power lines and retrofitting existing power lines.

Step 6: Mitigate problematic sections of power lines, both existing and planned, to minimize the effects of electrocution and collisions on birds by using state-of-the-art techniques.

Step 7: Develop and support evaluation programs that use standardized protocols to monitor the effectiveness of mitigation measures as well as to improve mitigation techniques, including monitoring of incidents (electrocution and collision) and the presence and movements of birds in order to assess the scale of impact.

5 Managing risks to birds from OHTLs in Egypt

In order to manage risks to birds from the power transmission infrastructure in Egypt both existing and future planned OHTLs need to be considered, evaluated and managed in different ways. Much of the existing OHTL network in Egypt has not have any avian risk evaluation of any kind, and thus there is no systematic knowledge of the scale and nature of risks to birds from this infrastructure through out most of the country. This type of information is now needed in order to start introduce appropriate mitigation measures in the highest risk areas and locations.

For planned OHTL developments the EIA process is the appropriate tool for screening projects and evaluating risks from new OHTLs to birds. However, some specific measures and adaptations are needed in order to better address avian risk concerns.

Applying the Mitigation Hierarchy

All development projects have some negative impacts on the environment and biodiversity. The "mitigation hierarchy" is a process applied to all EIA procedures seeking to minimise or eliminate such negative impacts. The mitigation hierarchy is composed of five steps (sometimes shortened to four steps): Avoidance, minimization, rectification (mitigation), reduction (often lumped with previous step), and finally offset. There is a preference for the application of the initial steps, rather than latter ones, as reaching the final step means that damage to natural resources is unavoidable and that the last resort is to offset them offsite.

Avoidance

Avoidance is the first step in the mitigation hierarchy. It is the complete elimination of any impact, by preventing it from occurring. It is obviously the most preferred form of mitigation, because it ensures no ecological or environmental damage is done. This step is taken at a strategic EIA level or at the option evaluation stage of an EIA where an activity is eliminated altogether from high risk region.

Avoidance is strongly recommended for all new OHTL in very high collision risk areas identified in the Gulf of Suez region.

Minimize

The second step is to minimize impact. Here, the we recognize that negative environmental impacts cannot be completely avoided; instead, steps are taken to ensure minimal damage is done to the environment and natural resources.

Figure 14. Transfer from the "normal" three tire transmission tower to a low lying tower with a single cross bar could reduce bird mortality, is considered a risk minimization technique. This example is implemented to the west of Hurghada, as well as, between Hurghada ad Gebel El Zeit, though other "normal" height power lines have been established in the same region.

Rectification

The third step, is to rectification of impacts, which implies that the impact has already happened; and that what we are doing now is damage control. In a way, rectification allows us to correct the mistake that led to the adverse environmental impact. This applies to the situation we have with already existing OHTLs in bird sensitive regions.

Reduction

If rectification is not possible, we reduce the extent of the impact through management practices and/or change in our methodology. It is when even reduction is not possible that we go for the final step of the mitigation hierarchy: biodiversity offset.

Biodiversity offset

Environmental offset is commonly defined as actions taken outside of the development site to compensate for the impacts in the development site. In effect, this means that the development authorities undertake environment conservation activities to compensate for what they do in order to achieve "no net environment loss", or more specifically "no net biodiversity loss".

Figure 15 The mitigation hierarchy of the EIA process

Assessment of risks to birds from OHTLs in Egypt

The available data on the impact of OHTLs on birds in Egypt indicates that there are potentially significant casualty levels in some regions or localities. However, this information for the most is still limited, patchy and not systematic. It is important to obtain more detailed and systematic knowledge of the impact of OHTLs on avifauna in Egypt, in order to better evaluate and manage risks at existing and future OHTL developments.

Systematic data on bird casualties from OHTL infrastructure is important for improving our understanding the nature and levels of risk in the different regions of Egypt, posed by different types of infrastructure. This knowledge will help anticipate risk levels for future developments in the power grid system, and help improve planning and risk management.

In this context NCE has embarked on conducting systematic risk assessment studies of OHTLs in representative locations and habitats throughout Egypt, examining different OHTL infrastructure, components and situations, during both the autumn and spring migration seasons, as well as winter in some cases.

Priority was given to existing power transmission infrastructure occurring in the "high risk regions" identified previously. The top priority for surveys is along the east and west coasts of Gulf of Suez (to a depth of 50 km from the coastline), including Suez and the southern portion of the Suez Canal Zone, Ain Sukhna region; south to Safaga. The work that NCE has been conducting in this respect since 2019 is presented by Baha El Din and Ezzat (2020).

Other sporadic OHTL casualty surveys have been conducted as part of pre and post construction monitoring, as well as carcass surveys at wind farms. It is important to collate the results from all these studies to help construct a better understanding of OHTL impacts on birds. However, these sporadic sources of data should not replace the need for dedicated systematic surveys that can produce accurate and rigorous casualty estimates. These estimates will form the scientific basis for managing the risks to avifauna from the power transmission system throughout Egypt.

There is a need for rapid assessment and reconnaissance surveys of the predetermined high risk and medium risk OHTLs over a large area in order to identify and or confirm hotspots that require further investigation and assessment. This should be followed by more focused monitoring studies of target sections of OHTLs with the objective of finding out casualty rates and risk factors, etc.

As an initial step in understanding the regional distribution of risk to birds from OHTL in Egypt a rapid assessment of large areas based on already available information and anecdotal data, combined with some reconnaissance surveys is planned to be conducted in the identified high and also the medium risk areas for birds.

The objective of this reconnaissance is to identify and or confirm hotspots that require further investigation and assessment, and provide an overall perspective of the relative risk levels at a regional level.

OHTL Rapid assessment and reconnaissance surveys

The methodology for the rapid reconnaissance is simple, and involves collecting available casualty data; identifying sample stretches of power lines in target regions where a combination of slow driving transects and spot (opportunistic) checks are made to assess general mortality levels. The rapid assessment is not meant to produce any montality rates, but is a practical tool for initial scoping of OHTLs to provide a 0/1 type data, that can help focus further investigations. This is an initial phase that could be practical in light of limited available data and limited resources available for large scale systematic investigations.

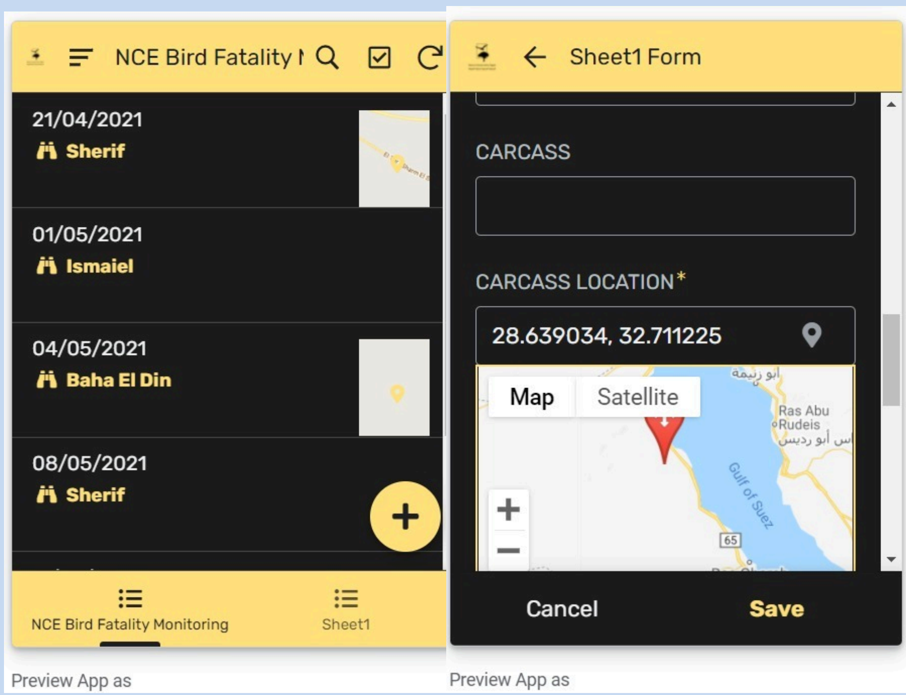
The surveys should be conducted during peak migration seasons. Coverage is extensive rather than intensive. All evidence of bird mortality will be recorded (bones, feathers, carcasses), per kilometre of length of each power line. Both autumn and spring should be covered and also in winter where power lines are found near wetlands with wintering water birds (e.g. Lake Burullus). The NCE Bird Fatality App. should be used as the main documentation and input tool to record all bird fatalities associated with OHTLs. This is particularly useful with non systematic surveys and reconnaissance.

The proposed schedule for rapid assessment and reconnaissance surveys should include the following power lines as a priority to provide indicators for different geographic areas of Egypt:

1. The new OHTL along the Red Sea south of Safaga to Berniece (still under construction).
2. The OHTL recently established on the sand bar of Lake Burullus.
3. The OHTL along the Meditrranean coast between Alamein and Salum.
4. The Aswan - Abu Simble OHTL.
5. Sample OHTL between Cairo and Ain Sukhna.
6. Sample low voltage OHTL in the Delta and or Fayoum.

The *NCE Bird Fatality App.* was developed in order to facilitate the documentation of carcasses in an efficient and transparent manner. The App. is used to document a bird carcass photographically, documents location, date, time, observer details and automatically transmits the record to a central repository via internet.

In this manner the NCE App. facilitates that any one can potential report fatality records and document them accurately and ensure that the record is retained and is accessible to those concerned.



The OHTL bird casualty data base

There is a need to establish a national repository of power line bird casualty records, which includes all relevant data for each bird carcass / or remains, in order to develop anticipated rates of casualty per kilometre for each region in the country and for each type of OHTL infrastructure and according to various environmental and seasonal conditions.

NCE has established a preliminary data base for known OHTL incidents that can be considered the core for the national data base. This data base is connected with the NCE bird fatality App., which is automatically being updated with new casualty records, from both casual as well as systematic surveys.

This data will be very important in establishing mortality rates in each region, in different seasons and by the different OHTL infrastructure and power line designs. The information generated will be extremely useful in estimating likely impacts for future OHTLs on birds and in estimating (background) mortality from existing OHTLs. The greater accumulation of data and application of rigorous scientific research standards in surveys and data analysis, will produce robust results that can be accepted by all parties including regulators and the industry, which can potentially be used in proposed offset measures and for any potential mitigation measures.

Establishing OHTL Collision Risk Map

All future OHTL developments in Egypt must be evaluated according to their location and position in relation to "collision risk zones". These zones are recognised based on known patterns of migration of the vulnerable target soaring bird species, in regions where very high density of migration is known, as well as where these birds are known to fly art low altitudes, particularly after sea crossings at bottlenecks of migration. Power lines in coastal regions adjacent to both the Red Sea and Mediterranean are known to pose a threat to both soaring and non-soaring birds, including water birds and even passerines, particularly during nocturnal migration (Bernardino, et al. 2018; Drewitt and Langston 2008).

Figure 15 presents a preliminary map of migratory bird sensitivity to OHTLs. This map is derived from known flyways of soaring birds, the Soaring Bird Atlas of Egypt (Baha El Din 2014), Birdlife online sensitivity tool, and published and unpublished data on bird mortality from power lines in Egypt.

Any future OHTL developments should be subjected to the EIA process in accordance with their position with the different risk zones. Each segment of the power line should be subjected to the relevant level of ornithological evaluation and scrutiny according to its occurrence within each risk zone. Thus one power line could be subject to several assessment levels along its entire length.

Very high risk zone

The exceedingly high risk zone is recognized in the southern half of the Gulf of Suez (between Ras Gharib and Hurghada, and between Abu Redies and Sharm El Sheikh (on the Sinai side of the Gulf), with a depth of about 5 km from the Red Sea coast.

In this region, which contains three Important Bird Areas (IBAs) that were selected based on being bottle necks for migratory soaring birds (Baha El Din 1999), soaring birds are highly vulnerable because when they make the crossing of the Gulf of Suez of the Red Sea waters they lose altitude and often are forced to fly very low near the ground. More over birds are usually tired or exhausted and commonly land to rest. Casualties from power lines and other similar structures like communication towers have been known to cause considerable and sustained mortality amongst these birds for many years now (e.g. Baha El Din and Ezzat 2020 and in prep.).

High risk zone

The high risk zone for collision of birds with OHTL is identified along the coastal zone of the entire Gulf of Suez and Gulf of Aqaba (to a depth of about 25 km), with the exceedingly high risk zone identified in the southern half of the Gulf of Suez. The nature of risk in this zone is similar to that in the preceding zone, except that the frequency and volume of incidents is less regular and more sporadic over a larger area.

Medium risk zone

Coastal areas along the Red Sea and the Mediterranean, as well as along the southern section of the Nile Valley have all been identified as areas of medium (or potentially high) risk for birds from power lines. This is based on observed and documented incidents of collision and electrocution in these regions, or predicted based on casualty levels witnessed in similar settings in the high risk zones in Egypt, or elsewhere in the region.

Low risk zone

Low risk zones for OHTL development are located in inland regions adjacent to coastal regions and the main soaring bird flyways, and along the Nile Valley and Delta. Thus, most of Sinai and the Eastern Desert , as well as the northern section of the Nile Valley fall within this zone. In these regions birds are not expected to encounter special conditions that would expose them to exceptional risk from OHTLs. Also the species of birds most likely to be encountered in these regions in significant numbers are less likely to have problematic interactions with OHTLs.

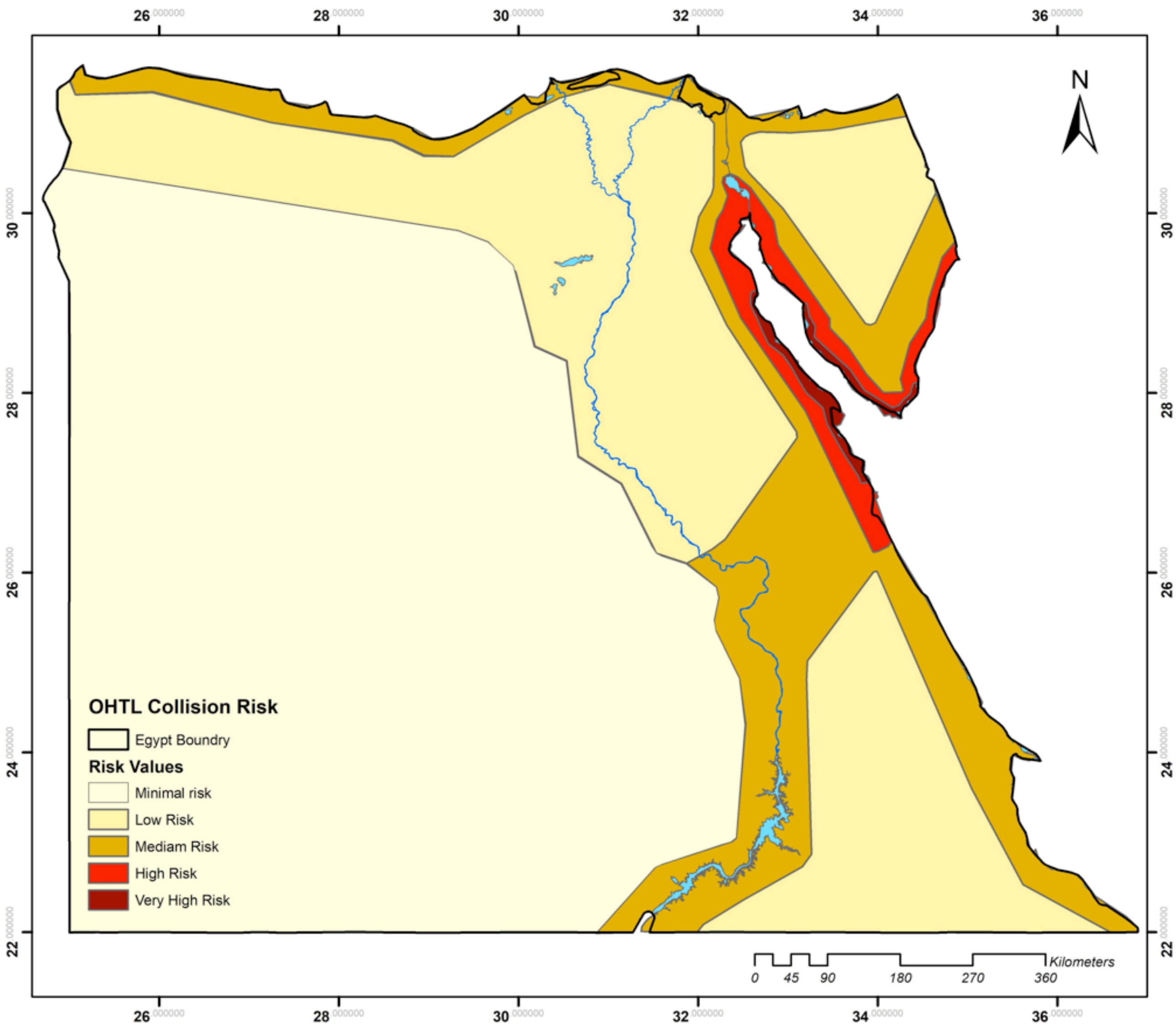


Figure 16. Preliminary OHTL Collision Risk Map for Egypt

Minimal risk zone

The areas of least concern are the interior of the Western Desert away from the four major oasis of Siwa, Farafra, Dakhla and Kharga; in these locations some areas of concern could exist. Generally speaking areas with water bodies and vegetation in the middle of hyper arid desert can act as a magnet to migrant birds. The presence of power lines in such locations should be assessed with care, and it is best to route power lines away from water bodies in the desert whenever possible (Step 1 in the mitigation hierarchy: Avoidance).

6 Mainstreaming avian considerations into EIA procedures for OHTLs

As discussed in previous sections the EIA process in Egypt follows the slandered steps applied world wide, starting with screening / scooping, review of alternatives, establishment of baseline conditions, evaluation of impacts, recommendations for mitigation, and monitoring. There is currently no specific consideration in the EIA process and procedures to address risks to birds from OHTLs in the Egyptian setting. There is a need to mainstream bird risk considerations within the EIA process when evaluating the environmental impact of OHTLs.

The EIA sequence

Initial screening

The screening process aims at identifying the general EIA requirements for each new planned or proposed OHTL development in Egypt, based on the anticipated risk levels according to the location and the nature of the proposed infrastructure. Screening is generally based on pre-existing information; the screening process should, as a minimum, use existing lists and maps for identifying protected areas and other important areas for birds, e.g. Bottlenecks, Ramsar Sites, Important Birds Areas (IBAs), Protected Areas. The OHTL Collision Risk Map is a tool to be used in the screening process. It is important that all relevant existing information sources about birds are made available to the competent authorities making screening decisions, when deciding whether critical sites/habitat may be affected.

All new and proposed OHTLs **of ALL voltages and heights** should be subject for ornithological evaluation by the EEAA. The main criteria used in the initial screening must include the location of the proposed OHTL in relation to the Collision Risk Map, identified above, and according to the physical characteristics of he OHTL (power line type, height and length, etc.).

The initial screening will identify the risk zones the power line is expected to pass through. As OHTL developments are linear in nature they are likely to intersect several zones of risk, thus could attract several levels of ornithological evaluation requirements along different segments of its length. According to initial screening and the identified Risk Zones through which the proposed power line will traverse, the likely risk levels that the power line poses can be designated, and hence the follow up steps can be prescribed accordingly. OHTLs can pass through zones of different risk designation; hence each each segment can attract different EIA requirement and the power line does not need to be all subject to the same level of evaluation.

The materials required for this step are detailed maps of the planned power line route along with its physical specifications including type, voltage, height, length end and start points. Potential alternative routs should be provided if available. The responsible body for the initial screening of the OHTL should be the EEAA (NCS and EIA department).

Consideration of alternatives

Generally, EIAs should include a full consideration of alternatives from the earliest possible stage in the development planning process. Ideally major alternative selection decisions should be made at the Strategic Impact Assessment stage as some political decisions and significant investment might have taken place by the time a project gets to the EIA stage, which may severely limit the scope for alternative options (Tucker and Treweek 2008). The main aims at this stage is to optimise outcomes by avoiding or minimising the most damaging impacts, while also looking for opportunities for positive environmental benefits.

Consideration of alternatives should not only be restricted to location and routing of OHTLs; but all options for potentially reducing negative impacts, such as pylon design, construction methods and operational management should be investigated (Tucker and Treweek 2008). For example, the selection of appropriate power-cable designs can significantly reduce the risks of bird collisions and electrocution (Haas et al. 2003).

Baseline review

This step aims to define the significance of an area to birds and to collect information on the likely impacts of OHTL development on the avifauna of the area. In an EIA the focus will be on the specific site or region where the development is taking place and would be detailed and extensive enough to provide a reasonable idea of the anticipated impacts. The baseline review will need to assess the importance of the project site and its zone of impact in relation to local, regional, national, flyway and global populations; this will require a broader analysis of data.

Pre-construction monitoring of birds in the project area is the main tool to establish baseline for OHTLs. This can be supplemented by literature reviews and data from near by wind farms and similar OHTL developments. Data from OHTL mortality in the region can also inform predicting casualty levels and the levels of risk.

Identification and prediction of main impacts

In theory impact assessments provide a balanced, collective evaluation of economic activities on environmental and ecological processes at large, with each component of the ecosystem of concern being evaluated according to distinct values and criteria. "Biodiversity specialists working on EIAs have a responsibility to ensure that they exercise sound professional judgement as to the minimum data/ levels of confidence required to characterise the environment and make defensible predictions. The key challenge is to produce a sufficiently robust analysis in the face of insufficient data, uncertainty and often lack of political will" Tucker and Treweek 2008).

In practice the prediction of impacts of infrastructure developments (such as OHTLs) on bird populations is very difficult, particularly in relation to long-term and large-scale impacts. This is because of the complexity of ecological systems, particularly when considering highly migratory species such as MSBs. The factors controlling population levels in such widely mobile species are very complex. Impact assessments should take the following into account (based mostly on Tucker and Treweek 2008):

- Population levels, mortality rates and recruitment levels in the flyway population as a whole, because changes in these may offset or exacerbate impacts from the project;
- The quality and carrying capacity of the impacted habitat and potential alternative habitats;
- Site fidelity and its potential effects on the ability for displaced birds to locate and use alternative habitats;
- The role of sites in supporting functionally connected (coherent) site networks (e.g. as critical migratory staging posts or wintering sites); and
- Location of adjacent projects of similar nature, which can have additional negative impacts on birds within the region of concern.

There are a range of approaches that can be used to predict and evaluate impacts, which vary from expert judgements; histories of similar case; results of post-construction monitoring; to Collision Risk Modelling (CRM).

Mitigation and avoidance measures

In this step appropriate avoidance and mitigation measures are identified to reduce any high risks or predicted mortality to acceptable levels. Mitigation measures should normally firstly explore all options for avoiding impacts on biodiversity before resorting to measures that seek to reduce impacts. This may entail desisting from erection of OHTLs in specific high risk areas (like the shores of the Gulf of Suez) that may be particularly damaging or seeking alternative locations that avoid particularly important sites (e.g. critical sites for MSBs). Mitigation and avoidance measures can include local rerouting of OHTLs, removal of un-natural points of attraction (such as waste dumps), burying power lines under ground, using lower pylons on a single plain, and the installation of markers and signage on OHTLs.

The selection of mitigation measures will depend on local conditions and the nature of the risks at each power line. The effectiveness of such measures need to be assessed subsequently through post-construction monitoring, evaluation and feedback for management.

Post-construction monitoring and evaluation

In the critical region of Gebel El Zeit, post-construction monitoring and shut-down on demand has been prescribed for the lifetime of most wind energy facilities due to the predicted risk to migratory soaring birds from these facilities and their infrastructure. Initial data suggests that infact power lines might be more damaging to these birds than the wind turbines are. For this reason post-construction monitoring is crucial to provide a better understanding of both existing OHTLs and those that will be constructed in the future in this and other regions of the country.

The better understanding of the problems posed by OHTLs to birds in Egypt will lead to better and more efficient management of these risks.

Reporting and feedback

It is critical for data collected in the post-construction phase to be digested and reported back to the appropriate stake holders to facilitate adaptive management measure and to ensure effective management of risk, particularly in high and very high risk zones for migratory soaring birds and waterbirds.

EIA prescriptions at different risk levels

In order to simplify procedures for practitioners that might not have extensive experience with dealing with bird risk issues or migratory soaring birds, the following guidance was developed to provide streamlined prescriptions for the proposed EIA procedures relavent to each of the risk zones for OHTLs in Egypt. Each site will have its additional specific requirements for sure, and these guidelines are generic.

Very high risk

General precautions

In this exceedingly risks zone it is recommended to have a complete ban on ALL new OHTLs in this region. All power transmission if needed is confined to local consumption needs (distribution rather than for transmission to other regions) and that all necessary power lines (and also telecommunication lines) are buried under ground. If avoidance measures fail in evading the need for the construction of new OHTL in this zone, then its extent of occurrence must be strictly minimized within this zone. Existing OHTLs in this zone should be dismantled and replaced with underground cables.

Pre-construction assessment requirements

Any new OHTL that must be erected in this exceedingly sensitive zone must go through a rigorous ornithological risk assessment. This includes high intensity field study of bird migration patterns along the entire length of the power line within the Very High Risk Zone. The ornithological field study should extend over two years and include both spring and autumn seasons (this is to address seasonal variations, as well as minimize potential annual fluctuations in migration patterns), and should cover the entire length of the proposed power line within the zone. This means that the field assessment sampling design needs to assess migration intensity and altitudes throughout the whole length of the proposed power line route.

Other parts of the proposed power line passing through zones of lesser risk qualification would be subject to the requirements for those zones.

Mitigation measures

Prohibit construction of all OHTLs within this zone (five kilometres from the coast), this include distribution lines. All OHTLs in this zone (new or existing) must have markers installed along the entire length of the power lines.

Post-construction monitoring

Any OHTL in this zone must have a high intensity post construction monitoring program (see below) implemented for a duration of at least five years after construction. The results of this post-construction monitoring should be used in informing better mitigation measures. Monitoring should be continued at low intensity indefinitely to assess bird mortality.

High Risk Zone

General precautions

Any new OHTLs within the High Risk Zone should maintain at least five km distance from the coast in the Gulfs of Suez and Aqaba regions.

Pre-construction assessment requirements

In this zone of high risk all new OHTLs should go through rigorous high intensity pre-construction risk assessment. This includes monitoring of bird migration characteristics along the length of the power line within the high risk zone (see details below).

The pre-construction monitoring study should cover one year at least, and include at least both spring and autumn seasons (this is to address seasonal variations). A high intensity sampling design should include the entire length of the proposed power line within the zone. This means that the field assessment sampling design needs to assess migration intensity and altitudes throughout the whole length of the proposed power line. Other parts of the power line passing through zones of lesser or greater risk qualification would be subject to the requirements for those zones.

Mitigation measures

Based on the results of the pre-construction assessment, all high risk stretches of the power lines in this zone (new or existing) must be marked using markers or reflectors.

Post-construction monitoring

New power lines established in this zone should have a high intensity post construction monitoring program (see below) implemented for a duration of two years after construction.

Moderate risk zone

General precautions

In the moderate risk zone OHTLs should be routed away from any bird attractions, such as wastewater treatment plants, municipal solid waste dumps, natural wetlands, whenever possible.

Pre-construction assessment requirements

Low intensity sampling of the entire length of proposed power line within this zone for one year, covering at least both spring and autumn (winter and summer could be included depending on location and bird species involved). Low intensity sampling would require monitoring of only a subset of the power line length and not its entire length.

Mitigation measures

Based on the results of the pre-construction assessment, all high risk stretches of the power lines in this zone (new or existing) must be marked using markers or reflectors. Locations that might prove to be highly risky for birds should be re-routed or buried to reduce risk levels.

Post-construction monitoring

New power lines established in this zone must have a low intensity post construction carcass monitoring program (see below) implemented for a duration of two years after construction.

Low risk

General precautions

OHTLs should be routed away from wastewater treatment plants, municipal solid waste dumps and natural wetlands.

Pre-construction assessment requirements

Desk-top assessment of potential risks along proposed route, combined with rapid reconnaissance of the areas along the proposed power line that could be risky to birds (such as near wastewater treatment plants, municipal solid waste dumps and natural wetlands), to identify locations of potential conflict. Low intensity monitoring of areas of potentially high risk could be required for the duration of one year to assess the level of risk at these locations.

Mitigation measures

No mitigation measures required along most of the length of the power line, pending the results of pre-construction monitoring near locations of high interest. Re-routing or marking could be required depending on levels of risk predicted.

Post-construction monitoring

Targeted surveys for carcases in the areas of anticipated high risk should be required for a duration of two years.

Minimal risk zone

General precautions

OHTLs should be routed away from wastewater treatment plants, municipal solid waste dumps, natural wetlands and any other bird attractions.

Pre-construction assessment requirements

Desk-top study of route, possibly combined with rapid reconnaissance of areas along the proposed power line that are potentially risky for birds, such as wetlands, oasis, solid waste dumps, etc.

Mitigation measures

No mitigation measures required along the length of the power line, pending the results of pre-construction reconnaissance near locations of high interest. Re-routing or marking could be required depending on levels of risk predicted.

Post-construction monitoring

Targeted surveys for carcases in the areas of anticipated high risk should be required for a duration of two years.

7 Monitoring protocols for OHTLs

Pre-construction monitoring

Pre-construction monitoring should take place in areas power lines are planned (not existing yet), and would focus on estimating future predicted risk levels mainly based on observing and recording flight altitude, volume and direction of flight of living birds along the power line route in a given region. In that sense it is similar in its objectives to pre-construction monitoring for wind farms. However, here the monitoring would aim at constructing a risk profile for a longitudinal space across a wide area of landscape, rather than a specific location or area.

The results from bird migration monitoring can be supplemented with carcass surveys from near by existing power lines (taking into account power line specs)

As power lines are static long lived structures that are cannot be managed through any dynamic means (e.g. through shut-down-on demand in the case of wind turbines), the main options for reducing damage to birds and other wildlife would be optimal rout planning and avoidance.

Table 2. Summary of recommended EIA related actions in relation to different OHTL collision risk ranks

	Recommended EIA Related Actions		
Collision Risk Rank	Pre-construction monitoring	Post-construction monitoring	Avoidance and mitigation
Very High Risk	High intensity: Minimum 2 years	High intensity: Minimum 5 years Low intensity: Indefinetly	Prohibit construction Reroute and burry cables Existing OHTLs should be dismantled
High Risk	High intensity: Minimum 2 years	High intensity: Minimum 3 years Low intensity: 2 years, beyond initial 3 years	No OHTL within 5 km of coast Rerouting could be extensive Avoid points of attraction to birds
Medium Risk	Low intensity for one year Assessment of specific areas or sites	Minimum of 1 year	No OHTL within 2 km of coast Avoid points of attraction to birds
Low Risk	Desk top study Low intensity assessment of specific sites	Not needed Low intensity assessment of specific sites	Avoid points of attraction to birds
Minimal Risk	Desk top study	Not needed Low intensity assessment of specific sites	Avoid points of attraction to birds

Methodology

Monitoring birds along proposed power lines

Monitoring of bird use of the air space occupied by future power lines would take place through a set of observation points selected along the anticipated or planned power line route, where observers would be stationed to make standardized observations of bird migration for the duration of the migratory or wintering seasons. A sample of locations along the power line should be selected to provide either a complete coverage of the power line (intensive sampling), or a subset of length of the power line (low intensity sampling). The selection of subset of locations should represent at least 25% of the power line length in the Risk Zone, and should include locations of species concern and should also be representative of all habitats along the route. The selection of methodology would be dependent of the location of the power line relative to the proposed Risk Zones (see Figure 17). Each observation point would visually monitor a circle with a radius of 2.5 km, with a minimum distance of five km between any two adjacent points.

Figure 17 Hypothetical map of high intensity sampling effort in Very High Risk Zone (yellow line), and low intensity sampling in High Risk Zone (blue line). The circles on the map have a

radius of 2.5 km and represent the locations of observation points selected along each proposed power line.

Observation techniques and routine

Observations would be conducted during daylight hours and all hours of the day should be covered for the entire duration of each of the two migratory seasons, spring and autumn. Frequency of monitoring at each location would depend on the intensity of sampling effort intended, with a weekly visit for each location throughout the season considered as a minimum. The specific distribution and timing of observation sessions should seek to maximize spatial and temporal representation of the entire study area.

At each location, observers would make regular 360º scans of the sky with binoculars to detect any (soaring) bird movements. Detailed observations of birds entering the monitoring area (a radius of 2.5 km). Birds detected entering this area are identified, counted, timed, their orientation and flight altitude would be documented during their passage.

The following data should be collected when birds are observed inside each site:

1. Time
2. Number of birds
3. Bird species
4. Direction of flight
5. Altitude
6. Behaviour (e.g. direct passage, resting, feeding, roosting, etc.)

Weather data

Weather data would be important for understanding patterns of bird movement and hence might help in understanding risks and finding alternates or appropriate mitigation measures. Hourly weather observations should be the slandered for pre-construction monitoring,, including the following:

1. Wind speed
2. Wind direction
3. Visibility (four categories: I < 5 km, II 5-10 km, III 10-15 km and IV > 15 km)
4. Special weather conditions (sand storms etc.)
5. Temperature

Equipment needed

1. Vehicles

2. GPS
3. Binoculars
4. Spotting scopes
5. Compass
6. Thermometer
7. Anemometer
8. Field guides, note books, data entry and data management set up
9. Communication equipment (phone)

Personnel

Qualified observers with excellent knowledge of the birds of the region, their identification and movements.

Post-construction monitoring

This is the main casualty assessment tool to be used to collect data on mortality levels along OHTLs. The objective of the focused and systematic monitoring is to gather basic information that would be critical for the management of risk from OHTLs: Casualty rates per length of power line, environmental and topographic factors affecting mortality rates, seasonality of incidents, weather conditions that might contribute to incident rates, taxonomic composition of casualties and effect of different OHTL infrastructure on bird casualties. Monitoring of bird mortality would target sections of power lines in locations that are known or highly anticipated to have high bird mortality due to collision or electrocution.

The data generated will be very important in developing risk models for future (and existing) OHTLs once a better understanding has been gain as to the main factors that influence mortality rates in different settings, and hence better plan and mitigate anticipated risks. This would contrast greatly with our current understanding, which is at the moment still very poor and based on predictions.

In order to maximize the benefit from the collected data sampled power lines should be representative of various topography, distance from coast, infrastructure type and season. Multi year monitoring of the same power lines would increase confidence in results; thus a minimum of two year monitoring is recommended.

Figure 18. Car survey of bird carcasses in longitudinal transect (50 meters on each side of the power lines) under power lines between El Tor and Sharm El Sheikh, spring 2021

Methodology

The carcass survey typically relies on longitudinal transects under power lines (e.g. Baha El Din and Ezzat 2020; Uddin, et al 2021). In the hyper arid environment of Egypt, which is mostly devoid of vegetation cover, surveys conducted from a vehicle would be efficient and effective. Transects are carried out from a slow-moving vehicle (average 10 km/hour) below selected target power lines. The vehicles are usually driven along service tracks that are usually located right under the power lines and facilitate easy access to the terrain. In some critical areas where accessibility by car is difficult, the observers would have to walk on foot to survey specific areas along the transects.

The ground is visually carefully surveyed for any bird carcasses and/or bird remains (feathers and skeletal remains) on both sides of the car to a distance of 60 meters on both sides of the power line). In practice the effective visual distance for the observer to detect intact carcasses (of average size) might be greater for larger birds of highly contrasting plumage such as storks or pelicans. Obviously small birds and bird remains will be much less detectible from a distance.

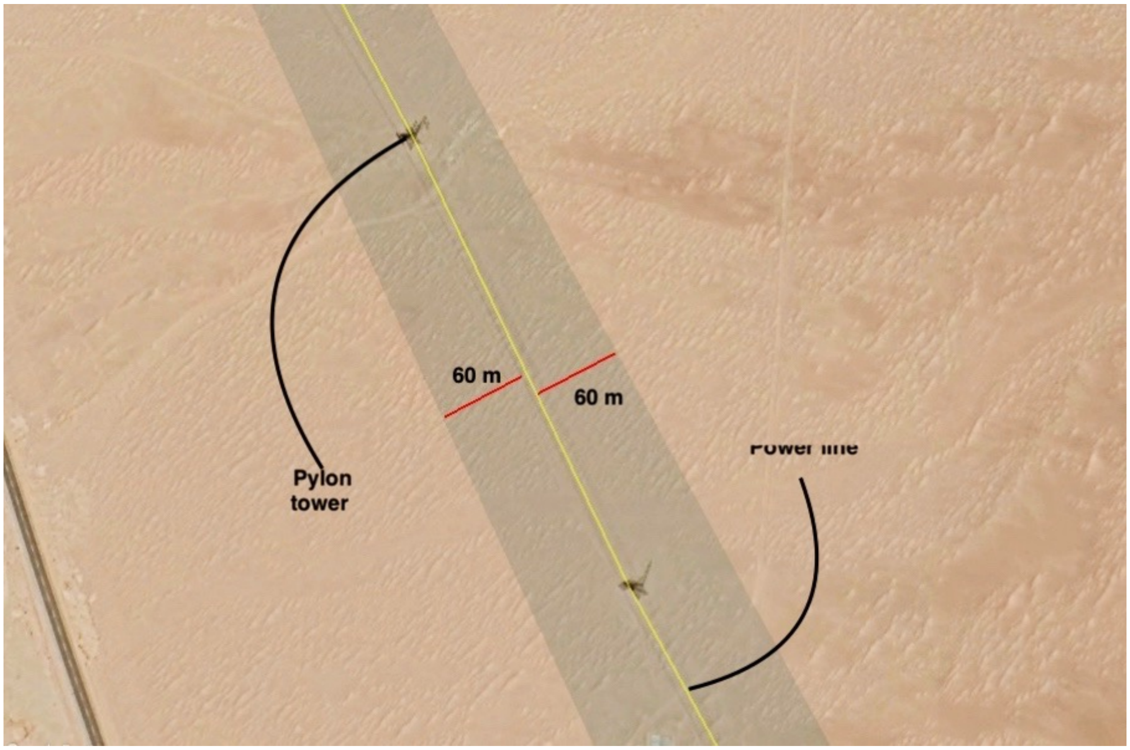


Figure 19 Map showing carcass survey technique under power lines. Grey band indicating visual scanning zone on both sides of the power line.

Data collection

When a carcass or bird remains are detected a standardized set of information and documentation should be made and collected in a standardized field form (Figure 18). Each carcass is given a unique serial number, photographed and any signs of predation and tracks of predators noted. Data collected include: Date, time, location, species (or species group), condition of carcass, and estimated time since incident. Fresh or intact carcasses are left in situ to help estimate the carcass persistence and removal rates along studied transects.

or entered via the NCE Fatality Recording application that can be downloaded and installed on any smart phone. The NCE developed Bird Fatality Monitoring App, to easily record and submit data of bird fatality incidents due to collision and electrocution by overhead transmission and distribution power lines. To get access to the app, send an email to the NCE: info@natureegypt.org. The app automatically documents location of carcass, date, observer name, generates a distinct serial number for each carcass and sends the data to a central database through the internet. This will ensure transparency and accurate data collection and storage.

Observer name: Emad. A			**Date:** 21-8-2021			**Time start:** 8:01	
Transect: Tor- Sharm			**Start** 27°51'11"N 34°8'19"E	**End** 28°12'34"N 33°40'36"E		**Type of power line** kV 220	
Serial no	**Lat.**	**Long.**	**Species**	**Condition**	**Time since incident**	**Cause**	**Distance from Power line**
4969361	28°11'37.32"N	33°41'15.68"E	White stork	Early decay	1 week	collision	10 m

Figure 20 Example of field sheet with data entry for a carcass found along the Tor – Sharm El Sheikh OHTL in South Sinai.

Timing and frequency

Over much of Egypt, including the Red Sea / Gulf of Suez carcass surveys should take place during the main migration seasons in autumn (10 August – 20 November) and in spring (20 February – 20 May). In wetland areas along the Mediterranean coast and Nile Valley, winter monitoring surveys should be required (1 December – 1 March).

Until better data is available on carcass removal in the various regions and environments of Egypt (see below), it is recommended that monitoring frequency should be weekly. Monitoring frequency can be reduced in regions where carcass removal is low.

Equipment needed

1. Vehicle
2. GPS
3. Camera
4. Binoculars
5. Smart phone (with the NCE Bird Fatality Monitoring App installed)
6. Field guides, note books, data entry form
7. Markers, tags and rope (to mark and tag carcasses)

Personnel

Two qualified observers with basic knowledge of the birds of the region and their identification in the hand or from feathers and or bones.

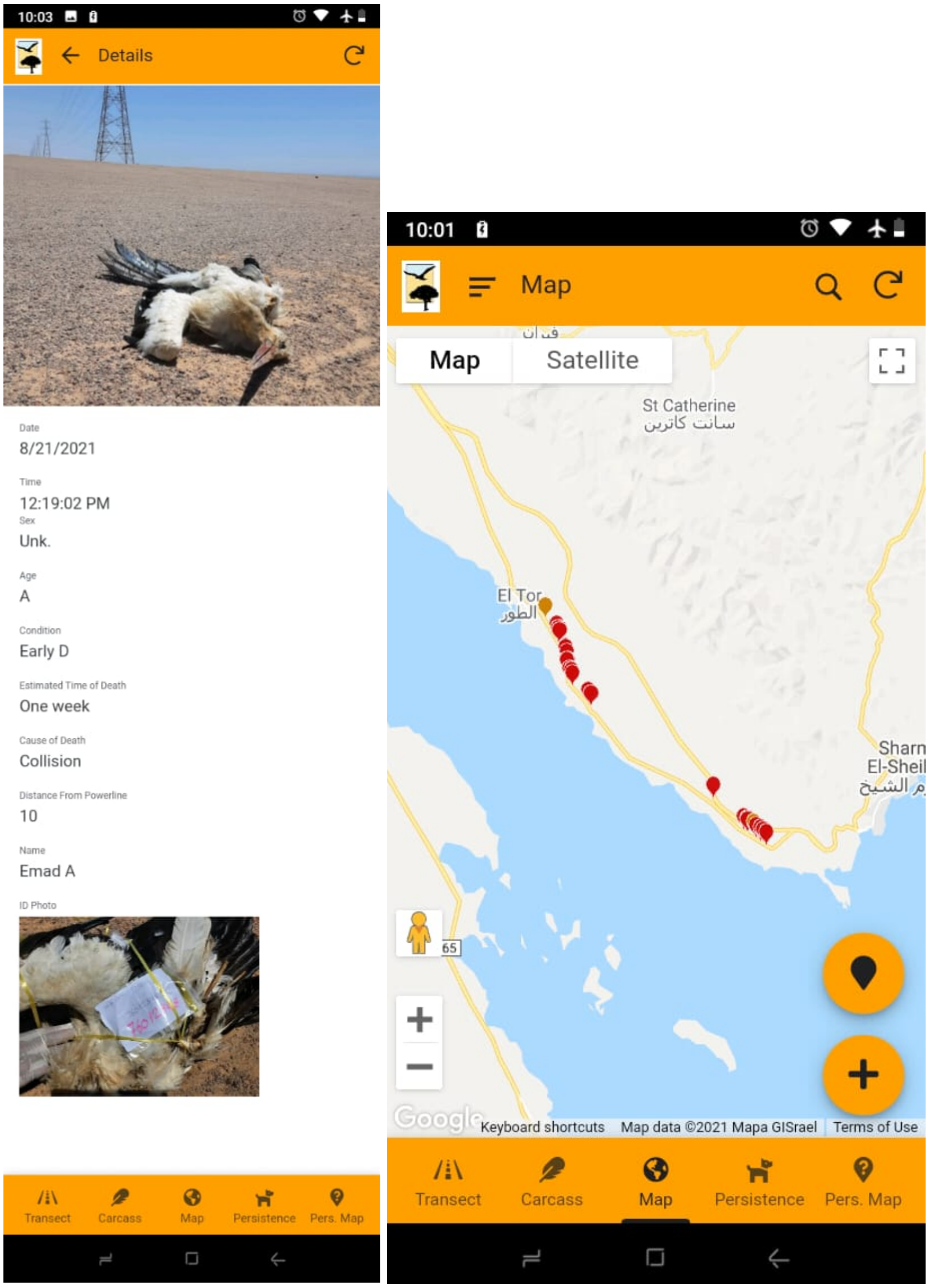


Figure 21 Screen shots from the NCE Bird Fatality Monitoring App, showing the data entry screen plus a screen of all the carcasses found (until 30 August 2021).

Figure 22. Documentation of bird carcass under the El Tor – Sharm power line

Carcass persistence

Carcass persistence simply means the length of time a carcass remains in-situ before it is consumed by scavengers and detritivores. Finding out the carcass removal rate is important when estimating mortality rates from power lines. Carcass removal rate is influenced by the presence and density of potential scavengers in the environment.

Estimating bird mortality from OHTLs is mainly carried out by carcass searches on the ground below the power lines. However, a high proportion of the birds killed may not be found during these surveys, leading to an underestimation of mortality. Four aspects can contribute to underestimating this mortality: (1) the removal by scavengers of carcasses, (2) the difficulty for observers to detect carcasses, (3) the accessibility of sites under power lines, and (4) the escape of wounded birds that die outside the search area, that is (Borner et al 2017). Due to these challenges, the calculation of true strike or electrocution rates is not easy to achieve (Bevanger 1999).

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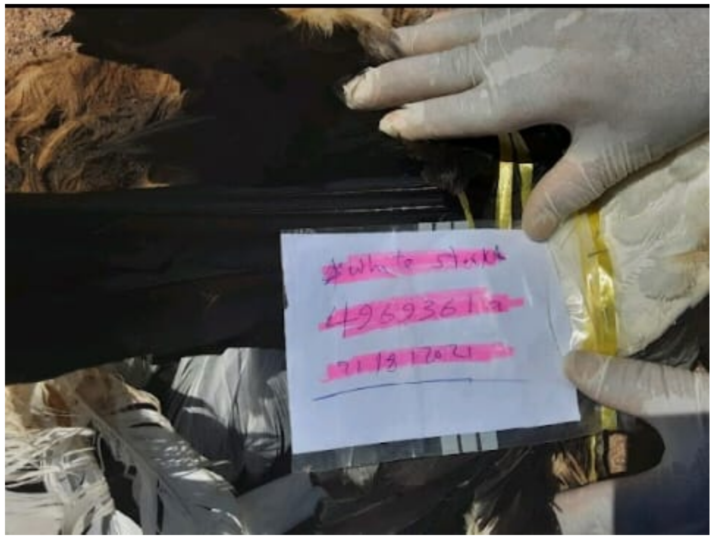

Figure 23 Carcass marking and tagging. Note unique serial number given to each carcass

Carcass persistence estimation protocols

In order to improve our understanding of carcass persistence in the Egyptian context it is important to build a removal rate profile for various regions of the country. For this purpose it is recommended to use any carcasses found during carcass surveys in monitoring removal and degradation rates of these carcasses in situ.

Any carcass found should be marked, tagged and given a distinct serial number (generated by the NCE Fatality app.) to help track their fate, reduce confusion and double counting during follow up surveys. On subsequent surveys of the of power line old carcasses are searched for according to their original location and condition, within a radius of about 50 meters from original locality. The status of the carcass is accordingly updated, if found the date and any changes in location (in relation to the original location) and condition of the carcass are noted. If not found then the date is noted and the carcass is identified as scavenged.

Bird fragments (bones and feathers) remains should be noted in initial surveys, but should be preferably removed to avoid recounting in subsequent visits. These fragments are not useful in estimating scavenging rates.

Carcass persistence in the Egyptian context

Generally speaking the number of scavengers in hyper arid environments, such as is the case over much of Egypt, is small to very small. Thus, it is anticipated that carcass removal would be fairly low over much of the country; i.e. having high carcass persistence. The main

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scavengers in the Egyptian environment are composed primarily of foxes and feral dogs; which have the capacity to roam widely in search of food items. In one case the Arabian Wolf *Canis lupes arabs* was documented scavenging dead white storks below a wireless transmitter antenna at Ras Mohammed, where tens of storks succumb every autumn (Marwan Aweigen, pers. com.). There are also documented incidents of Egyptian Vulture and Steppe Eagles scavenging on dead White Storks near Sharm El Sheikh wastewater treatment plant (Ismail Hatab,pers. com.).

Figure 24 Arabian Wolf *Canis lupes arabs* found feeding on dead white storks below a wireless antenna at Ras Mohammed, where tens of storks die every autumn (circa 2010, Marwan Aweigen, pers. com.).

Over longer periods carcasses usually deteriorate and get broken down by detritivores, however the very dry and hot climate of the Egyptian deserts slows down this process through desiccation. Thus, many carcasses get mummified and remain intact for a long period, before breaking up. Other factors that may lead to carcass removal from the immediate vicinity of the power lines includes strong wind that can blow carcasses and feathers away from the study transect.

DeVault, et al (2017) found that the use of surrogate species (such as use of chicken) to estimate carcass removal rates might distort casualty levels, as chicken carcass removal rates were significantly higher than that for raptors. Thus, it is recommended that only carcasses of birds found in situ should be used for the monitoring and assessment of carcass removal rates. This is the approach currently used in Egyptian trials.

In Egypt persistence trials for birds carcasses have been carried out in wind farms at Gebel El Zeit for several years now, showing an average carcass stay of between 14.7 and 24.7 days for large migratory soaring birds, while the value for a small bird was only 2 days (NREA 2019).

Most recently, results for 2021, were comparable with a removal rate of 2.17 days for small birds and 17.55 days for larger soaring birds (MSB project public presentation 2021).

The assumption that the same removal rate as that witnessed in Gebel El Zeit area could be applied else where is probably not accurate. It is most likely that carcass persistence will vary greatly by location and the nature of adjacent habitat and its fauna. In the South Sinai side of the Gulf of Suez persistence was much lower than the western side of the Gulf of Suez (NCE unpublished data from 2021). Carcass predation is likely to be higher in regions with more rainfall and or vegetation, like near the Nile Valley and in South Sinai where scavengers would be found naturally in greater numbers.

However, as a general rule making carcass surveys on a weekly basis probably provides a reasonable sampling level over much of the Egyptian territory to provide a fairly accurate picture of mortality rates at both power lines and wind turbines. This can be increased to 10 days or even 2 weeks if persistence tests indicate so.

Observer efficiency in finding bird carcasses

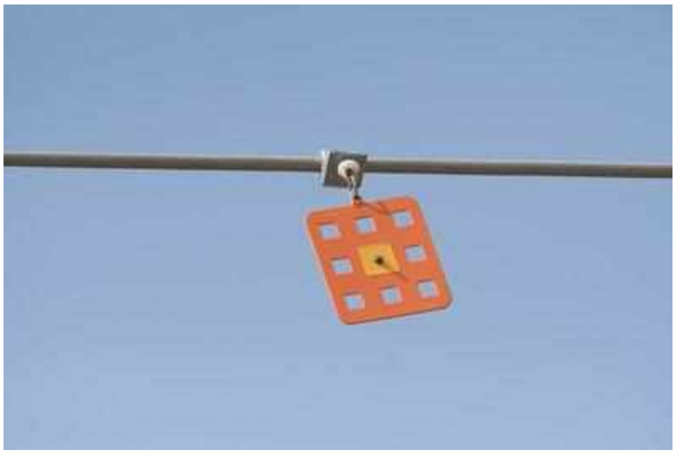
Carcass detection is also dependent on habitat complexity, vegetation cover, soil colour and species size. In less arid environments detection rates for large species ranged between 47% and 55.8%, and between 7% and 33.3% for small sized species (Borner et al (2017) and Ponce et al. (2010). While NREA (2019) estimated that observer efficiency in finding carcasses in Gebel El Zeit area was around 95% for large soaring birds, and 89% for small Passerines size. However, these estimates were all based on more intensive walking transects. Driving transects are likely to be much less efficient in detecting casualties, particularly smaller species. If we apply a precautionary approach, our casualty detection efficiency could reach half that of the walking transects implemented at Gebel El Zeit. Also given the strong winds in much of our region, its likely that many casualties are blown far away from the immediate impact with power lines, which would also be an important factor in reduced casualty detection.

Further more, observer efficiency from moving vehicle needs to be established for various habitats in Egypt, in order to accurately compensate for the likely lower detection capacity from vehicles.

8 Mitigation measures for existing and future OHTL

Mitigation measures can be introduced to reduce casualties from existing OHTLs at high risk location, but usually not on a very large scale. Mitigation measures for collision reduction are centred largely around making OHTLs more visible at critical sites. These measures include types of shinny flippers that rotate with wind, or brightly coloured balls or flags , placed on OHTLs in order to alert birds to their existence.

In some highly critical locations there could be justification for the moving of OHTLs or even moving them under ground. One example of this the local distribution low voltage power line north of Ras Shukheir, which is less than 10 km long, but causes constant casualties every year.



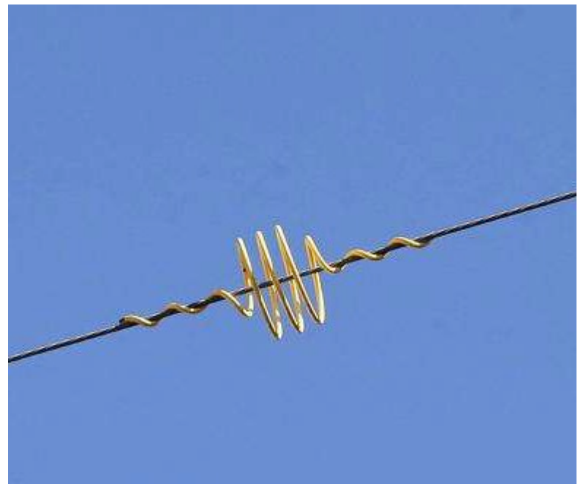


Figure 25 Examples of visual markers that can be placed on OHTL to alert birds to the presence of power lines and help reduce potential collision risks.

For risks from electrocution insulating covers can be placed on high risk locations or pylon designs, that present a significant risk to birds. These covers either shield the short conductors, or the length of power line where a potential short between the bird and live line can occur and are mostly applicable to small distribution lines.

Figure 26 Example of insulator that can be fitted on the most widespread distribution power lines in Egypt, which cause the greatest number of electrocutions.

9 Offsetting the impacts of OHTLs on birds

Biodiversity offsets are applied as a final step in the mitigation hierarchy (avoid, reduce, mitigate and offset). They aim at achieving a zero net loss to biodiversity. Offsets are often used when losses of biodiversity at one location are unavoidable, but are then compensated for with conservation actions elsewhere, which benefits the same biota and renders the net loss null, or even in positive territory.

This concept is perfectly suitable for large-scale infrastructure, such as OHTL networks, which might cause significant (and long term) damage to bird populations, and are extremely difficult to retrospectively adjust to reduce or eliminate the damage they cause.

The avian OHTL offset system would work by applying a monetary value to bird mortality per kilometre of existing OHTLs , after all potential mitigation measures have been applied; thus this bird mortality would be described as residual.

The funds generated would be used in conservation actions in other locations within Egypt to help reduce bird mortality (of the same species, mostly migratory soaring birds in this case). Examples could include improving water quality at waste water treatment plants (where many MSBs are known to succumb), or better enforcement of hunting management measures to prevent the hunting of these birds.

The value applied to the casualties would need to be carefully calculated using the Biodiversity Offset tools, which would include the cost for saving a similar number of birds of the same species in Egypt, the conservation status of the species and the rate of casualties per kilometre of OHTL.

The biodiversity offset value is calculated by assessing the cost of the off-site remedies that would lead to the preservation or restoration of an equivalent number of individuals of the same species (of the same conservation status,) to that which has been impacted by a specific length of OHTL, leading to zero loss of biodiversity.

This process can be complex .

The results of detailed monitoring surveys of OHTL avian casualties would be needed to establish a rigorous basis for the offset valuation. The avian OHTL offset system would include a carefully designed monitoring and evaluation component to constantly assess the effectiveness of conservation measures in achieving the zero loss to biodiversity objective.

10 Recommended steps to strengthen national capacity

Capacity is needed at three levels to facilitate the EIA process for OHTLs; within the main regulatory bodies the EEAA / NCS / EIA Department; the EETC; and finally within the consulting / scientific community.

There is some reasonable capacity within the EEAA, but this is limited in number and over stretched. There is certainly a need to supplement the current staff with additional capacity in order to facilitate more effective follow up and monitoring of OHTL developments. It is recommended that the EIA Department also increase its capacity in this area.

Within the EETC, it is strongly recommended that some resident ornithological capacity is acquired, which would facilitate better handling of the various avian issues associated with OHTLs.

Thanks to the wind energy industry, over the past decade a very capable national capacity in bird monitoring has evolved; although the numbers is still small given the high demand from the renewable energy sector for these individuals. The OHTL sector is anticipated to also have some sizable need for experienced ornithologists to conduct field monitoring and risk evaluation.

Pre-construction monitoring would require highly experienced individuals similar to those involved in monitoring and Shut-down-on-demand in the wind energy sector; with the same set of skills.

For post-construction monitoring individuals with lesser experience are required (for carcass searches).

For implementation and maintenance of mitigation measures there will be a need for limited but highly specialized experts that can manage these measures.

The Centre of Excellence at Gebel El Zeit is in a good position to develop future needed capacity, combined with the efforts of NCE working at the grass roots to engage fresh hands to get into post-construction carcass monitoring .

Carcass surveys are excellent entry points into bird monitoring at large, as it is relatively low skilled . Individual involved in carcass surveys can then qualify to start training at the Centre of Excellence and eventually be certified as a bird monitor, whoso services can be approved by the EEAA and other agencies. The details of this training and certification process is currently under development (the Migratory Soaring Birds Project UNDP/EEAA).

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