ANNEX 5.2

Final Report

on the Ornithological Investigation

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Final Report on the Ornithological Investigation at the West Nile Valley in Arab Republic of Egypt

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0 Summary

In November 2009 the Japan International Cooperation Agency ("JICA") and the New and Renewable Energy Authority of Egypt ("NREA") agreed to conduct a preparatory survey for the West Nile Valley Wind Farm Project, located to the northwest of Minya. The aims of the preparatory survey are to assess the project are and to identify the most promising area for a 200 MW wind farm, while considering other wind farms that may be proposed by the GoE in that area.

It is well known that construction and operation of large wind farms may lead to significant impacts on migrating birds caused by collisions with turbines or, to a lower degree, by barrier effects. Since there is no comprehensive understanding on the amount and the spatial distribution of migratory activity in the West Nile Valley an ornithological investigation was realized during autumn 2011 and spring 2012. The main objectives of the investigation was to collect significant baseline data on migrating birds, to describe migration patterns of relevant species, to identify and assess possible impacts, to prioritise areas for wind energy utilization, to propose criteria for selection of a site with the lowest impact on migrating birds and finally to recommend mitigation measures in order to minimize possible conflicts, if required.

A total 1,015 hours of standardized observation were carried out in autumn 2011 and about 965 hours in spring 2012. Observations took place from 32 sites in autumn and 30 sites in spring. Observation sites were distributed over the project area in a way that the major parts of the area were covered by observations. The project area has a size about 3,600 km² and extends about 97 km in length being about 54 km broad in the north and 33 km in the south. As some observation sites were located outside the project area, the study area exceeds the project area in the west and in the east.

Migratory activity in the study area was extremely low. In autumn 2011 65 individuals of 13 relevant species and in spring 2012 57 birds of 12 relevant species were recorded in the study area during standardized observation. Thus, overall migratory activity was 0.06 birds per hour in autumn and in spring. In comparison, at the western coast of the Red Sea migratory activity ranged between 32 and 158 birds per hour, total number of birds between 4,582 and 177,516.

An analysis of spatial distribution of bird migration within the study area reveals no distinctive patterns. Migratory activity was extremely low at all observation sites. There are no particular structures in the study area, which may serve as landmarks and may be important for orientation of migrating birds or which may offer good thermal uplifts.

Due to the very small number of recorded birds statistical evaluations are based on a small data basis. As a consequence, interpretations *e.g.* of spatial or temporal distribution of bird migration are subject to a high level of uncertainty.

Summing up, the importance of the study area for migrating soaring and gliding birds in Egypt has to be assessed as very low (it may have a general importance for migration of Blue-cheeked Bee-eaters in spring).

The local bird community was very poor in species and, moreover, bird density in the study area was very low. Furthermore, the study area was not a preferred roosting site for migrating birds. Only the vegetated areas in the oasis and larger wadis may have an importance for local and roosting birds on a local scale.

Due to the extremely low migratory activity of relevant species collision risk by operational wind turbines is not assumed to pose a major threat. Rare collisions at wind turbines within the study area cannot be excluded, but the expected collision rate will surely not cause significant effects on populations. In addition, a possible barrier effect of wind farms will not cause notable risk potential for the populations of relevant species. Establishing wind farms in the study area will not entail a noticeable risk potential for bird migration in autumn and spring. Consequently, regarding conservation of migrating birds, there is no need for spatial restrictions. Based on the results of the ornithological investigation the whole project area is equally suitable for wind power development with equally low presence of endangered birds.

The expected impact of wind farms within the project area on local or roosting birds was assessed as to be not significant and, hence, acceptable. However, the oasis and the larger wadis with their small patches of vegetation form specific elements in the desert and might be used as foraging and hunting sites for local and roosting birds. In order to minimize impacts, constructional works in the oasis and the larger wadis shall be minimized.

There is no need for implementing particular mitigation measures. Nevertheless, to minimize possible impacts on migrating and roosting birds, turbines with lattice towers and establishing areas that may attract migrating birds should be avoided. Moreover, if lighting of turbines is required due to aviation or any other legal requirements, the minimum number of intermittent flashing white light of lowest effective intensity should be used.

1 Introduction

1.1 Background and Aim of the Report

In November 2009 the Japan International Cooperation Agency ("JICA") and the New and Renewable Energy Authority of Egypt ("NREA") agreed to conduct a preparatory survey for the West Nile Valley Wind Farm Project in the West Nile Valley area, located to the northwest of Minya. The aims of the preparatory survey are to assess the 4,200 km² area — allocated by the Government of Egypt ("GoE") under the presidential decree for possible wind power utilization — and to identify the most promising area for a 200 MW wind farm, while considering other wind farms that may be proposed by the GoE in that area.

Installing large wind farms at the western bank of the Nile Valley may lead to significant impacts on migrating birds caused by collisions with turbines or, to a lower degree, by barrier effects. Since there is no comprehensive knowledge on the spatial distribution and number of migrating birds at the western bank of the Nile Valley, an ornithological investigation was regarded as crucial for the preparatory survey.

In autumn 2011 and spring 2012 bird migration was studied at the western bank of the Nile Valley by standardized observations. The main objectives of this ornithological investigation was to

- collect significant baseline data on migrating birds in autumn and in spring (mainly soaring and gliding species migrating during the day)
- describe migration patterns of relevant species in a quantitative way
- identify and assess possible impacts regarding development of wind power within the study area
- prioritise areas for wind energy utilization according to the level of significance of likely impacts on birds
- propose criteria for selection of a site with the lowest impact on migrating birds
- and finally recommend mitigation measures in order to minimize possible conflicts, if required

1.2 Project Area

The area suggested for wind farm development (project area) is located about 30 km west of the Nile Valley and has a size of about 3,600 km^2 (see Annex I), considering that about 600 km^2 of the original project area is not suitable for wind power utilization due to tip height restrictions. The area extends about 97 km in length from North to South, its width in the North being about 54 km and in the South about 33 km. The project area itself consists of dry desert (gravely and pebbly plains) and is almost completely without vegetation. Only in the larger wadis some scrub and / or desert grasses exist. In the middle of the project area a small "oasis" was found with a shallow body of water during site visits in January 2011. Most parts of the area are very uniform and rather flat or wavy (between 100 and 140 m asl). The northern part of the project area is more complex: groups of smaller hills (*e.g.* a group of dark hills called the "Black Continent") and elevated areas (between 150 and 190 m asl) can be found there. Moreover, large sand dunes can be found in the north-eastern part of the project area.

Different mining areas exist in the northern part of the project area; a smaller mining area is situated south of observation site A06. A 132 kV power line runs through the middle of the project area from Southeast to Northwest. Irrigation agriculture exists in the very south and at the eastern border in the middle part of the project area. The desert is nerved by tracks which were mainly made by 4-wheeled cars from Bedouins and rally cars.

Figure 1: The study area consists of dry desert nearly complete without vegetation (© Eike Eissing)

Figure 2: Montagu's Harrier migrating through the study area at one of the few existing vegetated areas (© Philipp Böning)

2 Methods

2.1 Data Collection

2.1.1 Standardized daytime field observations

Between 10th August and 28th October 2011 (autumn migration) as well as between 01th March and 18th May 2012 (spring migration) standardized daytime field observations were carried out. Thus, the study covers the main migration periods of relevant species (LESHEM & YOM-TOV 1996, BERGEN 2009).

In general the study design was similar to the ones which were used during investigations at the Red Sea (*e.g.* BERGEN 2009): using fixed observation sites. Observations were carried out by three teams - each with two ornithologists- under guidance of a chief ornithologist, who advised and supervised the ornithologists.

With regard to the extent of the project area, between 30 (spring migration) and 32 (autumn migration) observation sites were selected in order to obtain a representative sample of migration within and outside the project area. In autumn 2011 and spring 2012 three rows from west to east (perpendicular to the expected main flight direction of migrating birds) were established with ten observation sites each (see Annex I):

- row A in the north, observation sites A1 to A10 in autumn and spring
- row B in the middle, observation sites B1 to B10 in autumns and spring
- row C in the south, observation sites C1 to C10 in autumn
- row D in the very south, observation sites D1 to D10 in spring

The average distance between observations sites within a row was about 6 km, the distance between rows was between 12 and 30 km. A rather small distance between sites (located from west to east) and a rather large distance between rows (located from north to south) was chosen, because the main flight direction of migrating birds was expected to be from north to south in autumn and from south to north in spring, respectively. Consequently, migratory activities in the north and in the south were believed to be comparable enabling interpolation of data obtained at the three lines to areas without observations. By contrast, migratory activities in the eastern parts of the study area (located near the Nile Valley) and in the western parts (located in the western desert) were not believed to be generally comparable requiring a higher density of observation sites within a row.

In the north the study area extends about 54 km in width. Consequently, ten observation sites from west to east were necessary to cover the whole study area. This “ten sites”-approach was used in the middle and the south of the project area, too, enabling a standardized data analysis of spatial distribution of migratory activity. As the study area is smaller in the middle and in the south some observation sites were located outside the project area. So the study area exceeds the project area in the west and in the east (study area = project area and adjacent areas covered by observations).

Since it was very difficult to reach the far north and, thus, the required time to get to the north-western part of the project area would have been very long, only two additional observation sites were selected in the very north (called X5 and X7) for observations in autumn when migrating birds were believed to approach the study area in the north.

During autumn and spring each of the three teams made standardized daytime field observation for five hours. In autumn 2011 we used the observation sites on row A, B and C. 30 observation sites were visited regularly for one hour of observation (twice in a period of four days; see Table 1). Observations were carried out more or less simultaneously at the three corresponding observation sites by three teams with two ornithologists each. Every fifth day the additional observation sites (X5 and X7) in the far north were visited - each for a period of 2.5 hours. More or less at the same time the observation sites A5 and A7 as well as B5 and B7 were visited (each for 2.5 hours, too) leading to a higher total observation time at A5, A7, B5 and B7 compared to other sites (see Table 2).

In spring 2012 the schedule of standardized daytime field observations differed. We visited 30 observation sites at row A, B and D simultaneously for one hour twice in a period of four days (as in autumn 2011; see Table 1). In spring, when migrating birds were believed to approach the study area in the south, observations in the very north (at sites X5 and X7) were regarded as dispensable. Thus, no observations were carried out at sites X5 and X7 and all observations lasted 1.0 hour

As shown by earlier studies (i.e. BERGEN 2009), migratory activity is low in the early morning (within two hours after sunrise) and in the late afternoon (within two hours before sunset). Furthermore, in the early morning and in the late afternoon, bird migration is dominated by species which are more or less active flyers and thus do not depend on thermal uplifts (mainly Harriers). These species are not believed to be particularly vulnerable to collision. Consequently observations focused on the daily period within two hours after sunrise and two hours before sunset. Thus it was ensured that a high proportion of gliding and soaring birds were recorded which passed the study area during autumn and spring migration.

A rotation schedule was set up, enabling different sites within the study area being visited within different periods of the day (see Table 1), which lead to a representative distribution of spatial and temporal observation samples. Observations started at a fixed time in the morning and ended at a fixed time in the afternoon.

Standardized daytime field observations were not restricted to a particular distance from each observation site. As known from earlier studies many birds or -at least- flocks of migrating birds can be recorded and safely identified at distances of up to 5 km (in some cases even up to 20 km). Nevertheless, data will be prone to lose precision with increasing distance to the observer. In order to ensure a standardised recording and a safe identification of soaring and gliding birds, the analysis was restricted to birds migrating at distances of up to 2.5 km from each observation site. Thus, the obtained data set has a very high accuracy regarding species identification and estimation of numbers of birds as well as flight altitudes and flight directions.

Table 1: Schematic rotation schedule for observations at different sites and periods of the day within the study area

day of observation	team	autumn 2011 1 h intervals of 5 h observation period of 1 day					spring 2012				
		1 st hour	2 nd hour	3 rd hour	4 th hour	5 th hour	1 st hour	2 nd hour	3 rd hour	4 th hour	5 th hour
1st day	A	A1	A2	A3	A4	A5	A1	A2	A3	A4	A5
	B	B1	B2	B3	B4	B5	B1	B2	B3	B4	B5
	C	C1	C2	C3	C4	C5	D1	D2	D3	D4	D5
2 nd day	A	A6	A7	A8	A9	A10	A6	A7	A8	A9	A10
	B	B6	B7	B8	B9	B10	B6	B7	B8	B9	B10
	C	C6	C7	C8	C9	C10	D6	D7	D8	D9	D10
3 rd day	A	A5	A4	A3	A2	A1	A5	A4	A3	A2	A1
	B	B5	B4	B3	B2	B1	B5	B4	B3	B2	B1
	C	C5	C4	C3	C2	C1	D5	D4	D3	D2	D1
4 th day	A	A10	A9	A8	A7	A6	A10	A9	A8	A7	A6
	B	B10	B9	B8	B7	B6	B10	B9	B8	B7	B6
	C	C10	C9	C8	C7	C6	D10	D9	D8	D7	D6
5 th day	A	A5	A5	A5 A7	A7	A7	see 1st day				
	B	B5	B5	B5 B7	B7	B7					
	X	X5	X5	X5 X7	X7	X7					
6 th day		see 1st day					see 2nd day				
7 th day		see 2nd day					see 3rd day				
8 th day		see 3rd day					see 4th day				
9 th day		see 4th day					see 1st day				
10 th day	A	A5	A5	A5 A7	A7	A7	see 2nd day				
	B	B5	B5	B5 B7	B7	B7					
	X	X5	X5	X5 X7	X7	X7					
11 th day		see 1st day					see 3rd day				
...		...					...				

During an observation unit (lasting one or 2.5 hours) the field ornithologists "scanned" the horizon by binoculars with 8-10 times magnification as well as by telescopes with 20-60 times magnification. Once a bird or a flock of birds was detected, the following variables were determined:

- kind of species
- number of birds
- distance and direction to the observation site

  We identified the geographic coordinates of higher structures (hill tops) or conspicuous elements (*e.g.* single trees, power line pylons, further elements in the desert) by GPS and calculated the distances to each observation site. Moreover, the 2,500 m-circumference as well as other conspicuous elements were marked by poles with attached red flags that made these poles highly visible. This enabled us to estimate the distance of birds fairly accurately. Distance was estimated in steps of 500 m (up to a distance of 5 km). For greater distances we only used two classes: >5 km – 10 km and >10 km.

Furthermore, we immediately listed whether a bird or flock entered the study area or not.

- altitude

  We estimated minimum and maximum altitudes of birds / flocks above ground using four altitude classes: 1) 0 – 50 m, 2) >50 – 100, 3) >100 - 200 m, 4) >200 - 300 m and 4) >300 m above ground
- flight direction

  Flight direction was estimated using eight classes (with an extension of 45° each): 1) north-northeast (NNE), 2) east-northeast (ENE), 3) east-southeast, ...
- time of record

In the beginning and the end of an observation unit we measured climatic conditions (temperature, wind speed (Bft) and wind direction using eight classes (see above), cloud cover (in %)) and visibility. When climatic conditions changed substantially during an observation unit, measuring was repeated.

Whenever resting or sedentary birds were noticed during standard observation or while travelling through the study area they were recorded (species, number of birds, location).

All variables and further information were recorded on a standard form and transferred to database afterwards.

Standard daytime field observations focused on species which can be regarded as especially vulnerable to collision strikes or other negative impacts caused by wind turbines: these are mainly large birds (first of all, raptors, storks and pelicans) which principally migrate by soaring and gliding during daytime. Soaring and gliding birds seem to be especially vulnerable because of their restricted flight agility. Furthermore, populations of these long-lived species are susceptible to any additional cause of mortality because their rate of annual off-spring is so low (Drewitt & Langston 2006). Small migrating birds (passerines) were not recorded in a systematic way.

Several of the species that are relevant when assessing impacts of wind farms are of international conservation concern (see Annex II). Five species generally are of special interest within the impact assessment as they have an unfavourable conservation status according to the IUCN Red List of Threatened Species (IUCN 2004; see Annex II & III): Egyptian Vulture (*Neophron percnopterus*, Endangered), Greater Spotted Eagle (*Aquila clanga*) and Eastern Imperial Eagle (*Aquila heliacal*; both Vulnerable), as well as Pallid Harrier (*Circus macrourus*) and Red-footed Falcon (*Falco vespertinus*; both Near Threatened).

2.2 Data Analysis

2.2.1 Observational Time

The analysis comprises 904 observation units in autumn 2011 and 964 observation units in spring 2012 (Table 2).

Table 2: Number of observation units and time spent at each site in autumn 2011 and spring 2012. (in autumn rows A, B and C and sites X5 and X7, in spring rows A, B and D were visited)

autumn 2011			spring 2012		
observation site	observation units	observation hours	observation site	observation units	observation hours
A1	28.0	28.0	A1	33.0	33.0
A2	28.0	28.0	A2	31.0	31.0
A3	28.0	28.0	A3	31.0	31.0
A4	28.0	28.0	A4	31.0	31.0
A5	40.0	58.0	A5	31.0	31.0
A6	28.0	28.0	A6	32.0	32.3
A7	40.0	58.0	A7	32.0	31.8
A8	28.0	28.0	A8	32.0	32.0
A9	28.0	28.0	A9	32.0	31.9
A10	28.0	28.0	A10	32.0	31.9
A1-A10	304.0	340.0	A1-A10	317.0	317.0
B1	27	27.0	B1	34.0	34.2
B2	27	27.0	B2	34.0	34.0
B3	27	27.0	B3	33.0	33.0
B4	28	29.5	B4	33.0	33.0
B5	40	59.5	B5	33.0	33.0
B6	28	28.0	B6	33.0	33.0
B7	40	58.0	B7	33.0	33.0
B8	28	28.0	B8	33.0	33.0
B9	28	28.0	B9	33.0	33.0
B10	28	28.0	B10	32.0	32.0
B1-B10	301	340	B1-B10	331.0	331.2
C1	27.0	27.0	D1	33.0	33.0
C2	27.0	27.0	D2	32.0	32.0
C3	27.0	27.0	D3	31.0	31.0
C4	27.0	27.0	D4	31.0	31.0
C5	27.0	27.0	D5	31.0	31.0
C6	28.0	28.0	D6	32.0	32.0
C7	28.0	28.0	D7	32.0	32.0
C8	28.0	28.0	D8	31.0	31.0
C9	28.0	28.0	D9	32.0	33.0
C10	28.0	28.0	D10	31.0	31.0
C1-C10	275.0	275.0	D1-D10	316.0	317
X5	12	30.0	-	-	-
X7	12	30.0	-	-	-
X5 & X7	24	60	-	-	-

The total observational time amounts to 1,015 hours in autumn 2011 and 965 hours in spring 2012. In the majority of observation units synchronized observation took place. In autumn 2011 1 % and in spring 2012 6 % of the observation units were not synchronized due to car damages, sandstorms or other problems.

2.2.2 Standardized daytime field observations

Due to the very small number of recorded birds statistical evaluations are based on a small data basis. As a consequence, interpretations *e.g.* of spatial or temporal distribution of bird migration are subject to a high level of uncertainty.

Birds and records as well as weather data within observation units which were cancelled, e. g. because of a sandstorm, were not used in the analysis.

Wind speed and wind direction during standardized daytime field observations

Within the weather variables wind speed and wind direction are supposed to have the biggest effect on bird migration in Egypt. For each observation unit we averaged the wind speed, which was measured in the beginning and in the end. Afterwards we built three classes for wind speed:

- low wind speed: 0 to 2 Bft
- medium wind speed: > 2 to 4 Bft
- high wind speed: ≥ 4 Bft

Wind direction was reclassified into north (NNW, NNE), west (WNW, WSW), south (SSW, SSE) and east (ENE, ESE).

If the wind direction was similar in the beginning and the end of an observation unit we used this certain wind direction. When the wind direction differed it was classified as "changing".
Since the sample size of migrating birds was very low, we did not analyse if wind speed and wind direction had an effect on bird migration in the study area.

Number of migrating birds and species composition

In order to characterize bird migration, we calculated the total number of birds for each relevant species. Furthermore, we used the number of records as a further variable to describe migration patterns. A single record can either be an individual or a flock (independent of the number of birds). The number of records is an important variable because it is not influenced by flock size. In contrast, a single but large flock has a strong effect on the variable "number of birds". Therefore, the number of records gives additional information about migratory activity and continuity as well as on species-specific migration behaviour.

To ensure that none of the recorded birds were double counted during the synchronized observations we checked the dataset for possible double counts. Both in autumn 2011 and in spring 2012 one individual was possibly double counted. Since we could not exclude, that these were different individuals (and bearing in mind that these are only two birds) double counts were neglected in the analysis.

European Bee-eater (*Merops apiaster*) and Blue-cheeked Bee-eater (*Merops persicus*) are generally not regarded as relevant species, because they are active flyers which do not very much dependent on thermals uplifts. Consequently, both species are not expected to be particularly vulnerable to collisions with wind turbines. As Bee-eaters were the most common species (aside from small songbirds) the main results are also presented in Chapter 3.

Bee-eaters were mostly recorded acoustically by their flight calls. So, it was not possible to calculate the accurate number of birds. Similarly, once a flock of Common Cranes (*Grus grus*) was only heard and hence no number of birds was determined. For these species we used the number of flocks to describe migratory activity.

<u>Seasonal distribution of migratory activity</u>

To identify main migration periods we calculated the cumulative number of birds / records / flocks over time. By summing up the number of birds / records / flocks for every week during the study periods we calculated a weekly migratory activity. Different observational time during the weeks was corrected by calculating the number of birds for the minimum observation time of all weeks during autumn 2011 and spring 2012. In the last week of the spring migration period, observation time lasted 30 hours, which was found to be the minimum observation time per week during autumn and spring. Thus number birds / records / flocks per week were recalculated for 30 hours observational time.

<u>Daily distribution of migratory activity</u>

In order to analyse possible changes in migratory activity during the day, we calculated the relative frequency of all birds / records within observation units carried out during different times of the day. We summed up all birds / records in the 1st to 5th interval of the observation period of one day (see Table 1). Afterwards the results were summed up within the intervals for autumn 2011 and spring 2012.

In autumn 2011 some observation units lasted regularly 2.5 h (Table 1). Furthermore a very small number of observation units lasted longer than one hour due to car or other problems. Thereby birds / records cannot be related to one of the five periods of one day. So these observation units were excluded from the analysis.

To correct for temporal differences between the intervals we used the minimum observation time from the intervals during autumn and spring for standardization. The minimum observational time per interval was 166 hours in autumn 2011. To be able to compare the data within the intervals we recalculated the number of birds / records within the intervals for an observation time of 166 hours.

Altitude of migration

Regarding possible impacts of wind turbines on bird migration, flight altitude is a very important variable. Therefore, for each altitude class (see above) we summed up the total number of birds.

Spatial comparison of migratory activity

To analyse possible spatial differences we compared the total number of birds / records observed at the two westernmost (1 & 2), two central (5 & 6) and two easternmost observation sites (9, 10). The observational time differed between those groups of observation sites (for a detailed presentation of birds per observation site see Annex IV-C & V-C). To make the number of birds / records between these groups comparable we corrected for different observational time. Therefore we used the minimum observational time of these groups. We recalculated the number of birds / records for the minimum observational time of all three groups during autumn 2011 and spring 2012. In autumn and spring migration number of birds / records was recalculated for 82 hours.

Flight direction of migrating birds

We reclassified the flight direction into north, west, south and east as in the analysis for wind direction. Afterwards we summed up the number of individuals per flight direction.

Comparison of migration obtained by the recent and the previous studies

To determine whether migration was comparable to previous studies and to assess the significance of the study area for bird migration, we compared migratory activity and total number of birds for autumn and spring migration with data from the Red Sea, where similar studies were carried out between 2006 and 2010 (*e. g.* Bergen 2007a, 2009, 2011).

2.2.3 Non standardized observations of migrating resting and sedentary relevant and non-relevant birds

Observations of migrating, resting and sedentary birds were separated from the standard data set, as far as these birds were not observed in active migration during standardized daytime field observations (before or after resting) and belonged to the group of the relevant species. These observations were mainly made while driving through the desert. Furthermore migrating passerines were noted down during standardized daytime field observations.

In addition to the results of the standardized data set the occurrence of relevant species, sedentary birds and the most frequent non-relevant birds are also presented in Chapter 3.

3 Results

3.1 Wind speed & wind direction

In autumn 2011 and spring 2012 medium wind speed from northern directions was dominant (Fig. 3 & 4). The number of observation units with low and high wind speeds was more or less comparable. In comparison to autumn 2011, high wind speeds were recorded more often in the study area in spring 2012.

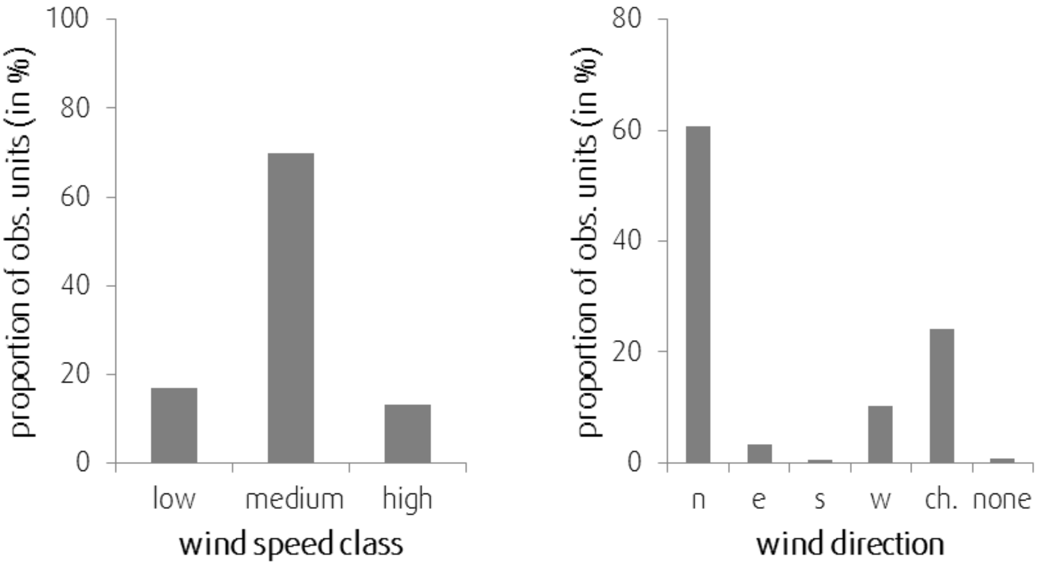

Figure 3: Wind speed (left) and wind driection (right) in autumn 2011 in the study area

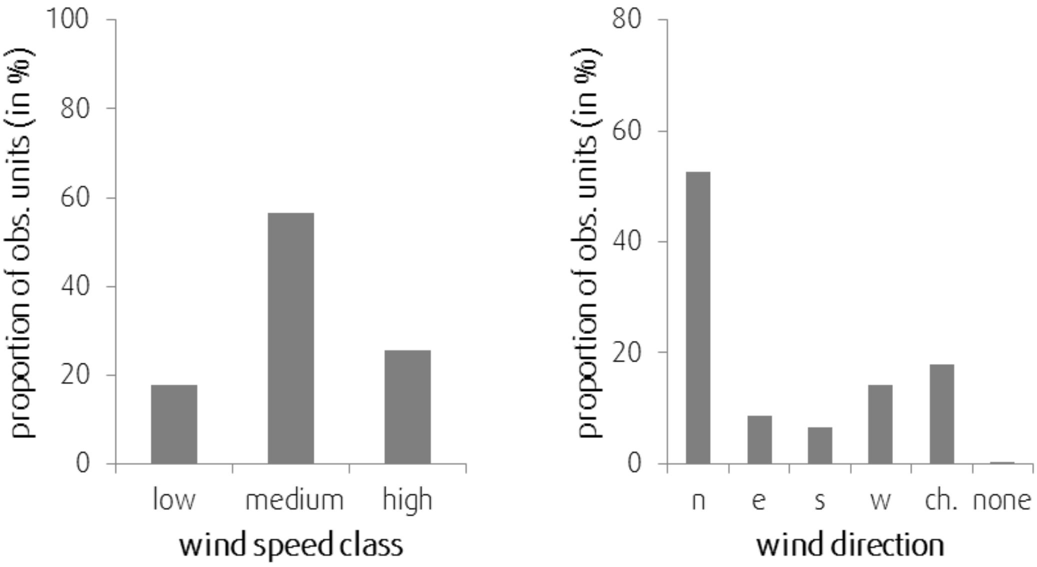

Figure 4: Wind speed (left) and wind direction (right) in spring 2012 in the study area (ch.= changing)

3.2 Bird Migration

3.2.1 Standardized Daytime Field Observations

Number of migrating birds, species composition and flock size

During standardized field observations in autumn 2011, a total of 65 birds from 13 relevant species were recorded within distances of up to 2.5 km from the observation sites (Table 3). In most cases single birds were recorded. Only few records of small flocks with up to five individuals exist.

Species composition is more or less comparable to the overall migration data set, which also includes records of birds in distances of more than 2.5 km (see Annex IV-A).

Table 3: Number of birds and records observed in autumn 2011 at distances of up to 2.5 km to the observation sites

species	scientific name	birds	records
Honey Buzzard	*Pernis apivorus*	12	6
Black Kite	*Milvus migrans*	1	1
Egyptian Vulture	*Neophron percnopterus*	1	1
Short-toed Snake Eagle	*Circaetus gallicus*	3	2
Marsh Harrier	*Circus aeruginosus*	9	8
Pallid Harrier	*Circus macrourus*	1	1
Montagu's Harrier	*Circus pygargus*	3	3
Steppe Buzzard	*Buteo buteo vulpinus*	4	3
Steppe Eagle	*Aquila nipalensis*	2	2
Booted Eagle	*Aquila pennata*	1	1
Common Kestrel	*Falco tinnunculus*	5	5
Red-footed Falcon	*Falco vespertinus*	10	4
Eleonora's Falcon	*Falco eleonorae*	1	1
Harrier	*Circus spec.*	1	1
Falcon	*Falco spec.*	8	5
unidentified raptor	-	3	3

In spring 2012 57 birds from 12 relevant species were observed in distances of up to 2.5 km around observation sites (Table 4). As in autumn 2011 mostly single birds were recorded, three records consisted of small flocks. Flight calls of a flock of Common Cranes were heard, but the observers were not able see the flock and to identify number of birds.
At a distance of more than 2.5 km only few birds were recorded (see Annex V-A).

Table 4: Number of birds and records observed in spring 2012 within distances of up to 2.5 km to the observation sites

species	scientific name	birds	records
White Stork	*Ciconia ciconia*	6	1
Honey Buzzard	*Pernis apivorus*	2	2
Black Kite	*Milvus migrans*	1	1
Egyptian Vulture	*Neophron percnopterus*	1	1
Short-toed Snake Eagle	*Circaetus gallicus*	5	5
Marsh Harrier	*Circus aeruginosus*	2	2
Pallid Harrier	*Circus macrourus*	1	1
Montagu's Harrier	*Circus pygargus*	2	2
Pallid / Montagu's Harrier	*Circus macrorus/pygargus*	5	5
Levant Sparrowhawk	*Accipiter brevipes*	1	1
Steppe Buzzard	*Buteo buteo vulpinus*	2	2
Lesser Kestrel	*Falco naumanni*	1	1
Common Kestrel	*Falco tinnunculus*	15	15
Common / Lesser Kestrel	*Falco naumanni/tinnunculus*	4	4
Falcon	*Falco spec.*	5	5
unidentified raptor	-	4	4
Common Crane	*Grus grus*	?	1

European Bee-eaters were recorded regularly in autumn and spring, as well as Blue-cheeked Bee-eaters in spring. Their number could not be determined because they were only recorded acoustically. In autumn we counted altogether 45 flocks of European Bee-eaters and two flocks of Blue-cheeked Bee-eaters. During spring a total of 66 flocks of European Bee-eaters and 32 flocks of Blue-cheeked Bee-eaters were registered.

Three species of special interest (due to their Red List Category, see Chapter 2.1) with a total of 14 individuals occurred during observations in autumn and spring.

- Egyptian Vulture: each one individual in autumn and spring
- Pallid Harrier: each one individual in autumn and spring
- Red-footed Falcon: ten individuals in autumn

(Note that there might have been further individuals of these or other species which might be found under Pallid / Montagu’s Harrier and unidentifiable Harrier, Falcon or raptor.)

<u>Seasonal distribution of migratory activity</u>

In autumn 2011 no gliding and soaring bird was recorded during the first two weeks of observation (Fig. 5). Most birds and records were made in the seventh week (end of September) of the study period. Almost 50% of the birds were recorded on 24th and 25th September.

During spring 2012 the number of birds and records increased slowly until the seventh week (mid of April) and decreased sharply afterwards (Fig. 5). In the last two weeks of the study period no bird of relevant species was recorded.

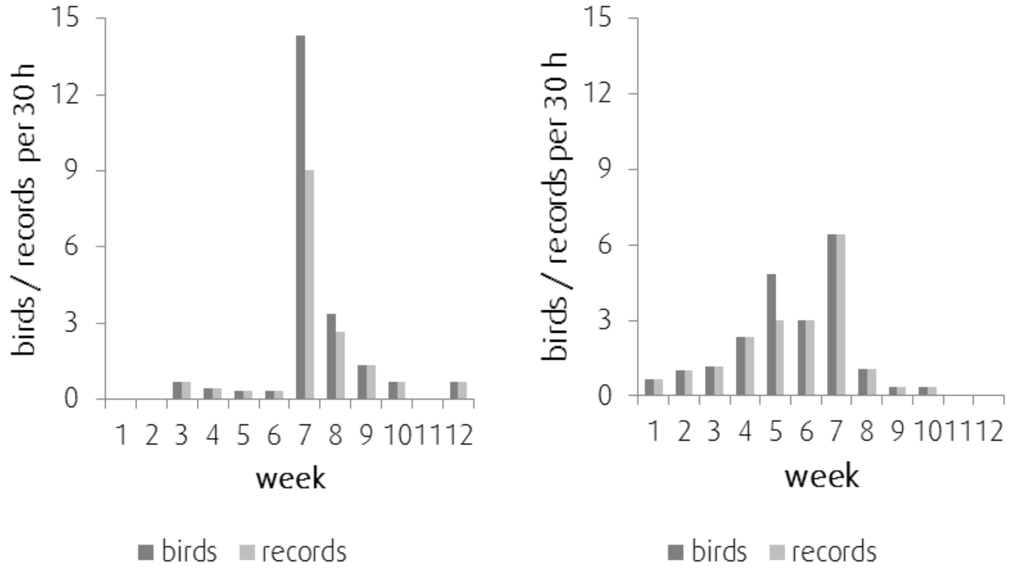

Figure 5: Seasonal distribution of birds and records in autumn 2011 (left) and spring 2012 (right)

In autumn flocks of European Bee-eaters appeared in the forth to seventh week (end of August to end of September; Fig. 6). The numbers of flocks decreased continuously from the fifth to the seventh week. The only (two) flocks of Blue-cheeked Bee-eaters were recorded in the fifth week of observation.

Migration of Blue-cheeked and European Bee-eaters separately proceeded in spring (Fig. 6). Blue-cheeked Bee-eaters firstly arrived in the fifth week (beginning of April), migration was completed in the eighth week (mid / end of April). European Bee-eaters firstly appeared in the eighth week and were recorded until the eleventh week (mid May) of observation. Flocks of Blue-cheeked Bee-eaters peaked in the fifth week, whereas the highest number of flocks of European Bee-eaters was recorded in the ninth week (end of April).

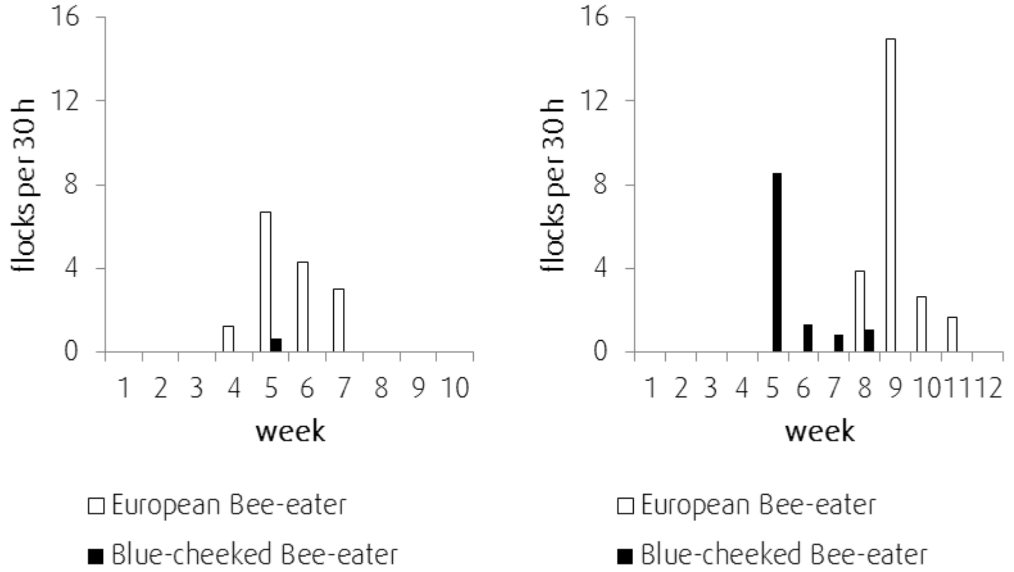

Figure 6: Seasonal distribution of flocks of European Bee-eaters and Blue-cheeked Bee-eaters in autumn (left; first week: 10.-17.08.2011) and spring (right; first week: 01.-07.03.2012)

<u>Daily distribution of migratory activity</u>

In autumn and spring migratory activity decreased from morning to midday and afternoon (Fig. 7). In both seasons about 70 % of all birds were recorded during the 1st and 2nd interval. The level of migratory activity within the intervals only slightly differed in autumn and spring.

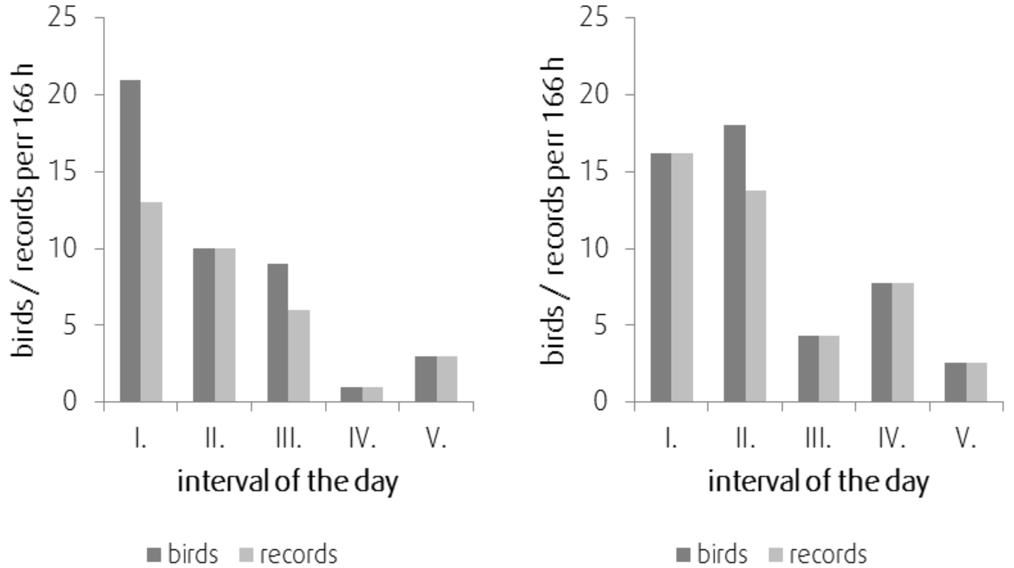

Figure 7: Daily distribution of birds and records in autumn (left) and spring (right)

Altitude of migrating birds

In autumn about 55 % of all recorded birds flew above 200 m (Fig. 8). In spring the proportion of birds at altitudes above 200 m was about 30 % (Fig. 8). About 25 % and 55 % of all birds were recorded at altitudes below 100 m in autumn and spring, respectively.

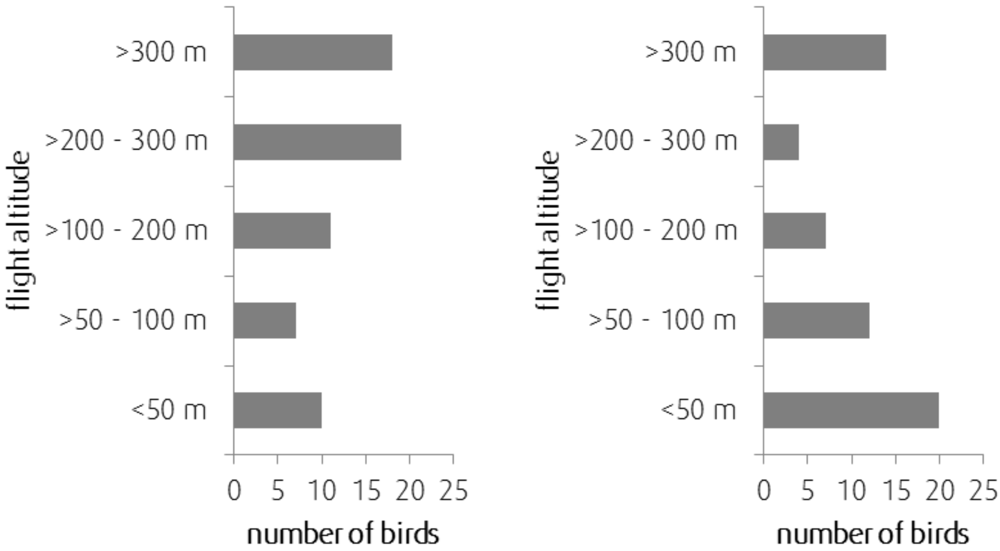

Figure 8: Flight altitude of birds in autumn (left) and spring (right)

Flight Directions

The majority of birds used flight directions which could be expected: In autumn about 86 % flew in southern directions (SSE, SSW; for a detailed presentation of number of birds per observation site and flight direction see Annex IV-D & V-D).

Northern flight directions (NNE, NNW) were most often recorded in spring (about 65 %). In comparison to autumn a higher proportion of birds used a more eastern flight direction in spring (ENE, about 25 %).

Spatial comparison of migratory activity

A comparison of birds and records from the two westernmost, central and easternmost observation sites results no remarkable differences within seasons as well as between autumn and spring (Fig. 9; for a detailed presentation of birds per observation site see Annex IV-C & V-C).

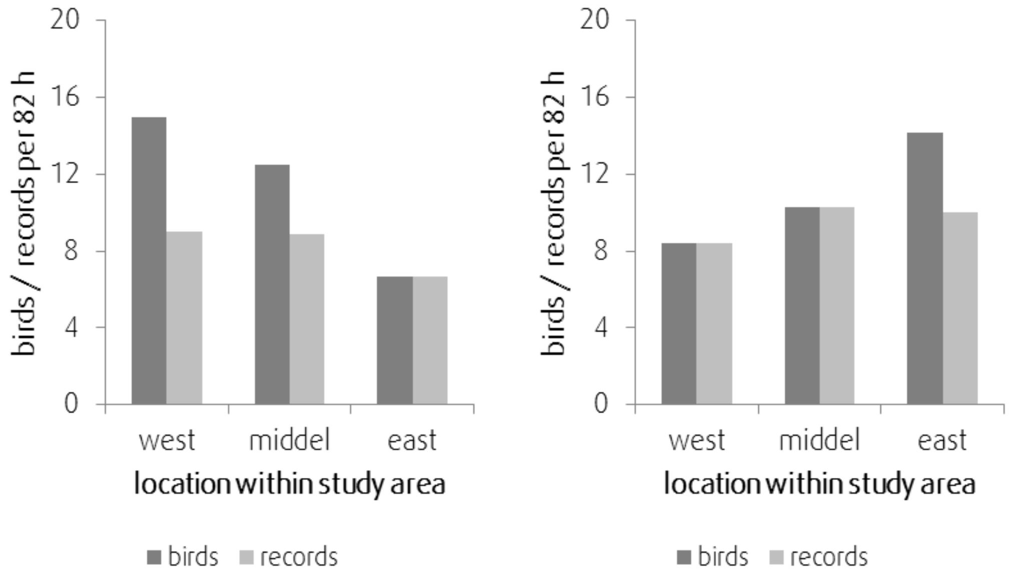

Figure 9: Spatial distribution of birds and records within a subset of the study area in autumn (left) and spring (right)

<u>Comparison of bird migration in the study area and bird migration at the Red Sea</u>

In distances of up to 2.5 km to observation sites a total of 65 and 57 birds were counted in autumn 2011 and spring 2012, respectively. Migration rate for all observation units and sites was about 0.06 birds per hour in autumn and spring.

At the western coast of the Red Sea migratory activity ranged between 32 and 158 birds per hour, total number of birds between 4,582 and 177,516 (at distances of up to 2.5 km to observation sites; Table 5).

To conclude compared to the results obtained at the Red Sea migratory activity in the study area was extremely low (Table 5), though the total observation time was higher at the West Nile Valley. Furthermore, the study areas in previous studies were at least 3.6 times smaller than the study area at the West Nile Valley (which exceeded the 3,600 km² project area).

Table 5: Migratory activity recorded at different areas at the Red Sea (data from BERGEN 2007a, 2009, 2011)

location	migration period		total number		birds / hours		area size (km²)
	autumn	spring	autumn	spring	autumn	spring	
Ras Gemsa to Ras Shukeir	2006	2007	39,687	95,067	86.5	157.7	1,000
Zafarana	-	2007	-	4,582	-	41.3	14
Gabel el Zayt	2008	2009	19,440	32,692	47.3	82.6	98
Ras Gharib	2010	2010	25,942	177,516	224.1	32.3	200
Nile Valley	2011	2012	65	57	0.06	0.06	3,600

3.2.2 Incidental observations of migrating, resting and sedentary birds in the study area

Migrating and resting birds of relevant species

While driving within the study area few observations of migrating and resting (roosting or foraging) birds were made in autumn 2011 and spring 2012 (Table 6). Beside the already mentioned raptor species we also registered low numbers of different Egret species, one Houbara/Macqueen's Bustard and one individual each of two Owl species.

Table 6: Number of relevant species which were observed by chance in autumn and spring (beyond standardized observations; migr.= migrating, rest.= resting).

species	scientific name	autumn 2011		spring 2012	
		migr.	rest.	migr.	rest.
Little Egret	*Egretta garzetta*	-	-	-	9
Squacco Heron	*Ardeola ralloides*	-	1	-	14
Cattle Egret	*Bubulcus ibis*	-	5	-	2
Little Bittern	*Ixobrychus minutus*	-	-	-	2
White Stork	*Ciconia ciconia*	-	-	-	2
Black Kite	*Milvus migrans*	-	-	-	2
Egyptian Vulture	*Neophron percnopterus*	-	-	1	2
Short-toed Snake Eagle	*Circaetus gallicus*	1	-	3	5
Marsh Harrier	*Circus aeruginosus*	4	1	1	-
Northern Harrier	*Circus cyaneus*	-	-	-	1
Pallid Harrier	*Circus macrourus*	2	3	1	1
Montagu's Harrier	*Circus pygargus*	1	6	4	7
Pallid/Montagu's Harrier	*Circus macrourus/pygargus*	-	5		
Levant Sparrowhawk	*Accipiter brevipes*	-	-	-	2
Eurasian Sparrowhawk	*Accipiter nisus*	-	3	-	1
Steppe Buzzard	*Buteo buteo vulpinus*	-	-	-	5
Long-legged Buzzard	*Buteo rufinus*	-	-	-	1
Booted Eagle	*Aquila pennata*	-	-	2	2
Lesser Kestrel	*Falco naumanni*	-	-	-	1
Common Kestrel	*Falco tinnunculus*	2	4	4	35
Red-footed Falcon	*Falco vespertinus*	-	1	-	-
Sooty Falcon	*Falco concolor*	-	2	-	-
Eurasian Hobby	*Falco subbuteo*	-	-	-	2
Barbary Falcon	*Falco pelegrinoides*	-	-	-	1
Houbara/Macqueen's Bustard	*Chlaydotis undulate/macqueenii*	-	-	-	1
Pharaoh Eagle-Owl	*Bubo ascalaphus*	-	-	-	1
Short-eared Owl	*Asio flammeus*	-	1	-	-

Final Declaration

We confirm that this report was prepared impartially and according to the best and latest state of knowledge. Data analysis was conducted with most possible accuracy.

Dortmund, October 01st 2012

Dr. Frank Bergen

4 Assessment of the Importance of the Study Area

The following assessment of the importance of the area focuses on migrating soaring and gliding birds.

4.1 General Migration Patterns

4.1.1 Basic Considerations of Migration in Egypt

Located on the Eurasian-East African Flyway Egypt is well known as a bottleneck for soaring and gliding birds. To avoid crossing the Mediterranean Sea and to choose the shortest route between wintering and breeding grounds most soaring and gliding birds migrate through Egypt along (i) the western and eastern coast of the Gulf of Suez, (ii) the Red Sea Mountains south of Suez and (iii) the Nile Valley south of Quena (CELMINS 1998, ORNIS CONSULT 1999 & 2002, MEYBURG *et al.* 2000, MEYBURG *et al.* 2002, MEYBURG & MEYBURG 2002, ATTUM in MEYBURG & MEYBURG 2002, MEYBURG *et al.* 2003, BIRDLIFE INTERNATIONAL 2005, BERGEN 2007a, MEYBURG & MEYBURG 2007, BERGEN 2009, BERGEN 2011, BAHAL EL DIN unpubl.).

During autumn migration large numbers of soaring and gliding birds can be found in the region of Suez, at Gabel El-Zayt and adjacent areas as well as on the Sinai Peninsula. In spring soaring and gliding birds concentrate on the west coast of the Gulf of Suez between Hurghada and Suez, in addition along the Red Sea Mountains up to Suez. The most frequently recorded species in those areas are White Storks, White Pelicans, Eagles and Buzzards as well as Levant Sparrowhawks (*e. g* NEWTON 2008).

However, in autumn a nameable portion of birds may use a more western route after having reached Suez. Those birds may follow the Nile Valley further south and may cross the Western Desert. Accordingly, in spring birds, which avoid crossing the Red Sea, may migrate along the Nile Valley further north and turn east heading for Suez.

Moreover, some species (*e.g.* Harriers) or at least portions of flyway populations from certain species (*e.g.* Honey Buzzard) do not avoid crossing the Mediterranean Sea. Those birds, which are supposed to migrate via Libya to their wintering grounds (in autumn) and European breeding sites (in spring), may also cross the Western Desert. This flyway consists (up to recent knowledge) of less than 2,000 birds and is mainly used by Honey Buzzards, Marsh Harriers and Black Kites (LUCIA *et al.* 2011). Finally, Falcons may cross the Mediterranean Sea and the Western Desert at any location because they migrate in active flight and do not depend on thermal uplifts (PANUCCIO 2011).

4.1.2 Number of migrating birds, species composition and flock size within the study area

During 1,015 hours of observation in autumn 2011 65 birds from relevant species were recorded at distances of up to 2.5 km to a site. During 965.2 hours of observation in spring 2012 the recorded number of migrating birds was comparable to the number in autumn (57 individuals). Though birds mostly migrated singularly the number of birds and the number of records do not remarkably differ. Migratory activity in the study area was extremely low: 0.06 birds / h in autumn and spring).

Most often Harriers and Falcons were recorded (autumn 57 %, spring 61 %). Large soaring and gliding birds like Storks, Vultures and Eagles comprise only a small proportion of all birds being recorded (autumn 11 %, spring 21 %). In autumn and spring flocks of European Bee-eaters were registered regularly, while flocks of Blue-cheeked Bee-eaters almost exclusively passed in spring.

When considering birds in distances of more than 2.5 km to observation sites a total of 72 birds in autumn and 74 birds in spring were recorded. Consequently, the main conclusions do not change if all recorded birds are included in the assessment.

4.1.3 Bird migration in the study area and at the Red Sea

In comparison to locations at the Red Sea migratory activity within the study area was extremely low (0.006 vs. 23.31 to 224.14 birds / h; see Table 5) in autumn and in spring. Whereas White Stork, Steppe Buzzard, Honey Buzzard, Levant Sparrowhawk, White Pelican and Steppe Eagle were most common at the Red Sea these species are absent or only occur in very low numbers at the West Nile Valley. The recent investigation clearly shows that no migration stream of soaring and gliding birds exists within the study area. The area is occasionally used by a low number of few species which migrate on broad front and do not avoid crossing the Mediterranean Sea (Harriers, Falcons).

4.1.4 Spatial distribution of migration within the study area

An analysis of spatial distribution of bird migration within the study area reveals that there are no distinctive patterns. Migratory activity was extremely low at all observation sites.

There are no particular structures in the study area, *e. g.* like mountain chains, which may serve as landmarks and may be important for orientation of migrating birds or which may offer good thermal uplifts.

4.2 Assessment of the Importance of the Study Area

4.2.1 Methods for assessing the Importance of an Area

Commonly, the importance of a site is assessed by two criteria: 1. the number of migrating birds / recordings, and 2. the conservational status (IUCN-Red List Category, see Annex II & III) of migrating species. In this process, species that are exposed to a higher threat are of special interest. As noted in Chapter 2.1, such species are Egyptian Vulture (Endangered), as well as Pallid Harrier and Red-footed Falcon (both Near Threatened).

The numbers of representatives of these species recorded within the study area, however, were very low. All species occurred mostly singularly at a few sites. This means, the conservational status according to the IUCN-Red List of a species cannot qualify as a decisive criterion in assessing the significance of the study area in a spatially differentiated way.

According to Birdlife International few species, which occurred within the study area, have an unfavourable conservation status in Europe and are concentrated in Europe like White Stork (SPEC 2-category, see Annex II & III). Other species occurring within the study area have an unfavourable conservation status in Europe but are not concentrated there (SPEC 3) like Short-toed Snake Eagle. In contrast, Common Kestrel, Honey Buzzard and Marsh Harrier are not of special conservational concern, as both species have a favourable status in Europe. Consequently, these species (amongst other species which occurred in the study area) are of minor importance in the impact assessment, whereas White Stork, Short-toed Snake Eagle and Egyptian Vulture have to be considered with special attention.

Several criteria have been developed by Birdlife International for the selection of areas which are internationally important for birds. Within the scope of this investigation two criteria are particularly relevant:

1. An area where at least 20,000 Storks, Raptors or Cranes regularly pass during spring or autumn migration is of international importance.
2. The second criterion is the abundance of each species in relation to the total flyway population. According to this, an area that regularly holds at least 1% of a flyway population of a threatened migratory species is of international importance, too. A flyway population is a population of a species sharing the same migration route linking breeding areas and wintering areas.

   We also used this criterion for unthreatened soaring and gliding birds to evaluate whether the study area is an important migration corridor.

All information at hand (data from standardized and non-standardized observations) was included in the assessment of the importance of the study area.

Furthermore, we assess the importance of the study area for migration of soaring and gliding birds in Egypt by comparing the obtained data with data from previous studies from the Red Sea.

The data on flyway populations were mainly taken from CarlBro (2009) after comparing this data with other available sources (see Table 7 for details) or the IUCN Red List (2004). To calculate the proportion (of birds which passed the study area) of the flyway population we applied a rather conservative approach by taking the average of minimum and maximum number of those flyway populations.

The number of European Bee-eaters and Blue-cheeked Bee-eaters could not be quantified, because flocks could only be recorded by their flight calls. We assumed that flocks of European Bee-eaters had an average size of about twenty, flocks of Blue-cheeked Bee-eaters of about ten birds. These flock sizes were estimated by a number of observations of European Bee-eaters and Blue-cheeked Bee-eaters near the Nile.

Considering that the observed area covers only a part of the whole study area and that a portion of all migrating birds probably was not recorded (due to several factors, *e. g.* flight altitude, awareness of the observer, detection probability is not 100 %), the recorded migrants obviously were only a fraction of all migrating birds. Furthermore we did not cover every day within autumn and spring migration. Therefore the number of birds is underestimated.

For a precise estimation of the total number of birds which passed the study area during the migration periods in autumn and spring the data is not suitable because of the low sample size and low number of birds. Thus a calculation can easily lead to an over- or underestimation.

So we just roughly estimated how many birds might have passed the study area during autumn and spring. Consequently, we assumed that at each observation day only 1/10 of all migrating birds were recorded (only one of ten observation sites in a row was studied during the observation units, assuming that birds are registered only once in one of three rows because they do not migrate exactly south or north). In addition we had to consider days without observation units. During ~ 1/7 of the study period in autumn and spring migration no observation was carried out (autumn and spring 12 days each).

This leads us to the assumption that the total number of birds is ten times higher because not every location was surveyed at every time. Furthermore the total number is supposed to be 1.2 times higher because observations were not carried out on every day within the study period.

We would like to highlight, that this is just a rough dimension which is used to estimate the total number of birds which may have passed the study area in autumn and spring. We did not take into account that, *e.g.* the migratory activity of the relevant species is not equally distributed over the total migration period and observation units did not last from sunrise to dawn.

4.2.2 Importance of the whole study area

Migration of species which of particular relevance for the impact assessment

For each species the portion of recorded birds was much lower than 1 % of the flyway population (Table 7). The portions of the flyway populations ranked between 0.0002 % (Steppe Buzzard spring) and 0.0301 % (Short-toed Snake Eagle spring).

Even when considering that more birds than recorded passed the study area the 1 %-criterion was not reached. For most species less that 0.01 % of the flyway population are believed to pass the study area. The portion of Short-toed Snake Eagle, Pallid Harrier, Booted Eagle and Red-footed Falcon ranges from about 0.02 to 0.03 %. For the following reasons we do not expect more individuals occurring in the study area:

- Short-toed Snake Eagles and Booted Eagles are large soaring and gliding birds, which try to avoid crossing the Mediterranean Sea (PANUCCIO *et al.* 2011). For those species the shortest route between breeding and wintering grounds leads along the Gulf of Suez and the Red Sea Mountain chain. Thus most individuals of these species are believed to cross the Western Desert further south in autumn and spring. This allows birds to save energy by minimizing the distance to the breeding or wintering grounds instead of heading north to the Mediterranean Sea. Only inexperienced juvenile birds sometimes cross the Mediterranean Sea (AGOSTINI *et al.* 2009)
- Harriers do not avoid crossing the Mediterranean Sea. They are less dependent on thermal uplifts and therefore migrate on broad front. Individuals of the flyway distribute over a wide area. So at every location in Egypt low numbers of Pallid Harriers can be expected. Furthermore there are only few individuals expected to migrate in the Western Desert, because the breeding grounds of Pallid Harriers are located mainly east of the Black Sea. The shortest way between breeding and wintering grounds leads along the Red Sea. On different sites at the Red Sea 14 to 82 individuals in a total were recorded per migration period (autumn or spring), though the observation time was only half of the recent study (BERGEN 2007a, 2009 & 2010).
- Red-footed Falcons migrate in active flight. Thus they do not avoid the Mediterranean Sea and migrate in broad front between breeding and wintering grounds. As a consequence, low numbers can be expected at every location in Egypt. At different sites at the Red Sea a total of 0 to 13 individuals were recorded per migration period (autumn or spring), though observation time was only half to three quarter of the recent study (BERGEN 2007a, 2009 & 2010).

Table 7: Number of recorded birds, portion (%) of the flyway population and conservational status of the species recorded in autumn 2011 and spring 2012 within the study area (LC= least concern, NT= near threatened, EN= endangered)

species	number of birds		% of flyway population		IUCN-Red List	SPEC
	autumn	spring	autumn	spring		
White Stork	-	6	-	0.0021	LC	2
Honey Buzzard	12	2	0.0052	0.0009	LC	non[E]
Black Kite	1	1	0.0006	0.0006	LC	3
Egyptian Vulture	1	1	0.0071	0.0071	EN	3
Short-toed Snake Eagle	3	5	0.0181	0.0301	LC	3
Marsh Harrier	9	2	0.0071	0.0016	LC	non
Pallid Harrier	1	4	0.0234	0.0234	NT	1
Montagu's Harrier	3	2	0.0047	0.0031	LC	non[E]
Pallid/Montagu's Harrier	-	2	-	-	-	-
Harrier spec.	1	-	-	-	-	-
Levant Sparrowhawk	-	1	-	0.0085	LC	2
Steppe Buzzard	4	2	0.0003	0.0002	LC	non
Steppe Eagle	2	-	0.0040	-	LC	3
Booted Eagle	1	-	0.0208	-	LC	3
Lesser Kestrel*1	-	1	-	0.0056	LC	1
Common Kestrel	5	15	0.0021	0.0063	LC	3
Common/Lesser Kestrel	-	4	-	-	-	-
Red-footed Falcon	10	-	0.0130	-	NT	3
Eleonora's Falcon*2	1	-	0.0057	-	LC	2
Falcon spec.	8	5	-	-	-	-
unidentified.	3	4	-	-	-	-
Common Crane**	-	?	-	< 1 %	LC	2

Flyway population size taken from:
*1 BirdLife International (2004), minimum population size
*2 Dimalexis *et al.* (2008)

Remarks:
** To reach the 1 % criterion the registered flock would have had a size of at least 350 individuals which hardly can be overlooked by observers who heard flight calls at the observation site

estimated flyway population size of European Bee-eater 5,229,000 and Blue-cheeked Bee-eater 861,000; estimation based on global population size, assuming that 70% of the birds use the Eurasien-East African Flyway, global population for Blue-cheeked Bee-eater was estimated by extrapolating the population size of Europe to the global range of the species

To conclude, the study area as a whole neither meets the first nor the second criterion which were developed by Birdlife International (see Chapter 4.2.1). Thus the study area is not of international importance for any species during autumn and spring migration. In comparison to locations at the Red Sea the migratory activity in the study area was extremely low.

Summing up, the importance of the study area for migrating soaring and gliding birds in Egypt has to be assessed as very low. This assessment remains valid even when considering data obtained by incidental observations. All species, which were not recorded during standardized daytime field observations, including some species of Egrets, Long-legged Buzzard, Sooty Falcon, Eurasien Hobby, Houbara/Macqueen's Bustard, Pharao Eagle Owl and Short-eared Owl occurred very seldom and in low numbers.

Migration of species which are of low relevance for the impact assessment

Flocks of European Bee-eaters and Blue-cheeked Bee-eaters were often recorded during standardized daytime field observations in autumn 2011 and spring 2012. Both species are regarded as "least concern" in the IUCN Red List. European Bee-eater is classified by Birdlife international as SPEC 3, Blue-cheeked Bee-eater was not evaluated. The estimated portion of recorded European Bee-eaters was 0.0144 % in autumn and 0.0211 % of the flyway population in spring. Regarding Blue-cheeked Bee-eater 0.0073 % in autumn and 0.1163 % of the flyway population were recorded. As the number of recorded birds was surely underestimated (see Chapter 4.2.1), the study area may be of a general importance for migration of Blue-cheeked Bee-eaters in spring.

All recorded songbirds (passerines) are not threatened according to IUCN (2004). All recorded songbirds refer to species which typically migrate on broad front. These species do not concentrate in certain areas and migratory activity is assumed to be equally distributed over North Africa. Consequently, the study area is at the most of general importance for these species.

Roosting and sedentary birds

Most parts of the study area are of minor importance for roosting and sedentary species. However, the oasis and the larger wadis contain small patches of vegetation. In these areas smaller concentrations of roosting passerines with up to 200 birds were occasionally found. Moreover sedentary birds were seen almost exclusively in the vegetated areas. These species occurred in low numbers which can be found in several desert habitats in Egypt. So the study area is neither an important stopover site for migrating passerines nor an important breeding site for sedentary species.

Nevertheless, within the study area the oasis and larger vegetated wadis can be regarded as important sites for migrating passerines and sedentary birds.

5 Bird-Wind Turbine Interactions

In recent years the construction of wind turbines has given rise to much controversy relating to bird conservational issues, mainly in Europe and the United States.

Considering utilization of wind energy within the study area, the major potential hazards to birds are mortality due to collision as well as barrier effects. Other possible impacts of wind turbines like displacement due to disturbance or direct habitat change and loss can be neglected, because the area, which is characterized by practically no vegetation and very dry climatic conditions with large differences in temperature between night and day, does not serve as an important breeding, wintering or resting site for one of the relevant species. Although resting birds might occur within the study area occasionally, they do not constantly use particular parts of it and only rest for a short period of time.

5.1 Collision Risk and Mortality

Wind turbines seem to add an obstacle for bird movements and research has shown that birds fly into rotor blades. Although some studies have recorded bird collisions, other studies give evidence that birds could detect the presence of wind turbines and generally avoid them.

5.1.1 Results of Collision Risks at Different Wind Farms

ERICKSON *et al.* (2001) collected data from many studies conducted at different wind farms in the U.S. The results indicate an average of 2.19 avian fatalities per turbine per year in the U.S. for all species combined and 0.033 raptor fatalities per turbine per year. At different wind farms in Europe the annual number of dead birds per turbine varies between 0.04 (PERCIVAL 2000) and 35.00 (EVERAERT *et al.* 2002) depending on site characteristics and bird densities. MADDERS & WHITFIELD (2006) pointed out that simply presenting mortality rates per turbine or per installed MW, in the absence of further information on the abundance of birds (or birds at risk of death), does little to inform about the collision risk by a wind farm. And LANGSTON & PULLAN (2004) suggested that a low collision rate per turbine does not necessarily mean that collision mortality is insignificant, especially in wind farms comprising several hundreds or thousands of turbines.

Comparably high mortality rates due to collision have been recorded at large wind farms in areas with high concentrations of birds: Altamont Pass in California (ORLOFF & FLANNERY 1992, HUNT 1995, SMALLWOOD & THELANDER 2004, THELANDER & SMALLWOOD 2007, SMALLWOOD & THELANDER 2008) and in the Campo de Gibraltar region (Cádiz) in Spain (BARRIOS & RODRIGUEZ 2004). In particular, large numbers of raptors have collided with wind turbines at these sites, including substantial numbers of Golden Eagles (*Aquila chrysaetos*) and Griffon Vultures (*Gyps fulvus*). These wind farm areas are characterized by large numbers of turbines (c. 7,000 at Altamont and 256 at Cádiz, which are often closely packed

together) and by predominantly small turbines comprised of lattice towers and high-speed rotors relatively close to the ground (PERCIVAL 2005). Both areas are located in mountainous surroundings, sustain important food resources and, consequently, high densities of birds, which thus are susceptible to collisions with turbines.
As with Altamont or Cádiz, most of all investigated wind farms affect stationary (breeding or wintering) birds and / or small passerines migrating at night. Thus, there is a great lack of information about collision risk for migrating birds, in particular about migrating raptors or other large birds.

During a 14-month study, which included two autumn migration periods, only two bird carcasses were found at a wind farm (66 turbines) near the Strait of Gibraltar: a Griffon vulture, which is a stationary (wintering) bird species in the region, and a Short-toed Snake Eagle. JANSS (2000) estimated that about 45,000 Griffon Vultures and 2,500 Short-toed Snake Eagles fly over the wind farm per year.

In contrast to these findings BARRIOS & RODRIGUEZ (2004), during a one-year period at a wind farm (called “PESUR”, 190 turbines) located less than 10 km away from the above mentioned study area, found 28 Griffon Vultures, twelve Common Kestrels, three Lesser Kestrels, two Short-toed Snake Eagles, one Black Kite and two White Storks. The authors estimated a mortality rate of 0.36 raptors per year per turbine. Considering the number of turbines, such increases in mortality rates may be significant for some birds, especially large, long-lived species with a generally low annual productivity and long maturation. BARRIOS & RODRIGUEZ (2004) concluded that mortality at wind power plants reflects a combination of site-specific (wind-relief interaction), species-specific and seasonal factors.

During a three-year study (2000-2002) 13 wind power plants containing 741 turbines were studied in Navarra (Spain; LEKUONA & URSÚA 2007). Thirty seven study plots containing 277 turbines were selected for fatality searches and behavioural bird observations. Overall 345 bird fatalities were recorded. Most dead birds were raptors (72.8 %) with the Griffon Vulture representing 63.1 % of raptor fatalities. Most raptors were killed during spring (March to June). By contrast, all three Lesser Kestrels were found during postbreeding migration, because there was a postbreeding roost near a wind plant.

At the wind farm “Al Koudia” (84 turbines) in northern Morocco, corpse searches were done over a three-month period in 2001 (EL GHAZI *et al.* 2001). Only two carcasses were found in autumn 2001 (one Pallid Swift (*Apus pallidus*) and one Woodlark (*Lullula arborea*), but no raptor or large bird). In autumn 2000, four other birds (mainly local, stationary species) were found by chance. It must be mentioned that the results might lead to an underestimation of collision risk, because no correction factors (*e.g.* for search efficiency or scavenger activity) were used.

At a wind farm (220 turbines) at the western bank of the Gulf of Suez (Egypt) corpse searches were carried out over a four-week period in spring 2007 (BERGEN 2007b). Body parts, feathers and bones of three birds were found, which had died weeks or months ago — possibly by collision with a turbine. No fresh bird corpse was found. Due to the characteristics of the study area and the high intensity of investigation, search efficiency and / or scavengers were not regarded to play an important role. Thus, the results strongly indicate that the number of collisions was very low if not zero throughout the period of investigation. It must be pointed out, however, that the study is limited due to the short period of investigation.

Occasional fatality searches at wind turbines in Hurghada wind farm did not reveal any evidence of bird mortality (BAHA EL DIN 1996).

5.1.2 Factors Influencing Vulnerability to Collision

The risk of collision depends on a broad range of external and internal factors (JOHNSON *et al.* 2000).

Weather, visibility and season

Collision risk seems to be greatest in poor flying conditions, such as strong winds that affect the birds' ability to control flight manoeuvres, or in rain, fog, and on dark nights when visibility is reduced (WINKELMAN 1992, LANGSTON & PULLAN 2004). But collisions occurred in conditions of good visibility, too: all of the 68 collisions at turbines of the above mentioned wind farm "PESUR" occurred on clear days (BARRIOS & RODRIGUEZ 2004); and collision of Vultures occurred rarely in strong winds, which could have indicated little manoeuvrability by the Vultures (see below).
At the wind farm "PESUR" all Vultures died between October and April, with 66.7 % of all accidents taking place between December and February (although the Griffon vulture is a resident species in the region). BARRIOS & RODRIGUEZ (2004) assumed that the seasonal pattern of Vulture deaths might be explained by flight behaviour. As is known, Griffon Vultures need vertical air currents to gain height. In winter low temperatures make thermals scarcer. Birds are thus constrained to gain height with slope updrafts, whose force on most winter days may be insufficient to lift Vultures well above the ridge, thereby exposing them to wind turbines.

Site-specific factors

It is quite obvious that a higher collision rate is to be expected at locations with high bird densities (LANGSTON & PULLAN 2004), especially by species vulnerable to collision. When comparing wind energy facilities, it appears that birds tend to be killed at rates that are proportional to their relative abundance amongst wind farms (SMALLWOOD & THELANDER 2004). However, there are several wind farms where the correlation between usage by birds and fatality is low (ERICKSON *et al.* 2001). An investigation at several wind power plants in Spain also confirmed that the relative abundance of species does not predict the relative frequency of fatalities (LEKUONA & URSÚA 2007).

CALIFORNIA ENERGY COMMISSION (2002) and ORLOFF & FLANNERY (1992) suggested that the abundance of ground squirrels within the Altamont Pass Wind Resource Area might significantly increase raptor foraging, and thus collision risk. Within some wind farms in Navarra (Spain), Vultures and Kites were apparently killed because of the nearby livestock carcass and dump sites (LEKUONA & URSÚA 2007).

HOWELL & DI DONATO (1991) identified significant topographical features associated with collision mortality. Notably mountain passes and hill shoulders, which tend to be the preferred crossing places for soaring species, were associated with multiple collisions.

Field studies in the Altamont Pass resource Area have clearly shown that not all turbines have an equal probability of causing raptor fatalities (MORRISION *et al.* 2007). While some turbines were involved in multiple fatalities, others killed none. Fifteen turbine strings, which are located in highly complex topographic areas, were responsible for 60 % of all raptor fatalities: 80 % of Red-tailed Hawk (*Buteo jamaicensis*) and 100 % of Golden Eagle.

The 190 wind turbines at the wind farm "PESUR" — which prompted a relatively high number of collisions (BARRIOS & RODRIGUEZ 2004) — are arranged in rows along the ridges of mountains or hills, too. However, the wind farm which is less than 10 km away from "PESUR" and which is arranged in a similar way, yielded evidence of only very few collision victims (DE LUCAS *et al.* 2004).

Turbine-specific factors

ORLOFF & FLANNERY (1992) suggested that the high collision rate at Altamont Pass might be correlated to the lattice towers of the wind turbines which provide many perches, thus attracting birds, particularly raptors, into the collision-risk zone. However, recent investigation showed that perching on wind turbines is a less important factor contributing to mortality than previously suspected (SMALLWOOD & THELANDER 2004).

PERCIVAL (2005) assumed that collision risk at small turbines with high-speed rotors and with the turbines often packed closely together is higher.

Differences in collision rates also appear between turbines within a single wind farm although the same turbine type is used: in the wind farm "PESUR" a single group of 28 turbines (from 190) was responsible for 57 % of Griffon vulture mortality. These turbines were arranged in two rows with little space between consecutive turbines (BARRIOS & RODRIGUEZ 2004). However, little or no risk was recorded for five turbine rows having exactly the same windwall spatial arrangement.

SMALLWOOD & THELANDER (2004) found that wind turbines were most dangerous at the ends of turbine strings, at the edges of gaps in strings, and at the edges of clusters of wind turbines. Furthermore, most isolated wind turbines killed disproportionately more birds.

BARCLAY *et al.* (2007) found that neither rotor diameter nor tower height have an effect on bird fatalities.

Species-specific Factors

Manoeuvrability and flight behaviour might be crucial factors to explain differences in collision risks between species (DREWITT & LANGSTON 2006).

Especially soaring birds, like Griffon Vulture or Golden Eagle, are believed to be particularly vulnerable to collision with wind turbines (LANGSTON & PULLAN 2004), because of their lower manoeuvrability and their dependence on thermals. In contrast, at "PESUR" other soaring birds, such as Common Buzzards (*Buteo buteo*) or Short-toed Snake Eagles, often circled together with Vultures in slope updrafts but did not closely approach the turbine blades and rarely collided with them. BARRIOS & RODRIGUEZ (2004) suggest that these species have lower wing loads than Vultures, and make a more efficient use of the ascending currents, gaining altitude faster and farther away from the turbines.

In the Altamont Pass Wind Resource Area SMALLWOOD *et al.* (2009) found that fatality rates were high for Red-tailed Hawk and American Kestrel (*Falco sparverius*), but low for Common Raven (*Corvus corax*) and Turkey Vulture (*Cathartes aura*), indicating specific behaviours or visual acuity differentiated these species by susceptibility to collision.

ORNIS CONSULT (1999) subdivided soaring birds into four different categories depending on manoeuvrability and flight behaviour. On the basis of this classification we can deduce the vulnerability of different species to collision (see Table 8).

Table 8: Assessment of species-specific vulnerability to collision depending on manoeuvrability and flight behaviour (adapted from ORNIS CONSULT 1999)

category	description	species	vulnerability to collision
very passive fliers	very dependent on thermals, avoid large bodies of water	Egyptian Vulture, Short-toed Snake Eagle and all Eagles of the genus Aquila	very high
less passive fliers	less dependent on thermals, majority avoids large bodies of water	Buzzards, Kites, Honey Buzzard, Storks, Cranes and Pelicans	medium to high
less active fliers	rely on thermals and avoid large bodies of water to a limited degree	Harriers and Sparrowhawks	low to medium
very active fliers	do not dependent on thermals, do not avoid large bodies of water	Falcons	very low

Nevertheless, collision risk seems to depend not only on manoeuvrability and flight behaviour but also to a large (or maybe larger) extent on species-specific avoidance behaviour.

The high number of collided Common Kestrel (a very active flier that does not depend on lifting air currents) and maybe Griffon Vultures too, might be explained with the absence of avoidance behaviour. At "PESUR" Kestrels sometimes perched on lattice towers, and Vultures frequently flew at

close distance to the blades, or between two adjacent turning turbines (BARRIOS & RODRIGUEZ 2004). Soaring flights at low wind speeds and crossing flights that commenced below blade height increased the risk of collision, as Vultures showed little reaction to the turbine with only 2 % altering their approaching flight pattern.
In the wind farm at the western bank of the Gulf of Suez the majority of birds migrating at altitudes below 100 m showed clear avoidance behaviour in the presence of the wind turbines (BERGEN 2007a). While Steppe Buzzards predominately changed flight direction and avoided to enter the wind farm area altogether, most Black kites increased altitudes and subsequently entered the wind farm at heights above rotor blades but also at heights of the area swept by the rotor. Thus, they passed over or through the wind farm. Furthermore, the results of the study indicate that birds migrating individually are less sensitive to the presence of wind turbines than flocks. Large flocks seem to avoid wind turbines at greater distances.

The preferred altitude of migration is likely to be another factor effecting collision risk in a species-specific way. Most birds of such species that tend to migrate at altitudes well above 200 m (*e.g.* Eagles) are unlikely to come close to the area swept by rotors of wind turbines. Other species that prefer to migrate at altitudes around turbine height might often come into the range of rotors and hence face a risk to collide.
Furthermore the altitude of migration above ground can be influenced by site, depending on the availability of thermal uplifts. At the western coast of the Gulf of Suez birds arrive mainly in altitudes below 200 m after having crossed the Red Sea in autumn (BERGEN 2010). Those birds cannot make use of any thermal uplifts and thus arrive at low altitudes. In Israel White Pelicans, White Storks, Lesser Spotted Eagles and Honey Buzzards flew on average at height bands between 344 and 1,123 m above ground during autumn and spring migration (LESHAM & YOM-TOV 1996 in NEWTON 2008) by making extensive use of thermal uplifts.

There are indications that migrating passerines might be vulnerable to collision, especially when migrating at night (because of poor visibility; LANGSTON & PULLAN 2004). Collisions of passerines were recorded at several wind farms (*e.g.* ERICKSON *et al.* 2001). But mass collisions, which occurred at lighthouses during some nights, were not documented at wind turbines. Until now, collision risk of nocturnal migrants at onshore wind farms does not seem to be a major concern, possibly for several reasons:

- Usually nocturnal migration by passerines is at altitudes well above turbine height (*e.g.*, ALERSTAM 1990, CARLBRO 2009), so there is a very low potential for these birds to come into the collision risk zone. We can suggest that nocturnal migrants should be most vulnerable during take-off soon after sunset and during descent. Furthermore, birds facing strong headwinds, forcing them to fly at lower altitudes, might face an increased risk of collision.

- Due to the large populations of most passerine species, they are not of major conservational interest. Results from studies in the United States indicate that the levels of fatalities are not considered significant enough to threaten local or regional population levels (STERNER *et al.* 2007).
- Most passerines have an r-selected reproductive strategy: individuals are short-lived, mature rapidly, have many offspring and a high adult and juvenile mortality. Consequently, additional mortality caused by wind turbines is unlikely to have a significant effect on populations of most passerine species.
- Mortality of passerines seems to be much higher at other man-made structures compared to mortality at wind turbines (ERICKSON *et al.* 2001).

Individual Factors

Finally, collision risk might be influenced by individual attributes of a bird (*e.g.* age, experience or fitness). It is quite obvious that the risk of collision varies depending on the stage of a bird's annual cycle (breeding, roosting or migrating).

Some studies indicate that immature birds are more vulnerable than adults, a phenomenon which may be attributed to the inexperience of younger birds. However, within the Altamont Pass Wind Resource Area most Golden Eagle mortalities were not juveniles but subadults and non-breeding adults (CALIFORNIA ENERGY COMMISSION 2002).

At "PESUR" (as well as at "Al Koudia") victims were usually species with resident populations rather than species appearing during migration (EL GHAZI *et al.* 2001, BARRIOS & RODRIGUEZ 2004).

5.1.3 Conclusion

Many studies have shown that birds are generally able to avoid collisions with wind turbines and do not simply fly into them blindly (*e.g.* DIRKSEN *et al.* 1998, DE LUCAS *et al.* 2004, DESHOLM 2006). Nevertheless, at a few locations relevant numbers of collision victims were found, leading to significant increases in mortality rates and possibly to population decreases.

As shown, the scale of collision depends on a wide range of factors which — in some cases — correlate with each other. It is quite plausible that a combination of factors (*e.g.* flight behaviour, wind speed and relief of location) influences collision risk. As a consequence, it is very difficult to transfer the results obtained at a particular wind farm to another. At present, there is insufficient information available to form a reliable judgement on the scale of collision at a proposed wind farm.

5.2 Barrier Effect

There are several reliable studies indicating that wind turbines have a disturbing effect on birds and hence may act as barriers to bird movement.

During a 14-month study at a wind farm (66 turbines in a single row on top of a mountain ridge) near the Strait of Gibraltar, 72,000 migrating birds were recorded during about 1,000 hours of observation from fixed observation points (JANSS 2000). The most abundant species were Black Kites, White Storks, House Martins (*Delichon urbica*) and Barn Swallows (*Hirundo rustica*). Most of the migrating birds observed were passing over the wind farm, but at a higher average altitude than over two control areas. Average flight altitude at the wind farm was more than 100 m above ground. Almost 72 % of all soaring birds (n = 16,225) displayed changes in flight direction in the wind farm area (DE LUCAS *et al.* 2004, DE LUCAS *et al.* 2007). Raptors appeared to be accustomed to the presence of turbines and many birds flew close to turbines (DE LUCAS *et al.* 2004).

During a behavioural study at thirty seven study plots containing 277 turbines most birds (58.6 %) flew very low (< 5 m). 24.1 % of all birds showed panic behaviour in the risk zone, 20,3 % a sudden change of flight, and 15,6 % a slight change of flight (LEKUONA & URSÚA 2007).

At the wind farm “Al Koudia” (84 turbines) in northern Morocco, autumn migration was observed over a three-month period in 2001 (EL GHAZI *et al.* 2001). Most birds (depending on species up to 100 %) showed clear avoidance behaviour in the presence of the turbines.

At a wind farm (220 turbines) at the western bank of the Gulf of Suez, the behaviour of migrating birds was observed over a four-week period in spring 2007 (BERGEN 2007). In the vicinity of the wind farm most birds (almost 88 %) used altitudes above 100 m, showed no clear reaction in presence of wind turbines and migrated over the wind farm. Most birds (over 83 %) migrating at altitudes below 100 m showed a clear reaction to the presence of wind turbines.
Black Kites most often increased altitude and subsequently entered the wind farm at heights above rotor blades but also at heights swept by the rotor. Thus, they passed over or through the wind farm. Some birds reacted to the presence of wind turbines with a combined vertical and horizontal behaviour. But change in flight direction alone was recorded relatively rarely. Accordingly, less than 11 % of all Black Kites did not pass the wind farm. In contrast, Steppe Buzzards did not change altitude in relevant numbers. The majority of birds changed their flight direction, so that they subsequently did not enter the wind farm area. Thus, Steppe Buzzards seem to regard the whole wind farm as a barrier. Consequently, Steppe Buzzards appear to be more sensitive to the presence of wind turbines, whereas Black Kites might be more vulnerable to collision.

The proportion of recordings of Black Kites changing altitude was markedly lower than the proportion of birds, indicating that birds migrating individually or in small flocks are less sensitive to the presence of wind turbines than flocks. The analysis of behaviour of Steppe Buzzards presents similar patterns.
Harriers usually migrated alone only a few meters above the ground. In the presence of wind turbines most Harriers showed no conspicuous reaction and simply flew through the wind turbines at heights below the rotor blades. A relevant number of birds (about 42 %) changed flight direction. As a consequence, one-third of migrating Harriers did not enter the wind farm area. Nevertheless, since the number of migrating Harriers was very low the findings must be treated with caution.
The results demonstrate that migrating birds were able to detect the presence of wind turbines and thus to react in an appropriate way depending on external (*e.g.* weather conditions) and internal (*e.g.* altitude, physical capabilities) factors. Birds at altitudes above 100 m simply migrated over the wind farm without any noticeable reaction. Birds at altitudes below 100 m became aware of the presence of wind turbines and apparently avoided them by changing their flight direction or increasing altitude. Sometimes birds seemed to avoid turbines in operation and purposefully approached a turbine not in operation and subsequently passed by.
A flight reaction of a bird in the vicinity of a turbine was recorded only twice. Irrespective of a bird's motivation (migrating, flying, hunting, resting) or of weather conditions, an appreciably irritated bird or a bird in a critical situation that might have led to a collision or to loss of flight control never occurred. Since the investigation refers to a rather short period, which did not cover the main migrating period of all species, results have to be verified.

Further studies have shown that birds alter their routes to avoid flying through on- and offshore wind farms (*e.g.* DIRKSEN *et al.* 1998, OSBORN *et al.* 2000, DESHOLM & KAHLERT 2005). However, there are also locations where large numbers of birds regularly fly through wind farms without diverting around it (*e.g.* EVERAERT *et al.* 2002, EVERAERT & STIENEN 2007).

PERCIVAL (2005) assumed that the ecological consequences of such a barrier effect are unlikely to be a problem at small wind farms. DREWITT & LANGSTON (2006) suggest that none of the barrier effects identified so far have significant impacts on populations. However, under certain circumstances barrier effects might lead to population level impacts indirectly, *e.g.* where a wind farm effectively blocks a regularly used air route between nesting and foraging areas, or where several wind farms interact cumulatively. Then large wind farms or a number of wind farms might lead to increased energy expenditure for birds and thus might reduce annual survival rates and / or breeding output (FOX *et al.* 2006, LANGSTON *et al.* 2006). In summary, until now it is quite difficult to judge whether avoidance behaviour causes a significant effect on individuals and, ultimately, on populations.

6 Impact Assessment

6.1 General Remarks on Limitations of Risk Assessment

As detailed in Chapter 5, collision rate depends on several factors and until now the cause-and-effect chain of collision is poorly understood. Very little is known about collision risk for migrating birds.

There have been a few attempts to predict collision rate at given wind farms with mathematical models (TUCKER 1996, BAND 2000, BAND *et al.* 2007). Modelling collision risk under the BAND model is a two-stage process. Stage 1 estimates the number of birds that fly through the rotor-swept area. Stage 2 predicts the proportion of these birds that will be hit by a rotor blade. The reliability of the collision model is limited by difficulties in gathering appropriate field data and by the large numbers of assumptions necessary during the modelling process, notably the level of collision avoidance. As a consequence, care must be taken not to overstate the model outputs. Nevertheless, MADDERS & WHITFIELD (2006) pointed out that alternative methods for estimating collision risk are less transparent or more subjective and at least vulnerable to the same potential biases. In contrast, CHAMBERLAIN *et al.* (2006) suggest that the value of the BAND collision risk model in estimating actual mortality rates is questionable until species-specific and state-specific avoidance probabilities can be better established. Therefore, the authors do not recommend the use of the model without further research into avoidance rates. LANGSTON & PULLAN (2004) sum up that collision risk models provide a potentially useful means of predicting the scale of collision attributable to wind turbines in a given location, but only if they incorporate actual avoidance rates in response to fixed structures and post-construction assessment of collision risk at wind farms that do proceed, to verify the models.

In summary, it is very difficult for several reasons to assess collision risk as well as avoidance behaviour, which might lead to increased energy expenditure caused by a proposed wind power plant within the study area. Thus, the following impact assessment should be regarded as a qualitative prediction of possible impacts.

6.2 Assessment of Possible Impacts on Migrating, Roosting and Sedentary Birds

Even though the survey focused on large soaring and gliding migrating birds whose populations are comparatively vulnerable to additional mortality (i. e. due to collisions with wind turbines) we also roughly assess possible impacts on roosting and sedentary birds which were detected in the study area in this chapter.

6.2.1 Predicting and assessing the weight of collision risk for migrating birds

Constructional Phase

Migrating birds are able to avoid obstacles, like vehicles required for construction, by active flight. So any collision during constructional phase is very unlikely.

Operational Phase

During autumn 2011 and spring 2012 very low numbers of migrating soaring and gliding birds were recorded within the study area. The most numerous species migrate on broad fronts and are not concentrated within certain locations. Though there is not always a strict correlation between abundance of birds and collision rate (see Chapter 5.1.1), it is reasonable to assume that collision risk is low in areas with low migratory activity. Thus, collision risk for migrating birds by operational wind turbines is not assumed to pose a major threat because migratory activity of relevant species in the study are was extremely low in autumn 2011 and spring 2012. Rare collisions at wind turbines within the study area might occur, but the expected collision rate will not cause significant effects on populations.

The most numerous group of species were Harriers and Falcons which are less vulnerable to collision. Harriers usually migrate few meters above ground and therefore rarely fly in the rotor swept area of wind turbines. In addition Harriers are active fliers and thus are classified as species with low to medium collision vulnerability. Falcons are supposed to have very low collision vulnerability because they are very active fliers. Only few Egyptian Vultures and Short-toed Snake Eagles were recorded within the study area, which are considered to be particularly vulnerable to collision at wind turbines.

An analysis of spatial distribution of bird migration within the study area revealed no distinctive patterns. Migratory activity was extremely low at all observation sites. Moreover there are no particular structures in the study area, *e. g.* mountain chains, which may serve as landmarks and may be important for orientation of migrating birds or which may offer good thermal uplifts. Thus, the above mentioned assessment (collision risk will not pose a major threat for migrating birds and will not affect bird populations of relevant species) is valid for the whole study area. Areas in which wind turbines might lead to a significant collision risk for migrating birds do not exist in the study area.

During spring the study area might be an important migration corridor for Blue-cheeked Bee-eaters. As Blue-cheeked Bee-eaters are active and agile fliers and therefore less vulnerable to collision a significant collision risk at wind turbines is not expected. Furthermore Blue-cheeked Bee-eaters have a "r-selected reproductive strategy" and, hence, additional mortality possibly caused by wind turbines is unlikely to have a significant effect on populations (see Chapter 5.1.2).

To conclude, establishing wind farms in the project area will not cause notable risk potential for the populations of the examined species.

6.2.2 Predicting and assessing the weight of barrier effects for migrating birds

Constructional Phase

Birds in active flight will not be affected during the constructional phase. Noise and dust emission at distinct construction sites might bring migrating birds to alter their flight path. This cannot be regarded as a significant impact.

Operational Phase

While avoidance behaviour reduces collision risk, it could result in wind farms acting as barriers to bird movement (*e. g.* DREWITT & LANGSTON 2006).

Birds might change horizontal flight direction in order to avoid a wind farm, which obviously leads to additional energy expenditure. Assuming at most a 35 to 55 km long string (length of the northern and southern edge of the project area) of wind turbines located perpendicular to a bird's flight path, one can assume that the additional flight distance caused by avoiding the whole project area will not be more than 55 km. It cannot be excluded that this decreases the fitness of individuals (especially when already weakened).

Another option to avoid a wind power plant is to change altitude (mostly by increasing) and subsequently to migrate above the critical zone of the wind turbines. Thermals are not believed to be a limiting factor within the study area. There should be a number of vertical air currents allowing birds to gain altitude. Hence, there is no reason to assume that increasing altitude will only be accomplished by active flight.

Since weather conditions (especially wind speed and direction) should be nearly the same within the whole study area, we do not expect that birds will face additional headwinds or other unfavourable conditions as a consequence of avoiding a row of wind turbines.

To conclude, although the degree of additional energy expenditure cannot be estimated precisely, a possible barrier effect will not cause notable risk potential for the populations of relevant species, because (according to the extremely low migratory activity) only very few birds might be affected.

6.2.3 Predicting and assessing the weight of collision risk and habitat loss for roosting and sedentary birds

Constructional Phase

The local bird community is very poor in species and, moreover, bird density in the study area is very low. The study area is not a preferred roosting site for migrating birds. Only the vegetated areas in the oasis and larger wadis might have an importance for local and roosting birds on a local scale. The area required for infrastructural elements is rather small compared to the whole study area. Thus, even after construction of turbines there will be enough appropriate habitats available for local birds. Hence, the impact on local and roosting birds caused by construction of wind farms within the study area is assessed not to be significant. However, the oasis and the larger wadis that have small patches of vegetation form specific elements in the desert and might be used as foraging and hunting sites for local and roosting birds. In order to minimize impacts, constructional works in the oasis and the larger wadis shall be minimized.

Local and roosting birds might be affected by disturbance during the constructional phase. However, disturbance effects are restricted to a rather small area compared to the whole study area. Thus, birds can find alternative habitats for the time of constructional works. Moreover, constructional work is limited to a rather short period of time. Local and roosting birds can reoccupy all areas after construction phase. To conclude, the impact on local and roosting birds caused by disturbance is assessed not to be significant.

An increase of bird numbers within the study area might increase the risk of collision during operation of turbines. Thus, attracting birds has to be avoided both, during construction and operation of a wind farm. Therefore, garbage should be removed directly from the wind farm area. Construction of areas with open water and houses with vegetation within the wind farm area should be avoided, too.

Operational Phase

Local and roosting birds might be affected by disturbance during the operational phase of wind farms. However, most species are known to be unsusceptible to the nearly constant acoustic and visual stimuli of wind turbines. The local bird community is very poor in species and, moreover, bird density in the study area is very low. The study area is not a preferred roosting site for migrating birds. To conclude, the impact on local and roosting birds caused by disturbance related to operating turbines is assessed as not to be significant.

Local and roosting birds might be affected by disturbances from human activities during the operational phase of wind farms. However, human activity is expected to be rather limited in time and space. In conclusion, the impact on local and roosting birds caused by disturbances related to maintenance is assessed as not to be significant.

Local and roosting birds will also face the risk of collision at operating turbines. However, resident birds are aware of turbines and their behaviour might be better adapted to the presence of turbines.

The local bird community is very poor in species and, moreover, bird density in the study area is very low. The study area is not a preferred roosting site for migrating birds. Hence, collision risk for local and roosting birds is rather low and will not lead to significant impacts.
An increase of bird numbers within the study area might increase the risk of collision during operation of turbines. Thus, attracting birds should be avoided both, during construction and operation of a wind farm.

6.2.4 Synopsis – Final Assessment

Due to the extremely low migratory activity of relevant species collision risk by operational wind turbines is not assumed to pose a major threat. Rare collisions at wind turbines within the study area cannot be excluded, but the expected collision rate will surely not cause significant effects on populations. In addition, a possible barrier effect of wind farms will not cause notable risk potential for the populations of relevant species. Establishing wind farms in the study area will not entail a noticeable risk potential for bird migration in autumn and spring. Consequently, regarding conservation of migrating birds, there is no need for spatial restrictions. Based on the results of the ornithological investigation the whole project area is equally suitable for wind power development with equally low presence of endangered birds.

6.3 Mitigation Measures

6.3.1 Current knowledge

Possible mitigation measures to reduce impacts of wind farms on birds are limited. A compilation of special literature was done within the scope of this study. However, according to the results of the investigation (very low migratory activity within the study area and, hence, little risk on birds) there is no need for such specific mitigation measures. Nevertheless, to make the study complete the compiled review on potential mitigation measures is enclosed as Annex VIII to this study.

6.3.2 Final recommendations with regards to mitigation measures

Construction and operation of wind farms within the entire study area will not lead to significant impacts on population of birds. Hence, there is no need for implementing particular mitigation measures. Nevertheless, to minimize possible impacts on birds and habitats the following recommendations should be considered:

- Constructional works next to the oasis, water wells and in the larger wadi beds shall be minimized and limited to road construction/improvement and laying of cables in trenches.
- Avoid lightening of turbines if possible. Lightening of wind turbines can attract birds (especially passerines migrating at night) and lead to a higher collision risk at operational turbines. If lighting of turbines is required due to aviation or any other legal requirements, use the minimum number of intermittent flashing white light of lowest effective intensity admitted.
- Avoidance of turbines with lattice towers in order to reduce suitable perching sites.
- Avoidance of establishing areas that would attract migrating birds (waste dump, open water bodies, gardens or houses with vegetation).

Final Declaration

We confirm that this report was prepared impartially and according to the best and latest state of knowledge. Data analysis was conducted with most possible accuracy.

Dortmund, September 26th 2012

Dr. Frank Bergen

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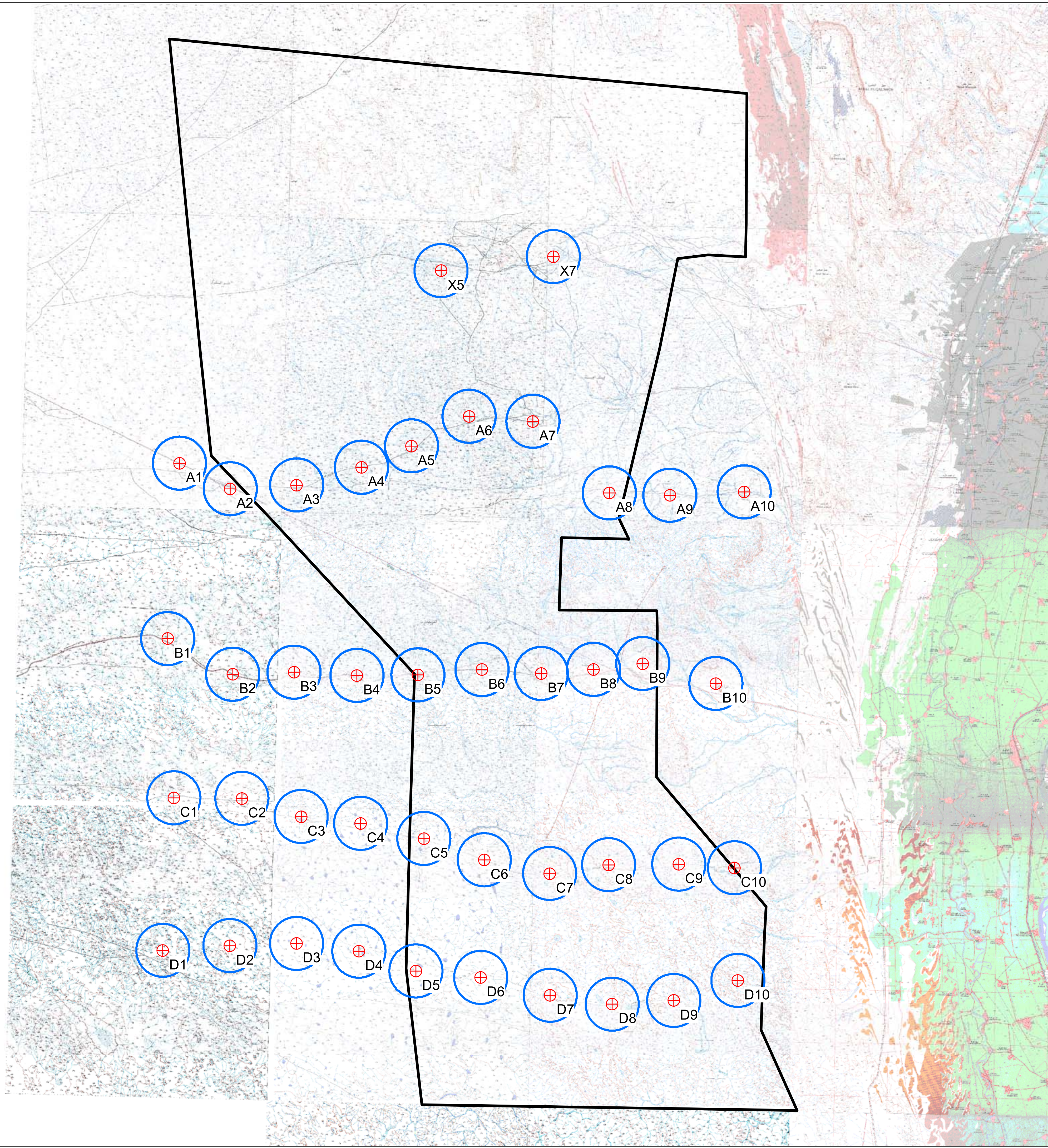
Annex

Final Report on the Ornithological Investigation at the West Nile Valley in Arab Republic of Egypt

ecoda

client:
Oriental Consultants Co., Ltd., Tokyo
Japan International Cooperation Agency, Tokyo

Annex I Overview of the study area
distribution of observation sites
in the study area in 2011 and 2012



study area

observation site

2.5 km circumference

boundary project area

editor: Lars Gaedicke, October 01th 2012

0 25 km

1:375.000

N

Annex II Relevant species, which are known to migrate along Egypt

nr	species	scientific name	IUCN Red List	SPEC
1	Greater Flamingo	*Phoenicopterus roseus*	Least Concern	3
2	Great White Pelican	*Pelecanus onocrotalus*	Least Concern	3
3	Grey Heron	*Ardea cinerea*	Least Concern	Non-SPEC
4	Purple Heron	*Ardea purpurea*	Least Concern	3
5	Western Reef Heron	*Egretta gularis*	Least Concern	-
6	Squacco Heron	*Ardeola ralloides*	Least Concern	3
7	Cattle Egret	*Bubulcus ibis*	Least Concern	Non-SPEC
8	Black-crowned Night Heron	*Nycticorax nycticorax*	Least Concern	3
9	Glossy Ibis	*Plegadis falcinellus*	Least Concern	3
10	Eurasian Spoonbill	*Platalea leucorodia*	Least Concern	2
11	Black Stork	*Ciconia nigra*	Least Concern	2
12	White Stork	*Ciconia ciconia*	Least Concern	2
13	Osprey	*Pandion haliaetus*	Least Concern	3
14	Honey Buzzard	*Pernis apivorus*	Least Concern	$Non\text{-}SPEC^E$
15	Black Kite	*Milvus migrans*	Least Concern	3
16	Egyptian Vulture	*Neophron percnopterus*	Endangered	3
17	Short-toed Snake Eagle	*Circaetus gallicus*	Least Concern	3
18	Marsh Harrier	*Circus aeruginosus*	Least Concern	Non-SPEC
19	Pallid Harrier	*Circus macrourus*	Near Threatened	1
20	Montagu's Harrier	*Circus pygargus*	Least Concern	$Non\text{-}SPEC^E$
21	Levant Sparrowhawk	*Accipiter brevipes*	Least Concern	2
22	Eurasian Sparrowhawk	*Accipiter nisus*	Least Concern	Non-SPEC
23	Steppe Buzzard	*Buteo buteo vulpinus*	Least Concern	Non-SPEC
24	Long-legged Buzzard	*Buteo rufinus*	Least Concern	3
25	Lesser Spotted Eagle	*Aquila pomarina*	Least Concern	2
26	Greater Spotted Eagle	*Aquila clanga*	Vulnerable	1
27	Steppe Eagle	*Aquila nipalensis*	Least Concern	-
28	Eastern Imperial Eagle	*Aquila heliaca*	Vulnerable	1
29	Booted Eagle	*Aquila pennata*	Least Concern	3
30	Lesser Kestrel	*Falco naumanni*	Least Concern	1
31	Common Kestrel	*Falco tinnunculus*	Least Concern	3
32	Red-footed Falcon	*Falco vespertinus*	Near Threatened	3
33	Eleonora's Falcon	*Falco eleonorae*	Least Concern	2
34	Sooty Falcon	*Falco concolor*	Near Threatened	-
35	Eurasian Hobby	*Falco subbuteo*	Least Concern	Non-SPEC
36	Lanner Falcon	*Falco biarmicus*	Least Concern	3
37	Barbary Falcon	*Falco pelegrinoides*	Least Concern	Non-SPEC
38	Peregrine Falcon	*Falco peregrinus*	Least Concern	Non-SPEC
39	Common Crane	*Grus grus*	Least Concern	2
40	Blue-cheeked Bee-eater	*Merops persicus*	Least Concern	-
41	European Bee-eater	*Merops apiaster*	Least Concern	3

Annex III-A Explanation of different categories of "The IUCN Red List of Threatened Species" (International Union for the Conservation of Nature and Natural Resources) http://www.iucnredlist.org/)

ENDANGERED (EN)
A species is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU)
A species is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT)
A species is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC)
A species is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant species are included in this category.

Annex III-B Explanation of different categories of conservation status of all wild birds in Europe (BirdLife International) http://www.birdlife.org/action/science/species/birds_in_europe/index.html

SPEC 1
European species of global conservation concern

SPEC 2
Unfavourable conservation status in Europe, concentrated in Europe

SPEC 3
Unfavourable conservation status in Europe, not concentrated in Europe

Non-SPEC^{E}
Favourable conservation status in Europe, concentrated in Europe

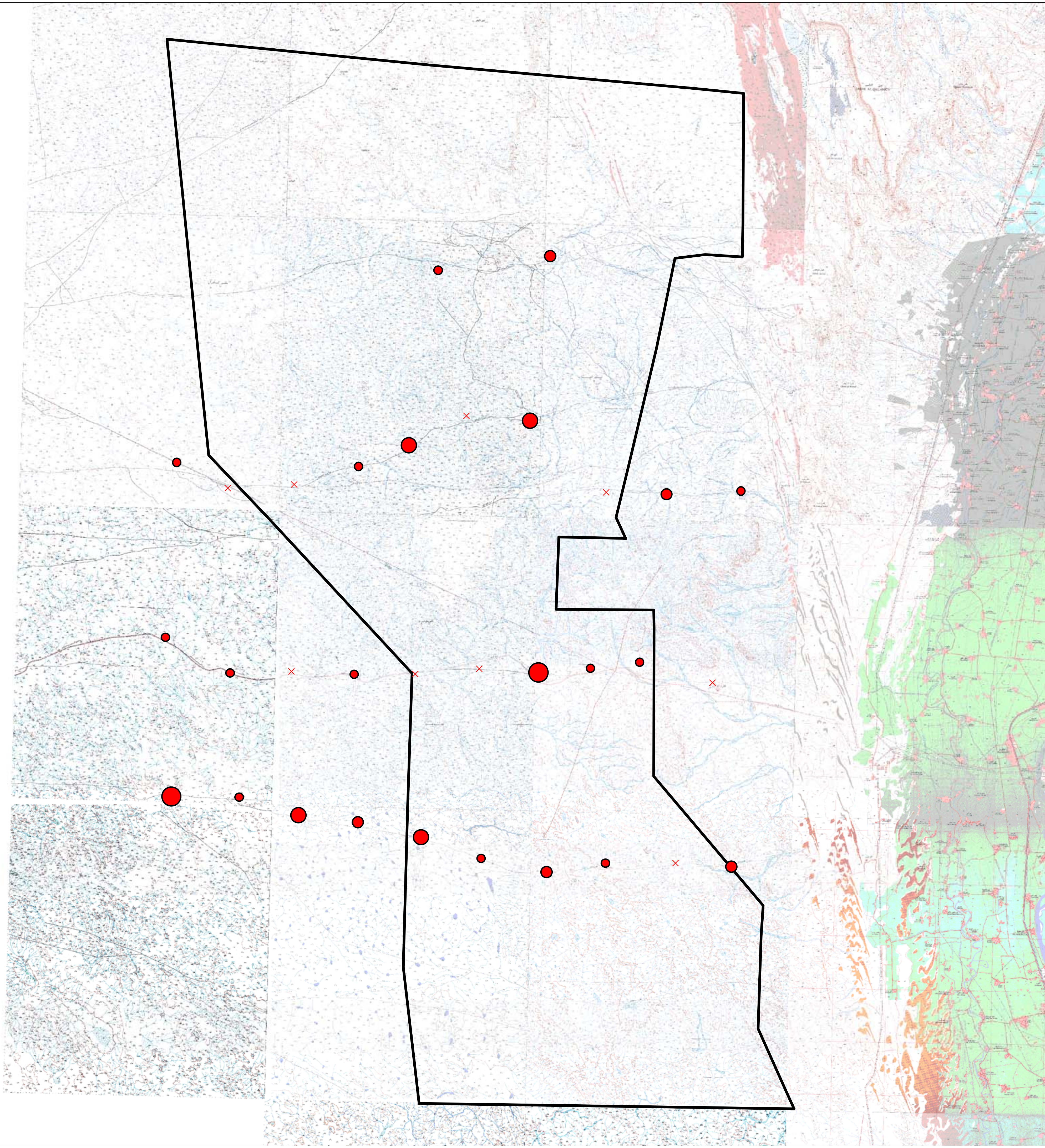
Non-SPEC
Favourable conservation status in Europe, not concentrated in Europe

Annex IV-A Total number of birds / records observed during standardized daytime field observations (overall migration) and observed within distances of 2.5 km to an observation site in autumn 2011

scientific name	overall migration		observation site	
	number	records	number	records
Honey Buzzard	12	6	12	6
Black Kite	1	1	1	1
Egyptian Vulture	1	1	1	1
Short-toed Snake Eagle	3	2	3	2
Marsh Harrier	10	9	9	8
Pallid Harrier	1	1	1	1
Montagu's Harrier	4	4	3	3
Pallid/Montagu's Harrier	1	1	0	0
Harrier spec.	1	1	1	1
Steppe Buzzard	4	3	4	3
Steppe Eagle	2	2	2	2
Booted Eagle	1	1	1	1
Common Kestrel	5	5	5	5
Red-footed Falcon	10	4	10	4
Eleonora's Falcon	1	1	1	1
Falcon	8	5	8	5
unidentified raptor	7	4	3	3
total	75	51	65	47

Annex IV-B Total number of birds migrating during standardized daytime field observations (a: all observations) and within distances of 2.5 km at each observation site (o: observation sites) in autumn 2011

species	A																				B																				C																				X			
	1		*2*		*3*		*4*		*5*		*6*		*7*		*8*		*9*		*10*		*1*		*2*		*3*		*4*		*5*		*6*		*7*		*8*		*9*		*10*		*1*		*2*		*3*		*4*		*5*		*6*		*7*		*8*		*9*		*10*		*5*		*7*	
	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a
Honey Buzzard	.	.	.	.	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	1	1	3	3	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Black Kite	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Egyptian Vulture	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Short-toed Snake Eagle	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Marsh Harrier	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	3	3	.	.	1	2	1	1	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.
Pallid Harrier	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Montagu's Harrier	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Pallid/Montagu's Harrier	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Steppe Buzzard	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.
Steppe Eagle	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Booted Eagle	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Common Kestrel	.	.	.	.	.	.	.	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.
Red-footed Falcon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	.	.	.	.	.	.	4	4	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Eleonora's Falcon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Harrier	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.
Falcon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	2	2	.	.	3	3	.	.	.	.	.	.	.	.	1	1	.	.	.	.
unidentified raptor	.	.	.	.	.	.	.	.	1	1	.	.	1	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
total	1	1	0	0	0	0	1	1	6	6	0	1	4	4	0	0	2	2	1	1	1	1	1	1	0	0	1	1	0	0	0	0	9	13	1	2	1	1	0	0	11	11	1	1	7	8	2	2	5	5	1	1	2	2	1	1	0	0	3	3	1	1	2	2



Final Report on the Ornithological Investigation at the West Nile Valley in Arab Republic of Egypt

ecoda

client:
Oriental Consultants Co., Ltd., Tokyo
Japan International Cooperation Agency, Tokyo

Annex IV-C Spatial distribution of birds in autumn 2011

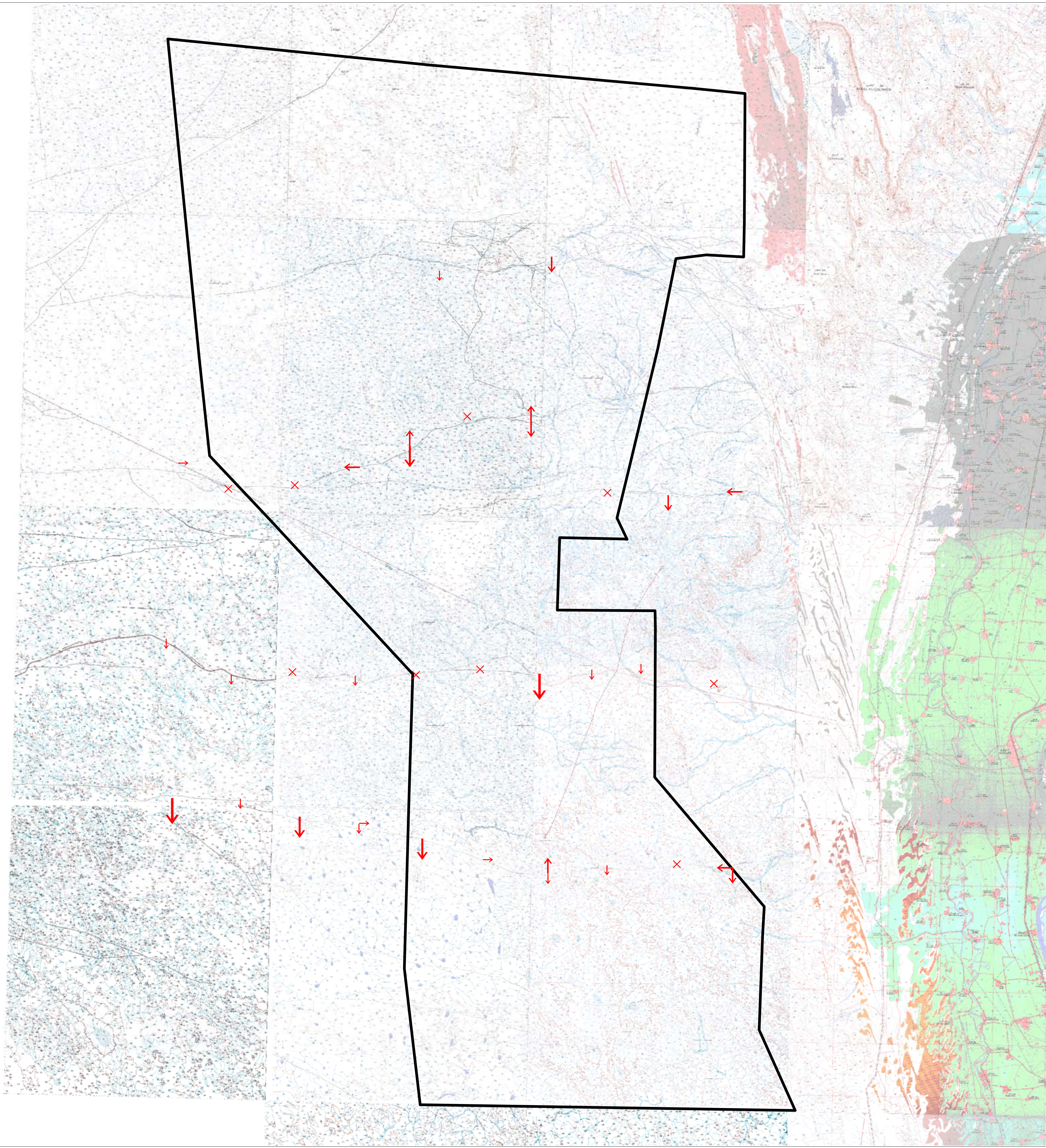
number of birds in 2.5 km distance of observation sites

number of birds

- 0
- 1
- 2 - 3
- 4 - 7
- 8 - 11

boundary project area

editor: Lars Gaedicke, October 01th 2012



Final Report on the Ornithological Investigation at the West Nile Valley in Arab Republic of Egypt

ecoda

client:
Oriental Consultants Co., Ltd., Tokyo
Japan International Cooperation Agency, Tokyo

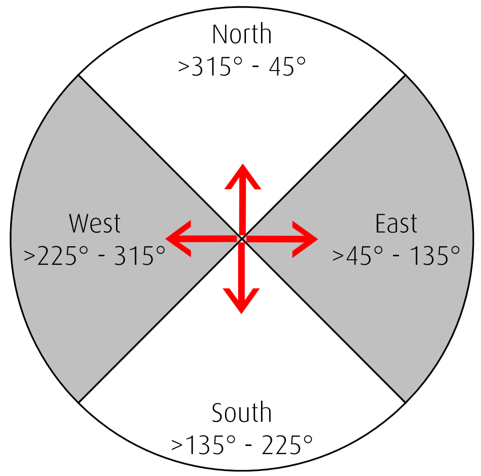
Annex IV-D
Schematic illustration of flight direction of birds in autumn 2011

number of birds in 2.5 km distance of observation sites

number of birds

- × 0
- ↓ 1
- ↓ 2 - 3
- ↓ 4 - 7
- ↓ 8 - 11

four categories were used for analysis of flight directions:



boundary project area

editor: Lars Gaedicke, October 01th 2012

0 25 km

1:375.000

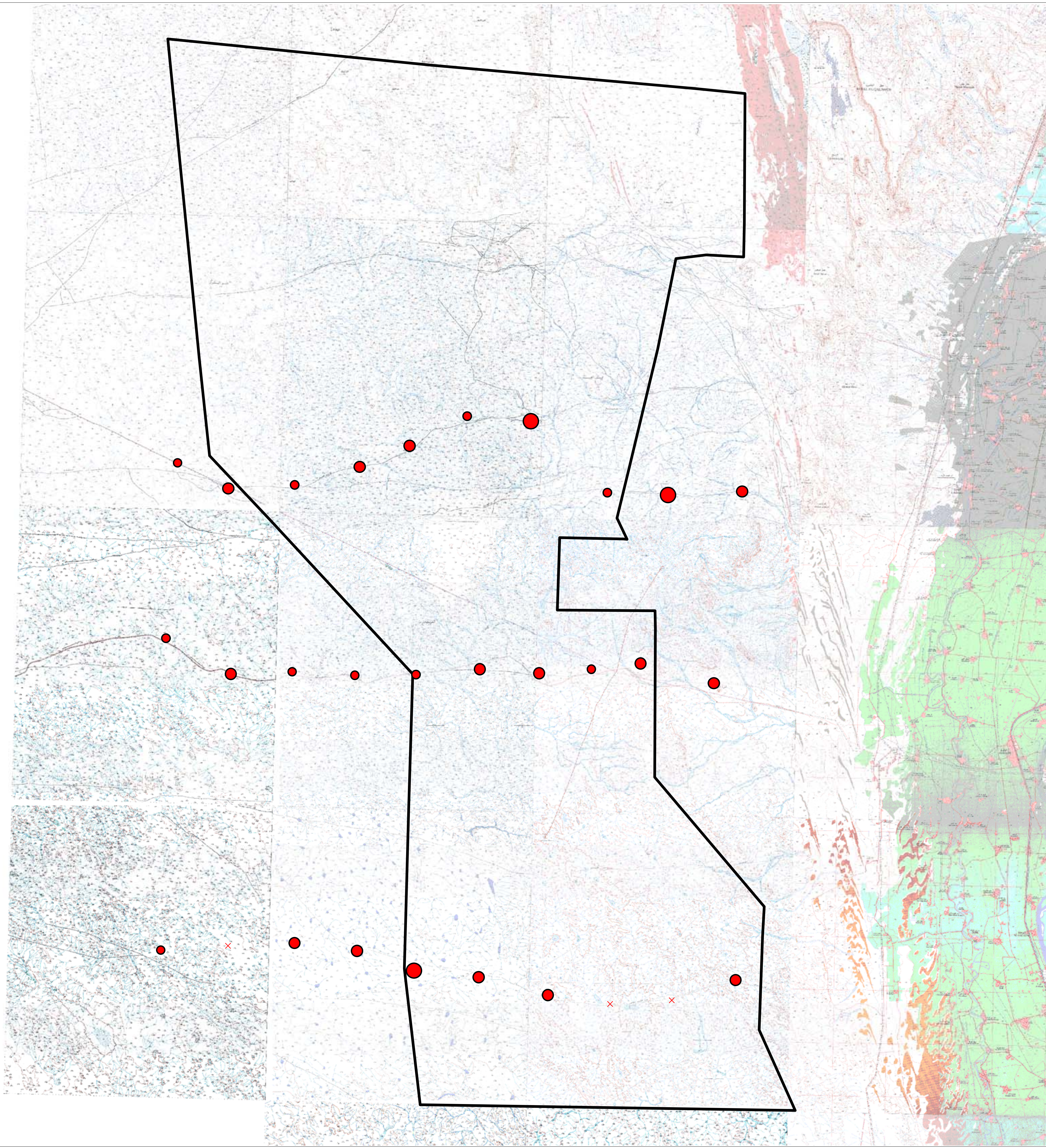
N

Annex V-A Total number of birds / records observed during standardized daytime field observations (overall migration) and observed within distances of 2.5 km to an observation site in spring 2012

scientific name	overall migration		observation site	
	number	records	number	records
Black-crowned Night Heron	8	1	0	0
White Stork	6	1	6	1
Honey Buzzard	3	3	2	2
Black Kite	1	1	1	1
Egyptian Vulture	1	1	1	1
Short-toed Snake Eagle	5	5	5	5
Marsh Harrier	3	3	2	2
Pallid Harrier	1	1	1	1
Montagu's Harrier	2	2	2	2
Pallid/Montagu's Harrier	5	5	5	5
Levant Sparrowhawk	1	1	1	1
Steppe Buzzard	2	2	2	2
Common Buzzard	2	2	2	2
Lesser Kestrel	1	1	1	1
Common Kestrel	18	17	15	15
Common/Lesser Kestrel	4	4	4	4
Falcon	7	7	5	5
unidentified raptor	5	5	4	4
Common Crane	?	1	?	1
total	75	62	59	54

Anex V-B Total number of birds migrating during standardized daytime field observations (a: all observations) and within distances of 2.5 km at each observation site (o: observation sites) in spring 2012

species	A																				B																				D																			
	1		*2*		*3*		*4*		*5*		*6*		*7*		*8*		*9*		*10*		*1*		*2*		*3*		*4*		*5*		*6*		*7*		*8*		*9*		*10*		*1*		*2*		*3*		*4*		*5*		*6*		*7*		*8*		*9*		*10*	
	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a	o	a
Black-crowned Night Heron	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
White Stork	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	6	.	.	.	.	.	.	.	.	.	.
Honey Buzzard	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Black Kite	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Egyptian Vulture	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Short-toed Snake Eagle	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	1	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Marsh Harrier	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pallid Harrier	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Montagu's Harrier	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pallid/Montagu's Harrier	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Levant Sparrowhawk	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Steppe Buzzard	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lesser Kestrel	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Common Kestrel	.	.	.	.	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	3	3	.	.	1	1	.	.	1	1	.	.	1	1	1	1	1	1	.	.	1	1	1	1	.	.	2	2	2	2	.	.
Common/Lesser Kestrel	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Falcon	.	.	.	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	.	.	1	1	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
unidentified raptor	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.
Common Crane	.	.	.	.	.	.	.	.	.	.	.	.	?	?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
total	1	1	1	1	1	3	3	3	3	3	0	0	0	0	1	9	2	2	2	2	1	1	2	3	2	2	1	1	4	6	1	1	2	3	2	2	5	6	2	2	3	3	1	1	1	1	0	0	7	7	2	2	0	0	2	3	3	3	2	2



Final Report on the Ornithological Investigation at the West Nile Valley in Arab Republic of Egypt

ecoda

client:
Oriental Consultants Co., Ltd., Tokyo
Japan International Cooperation Agency, Tokyo

Annex V-C Spatial distribution of birds in spring 2012

number of birds in 2.5 km distance of observation sites

number of birds

- × 0
- ● 1
- ● 2 - 3
- ● 4 - 7
- ● 8 - 11

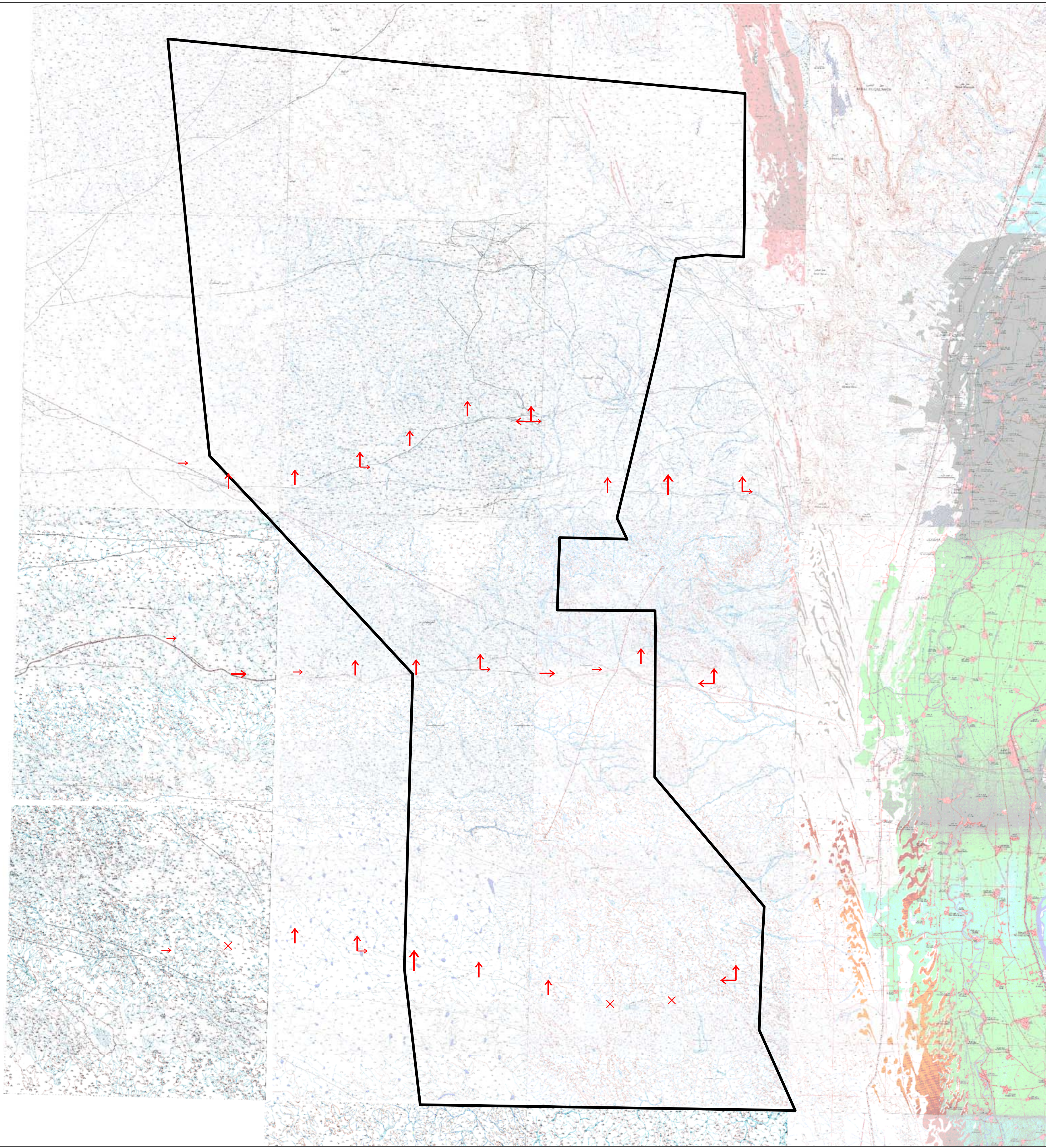
▭ boundary project area

editor: Lars Gaedicke, October 01th 2012

0 25 km

1:375.000

N



Final Report on the Ornithological Investigation at the West Nile Valley in Arab Republic of Egypt

ecoda

client:
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Japan International Cooperation Agency, Tokyo

Annex V-D
Schematic illustration of flight direction of birds in spring 2012

number of birds in 2.5 km distance of observation sites

number of birds

× 0
↓ 1
↓ 2 - 3
↓ 4 - 7
↓ 8 - 11

four categories were used for analysis of flight directions:

North >315° - 45°
East >45° - 135°
South >135° - 225°
West >225° - 315°

boundary project area

editor: Lars Gaedicke, October 01th 2012

0 25 km
1:375.000
N

Annex VI-A Migrating and resting non-relevant species recorded during standardized daytime field observations and accidentally in autumn 2011 (sedentary birds excluded)

species	scientific name	number
Common Quail	*Coturnix coturnix*	1
Common Cuckoo	*Cuculus canorus*	1
White-throated Kingfisher	*Halcyon smyrnensis*	1
Red-backed Shrike	*Lanius collurio*	55
Great Grey Shrike	*Lanius excubitor*	1
Lesser Grey Shrike	*Lanius minor*	2
Woodchat Shrike	*Lanius senator*	2
Calandra Lark	*Melanocorypha calandra*	1
Greater Short-toed Lark	*Calandrella brachydactyla*	26
Sand Martin	*Riparia riparia*	2
Barn Swallow	*Hirundo rustica*	169
Sedge Warbler	*Acrocephalus schoenobaenus*	8
Eurasian Reed Warbler	*Acrocephalus scirpaceus*	4
Great Reed Warbler	*Acrocephalus arundinaceus*	1
Eastern Olivaceous Warbler	*Hippolais pallida*	1
Icterine Warbler	*Hippolais icterina*	3
Willow Warbler	*Phylloscopus trochilus*	86
Common Chiffchaff	*Phylloscopus collybita*	33
Eurasian Blackcap	*Sylvia atricapilla*	1
Common Whitethroat	*Sylvia communis*	4
Lesser Whitethroat	*Sylvia curruca*	11
Barred Warbler	*Sylvia nisoria*	2
Rüppell's Warbler	*Sylvia rueppelli*	3
Sardinian Warbler	*Sylvia melanocephala*	1
Spectacled Warbler	*Sylvia conspicillata*	1
Spotted Flycatcher	*Muscicapa striata*	7
Collared Flycatcher	*Ficedula albicollis*	1
Thrush Nightingale	*Luscinia luscinia*	2
Common Redstart	*Phoenicurus phoenicurus*	4
Whinchat	*Saxicola rubetra*	8
Eurasian Stonechat	*Saxicola torquatus*	4
Northern Wheatear	*Oenanthe oenanthe*	1
Eastern Black-eared Wheatear	*Oenanthe melanoleuca*	2
Desert Wheatear	*Oenanthe deserti*	7
Isabelline Wheatear	*Oenanthe isabellina*	4
Eurasian Golden Oriole	*Oriolus oriolus*	11
White Wagtail	*Motacilla alba*	241
Citrine Wagtail	*Motacilla citreola*	1
Tawny Pipit	*Anthus campestris*	8
Red-throated Pipit	*Anthus cervinus*	39
Ortolan Bunting	*Emberiza hortulana*	1
Corn Bunting	*Emberiza calandra*	1
Common Rosefinch	*Carpodacus erythrinus*	1
Yellow Wagtail	*Motacilla flava spec.*	40

Annex VI-B Migrating and resting non-relevant species recorded during standardized daytime field observations and accidentally in spring 2012 (sedentary birds excluded)

species	scientific name	number
Common Quail	*Coturnix coturnix*	11
Little Ringed Plover	*Charadrius dubius*	3
Common Snipe	*Gallinago gallinago*	1
Common Greenshank	*Tringa nebularia*	1
Green Sandpiper	*Tringa ochropus*	5
Wood Sandpiper	*Tringa glareola*	2
Little Stint	*Calidris minuta*	9
European Turtle Dove	*Streptopelia turtur*	32
Eurasian Collared Dove	*Streptopelia decaocto*	6
Common Cuckoo	*Cuculus canorus*	6
Common Swift	*Apus apus*	32
Pallid Swift	*Apus pallidus*	4
Eurasian Hoopoe	*Upupa epops*	19
Eurasian Wryneck	*Jynx torquilla*	5
Great Grey Shrike	*Lanius excubitor*	4
Lesser Grey Shrike	*Lanius minor*	1
Masked Shrike	*Lanius nubicus*	2
Woodchat Shrike	*Lanius senator*	14
Hooded Crow	*Corvus cornix*	12
Bar-tailed Lark	*Ammomanes cincturus*	22
Desert Lark	*Ammomanes deserti*	1
Greater Short-toed Lark	*Calandrella brachydactyla*	268
Sand Martin	*Riparia riparia*	13
Barn Swallow	*Hirundo rustica*	599
Red-rumped Swallow	*Cecropis daurica*	4
Common House Martin	*Delichon urbica*	37
Eurasian Reed Warbler	*Acrocephalus scirpaceus*	14
Eastern Olivaceous Warbler	*Hippolais pallida*	16
Willow Warbler	*Phylloscopus trochilus*	2
Common Chiffchaff	*Phylloscopus collybita*	21
Eastern Bonelli's Warbler	*Phylloscopus orientalis*	3
Garden Warbler	*Sylvia borin*	3
Common Whitethroat	*Sylvia communis*	15
Lesser Whitethroat	*Sylvia curruca*	28
Asian Desert Warbler	*Sylvia nana*	1
Eastern Orphean Warbler	*Sylvia crassirostris*	3
Arabian Warbler	*Sylvia leucomelaena*	1
Rüppell's Warbler	*Sylvia rueppelli*	19
Subalpine Warbler	*Sylvia cantillans*	10
Sardinian Warbler	*Sylvia melanocephala*	3
Spectacled Warbler	*Sylvia conspicillata*	7
Spotted Flycatcher	*Muscicapa striata*	31
European Pied Flycatcher	*Ficedula hypoleuca*	1
Collared Flycatcher	*Ficedula albicollis*	2
Thrush Nightingale	*Luscinia luscinia*	3
Rufous-tailed Scrub Robin	*Cercotrichas galactotes*	6
Common Redstart	*Phoenicurus phoenicurus*	8
Whinchat	*Saxicola rubetra*	20
Northern Wheatear	*Oenanthe oenanthe*	58
Black-eared Wheatear	*Oenanthe hispanica*	2
Eastern Black-eared Wheatear	*Oenanthe melanoleuca*	9

Annex VI-B continuation

species	scientific name	number
Red-tailed Wheatear	*Oenanthe xanthoprymna*	1
Desert Wheatear	*Oenanthe deserti*	10
Isabelline Wheatear	*Oenanthe isabellina*	5
Rufous-tailed Rock Thrush	*Monticola saxatilis*	2
Eurasian Golden Oriole	*Oriolus oriolus*	1
Rosy Starling	*Pastor roseus*	1
White Wagtail	*Motacilla alba*	51
Western Yellow Wagtail	*Motacilla flava*	15
Black-headed Wagtail	*Motacilla feldegg*	16
Tawny Pipit	*Anthus campestris*	29
Tree Pipit	*Anthus trivialis*	19
Red-throated Pipit	*Anthus cervinus*	5
Ortolan Bunting	*Emberiza hortulana*	1
Pale Rockfinch	*Carpospiza brachydactyla*	1
Pipit spec.	*Anthus spec.*	31
Swallow spec.		17
Wagtail spec.	*Motacilla spec.*	2
Wheater spec.	*Oenanthe spec.*	13
Yellow Wagtail	*Motacilla flava spec.*	150

Annex VII Pictures of species from the study area and its surrounding

Figure VII-1: A flock of Squacco Herons resting in the study area (© Sören Schweineberg)

Figure VII-2: One of the few Egyptian Vultures (age: first year), which migrated through the study area (© Joscha Beninde)

Figure VII-3: Short-toed Snake Eagle gaining height while migrating in the study area (© Elias Stich)

Figure VII-4: Honey Buzzard resting in the study area (© Joscha Beninde)

Figure VII-5: Wood Sandpiper (Tringa glareola), a wader which is usually found in wetlands, resting in the study area (© Michael Werner)

Figure VII-6: Reed Warbler (Acrocephalus scirpaceus) at an observation site (© Eike Eissing). Shadow is used to reduce the impact of the sun while resting in deserts during the day.

Figure VII-7: Rüppel's Warbler (SylVIIa ruepelli; male) were often resting and foraging in scrubs within the study area (© Elias Stich)

Figure VII-8: Eastern Black-eared Wheatear (Oenanthe melanoleuca; male) in the study area (© Elias Stich)

Figure VII-9: Black-headed Wagtails (*Motacilla flava feldegg*; male) belonged to the commonest migrating and resting passerines during autumn and spring in the study area (© Elias Stich)

Figure VII-10: Chestnut-bellied Sandgrouse (*Pterocles exustus*) recorded outside the study area at the Nile Valley near Al Bahnasa (© Elias Stich)

Figure VII-11: Blue-cheeked bee-eaters (*Merops persicus*) were regularly recorded in the study area during spring migration period (© Elias Stich)

Figure VII-12: A Blue-cheeked bee-eaters (*Merops persicus*) recorded at the Nile Valley near AL Bahnasa (© Elias Stich)

Figure VII-13: The Black-winged kite (*Elanus caeruleus*) is a common raptor species at the Nile Valley, but it did not appear in the study area (© Elias Stich)

Figure VII-14: The Hoopoe (*Upupa epops*) was occasionally found in the study area (© Joscha Beninde)

Annex VIII Current knowledge on possible mitigation measures

As a general recommendation, mitigation measures developed to avoid impacts should be given priority over those that reduce impacts or compensate for impacts. Apparently a key factor in avoiding impacts is a careful turbine placement (macro-siting), that is to say, ensuring that key areas of conservational importance and sensitivity are avoided.
JOHNSON *et al.* (2007) distinguish between three primary types of mitigation measures to reduce collision risk at wind turbines: modifying the siting of entire wind farms as well as placement of individual turbines, modification of turbines and other wind power plant structures and modification of habitats. Following JOHNSON *et al.* (2007) one can differentiate between:

<u>Modification of the siting of entire wind farms as well as placement of individual turbines</u>
First, a reasonable siting of wind farms is crucial to prevent unacceptable impacts. This includes avoiding critical areas, *i.e.* Wadis and the oasis with vegetation, which are used as stopover sites by migrating passerines and used as hunting area of raptors.

DREWITT & LANGSTON (2006) recommend avoiding alignment of turbines perpendicular to main flight paths of birds and providing corridors between clusters, aligned with main flight trajectories, within large wind farms. Also HÖTKER (2005) and EXO *et al.* (2005) suppose that maintaining gaps within large wind power plants could decrease impacts. Gaps might enable migrating birds to avoid turbines and to pass a large wind power plant safely (see Figure VIII.1). Consequently, shorter turbine strings may mitigate a barrier effect (DE LUCAS *et al.* 2007). Hence, implementing escape corridors might allow birds to leave the wind farm area in a safe way and without larger efforts.
However, effects of such corridors need to be examined and tested (LANGSTON *et al.* 2006).

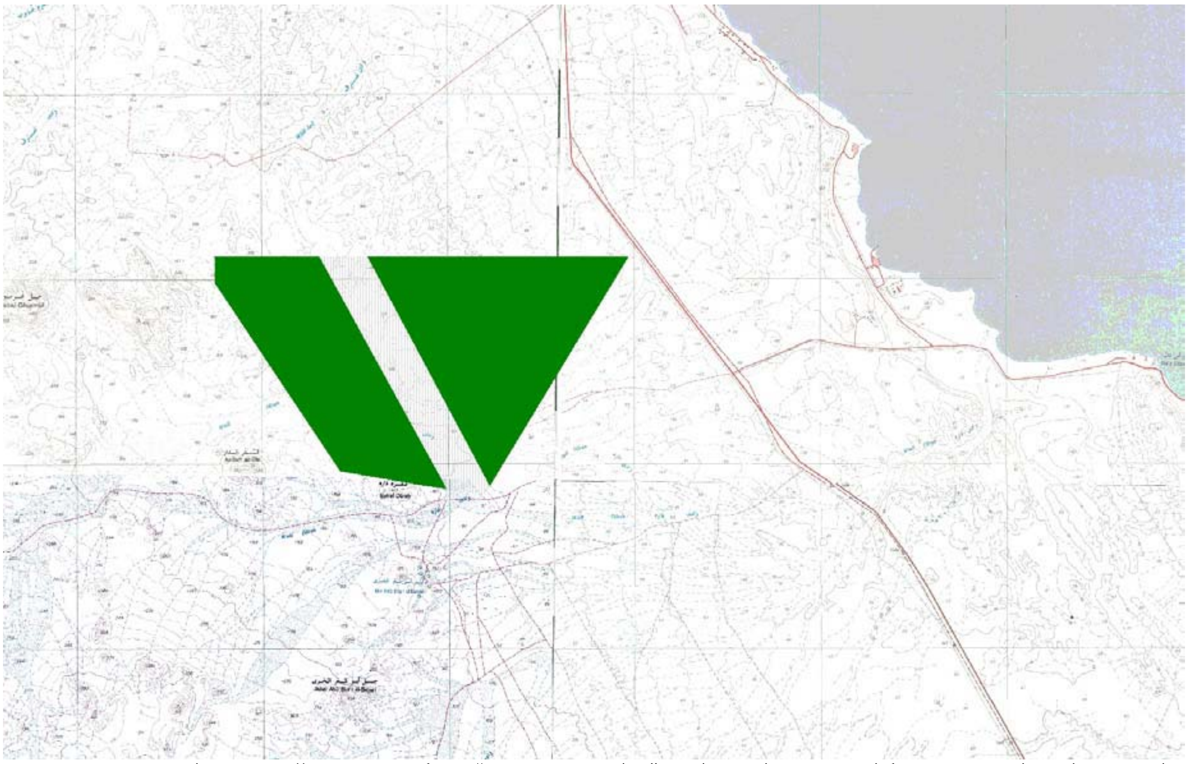

Figure VIII.1: Schematic illustration of an "escape corridor" within a huge wind farm. Note that the corridor is orientated parallel to the dominating wind-direction.

ORLOFF & FLANNERY (1992) reported that end-row turbines had higher fatality rates than turbines within strings. Also, SMALLWOOD & THELANDER (2004) found that wind turbines were most dangerous at the ends of turbine strings, at the edge of gaps in strings, and at the edges of clusters of wind turbines. Other studies found no significant difference in the rate of mortality at end-row versus other turbine locations (*e.g.* HOWELL & NOONE 1992, THELANDER & RUGGE 2001). Higher collision rates found at end-row turbines might be related to topographical features (ridges, slopes or hill shoulders), where turbine strings end, or to other factors (prey availability).
The CALIFORNIA ENERGY COMMISSION (2002) indicated that turbines spaced closely together might enhance collision risk by making it more difficult for large birds to clear the space between blades. BARRIOS & RODRIGUEZ (2004) found most fatalities and risk situations at two strings with little space between consecutive turbines, indicating that more space might reduce collision risk.
Overall, the relationship between spatial configuration of turbines and higher fatalities (including impacts of end-row versus mid-row turbines, differently sized gaps between turbines in a string, and clustering versus open configurations) remains uncertain (STERNER *et al.* 2007).

Modification of turbines
Perching by raptors on wind turbines has been implicated in higher rates of mortality (ORLOFF & FLANNERY 1992). Although not all investigations support this assumption (*e.g.* THELANDER & RUGGE 2000, SMALLWOOD & THELANDER 2004), installation of turbines with tubular towers and avoiding other structures suitable for perching are simple measures to reduce raptor activity within an area and hence collision risk.

Due to the large area swept by a rotor, collision risk is believed to be higher at taller turbines. Nevertheless, ORLOFF & FLANNERY (1992) found no relationship between height of turbines and risk of collision. Furthermore, in other studies shorter turbines appear to have even higher collision rates (CALIFORNIA ENERGY COMMISSION 2002). Obviously, other factors (slope, topography, proximity to prey, species concerned, status of species (breeding, resting, migrating)) all play a more important role for collision mortality (see also HÖTKER 2006). Thus, regarding turbine height, mitigation measures should be site-specific and dependent on the group of species most likely at risk (JOHNSON at al. 2007).
Lighting of turbines is believed to increase the risk of collision on man-made structures by attracting and disorientating birds (*e.g.* DREWITT & LANGSTON 2006). This is mostly a problem for nocturnal migrants (primarily passerines) during conditions of poor visibility. According to UGORETZ (2001), birds are more sensitive to and even appear attracted by red light. Quickly flashing white strobe lights appear to be less attractive. The consensus among researchers is to avoid lighting turbines when and where possible (JOHNSON *et al.* 2007). If lighting is crucial, the current recommendation is to use the minimum number of intermittent flashing white lights of lowest effective intensity (DREWITT & LANGSTON 2006).

Research with captive American Kestrels (*Falco sparverius*) and Red-tailed Hawks indicates that painting turbine blades can increase blade visibility in a variety of conditions. Based on experiments with several patterns painted on blades, MCISAAC (2001) recommended a pattern with square-wave black-and-white bands that run across the blade. HODOS (2003) have proposed that motion smear may reduce the ability of raptors and other birds to see turbine blades. Thus, motion smear might be a reason for collisions during daytime, in which the visual faculty of birds is actually good. Motion smear primarily occurs at the tips of the blades, and may make blades virtually transparent at high velocities. Anti-motion smear patterns may increase the visibility of turbine blades at distances at which raptors could still safely manoeuvre away from them. Studies with captive raptors indicate that a single, solid black blade paired with two white blades (or a single-blade, thin-stripe pattern) is the most visible stimulus (HODOS 2003; see Figure VIII.2).
Since most diurnal birds, including raptors, seem to be able of detecting Ultra Violet (UV) light, there have been efforts to reduce collision risk by painting turbine blades with UV reflective paint (KREITHEN & SPRINGSTEEN 1996, MCISAAC & KREITHEN 1996, see also JOHNSON *et al.* 2007). However, YOUNG *et al.* (2003), who tested this hypothesis in the wind plant of Foot Creek Rim (Wyoming) found no evidence that there is a difference in bird use, collision risk or mortality (which was generally low) between turbine blades with a UV-light reflective paint and those covered conventionally.

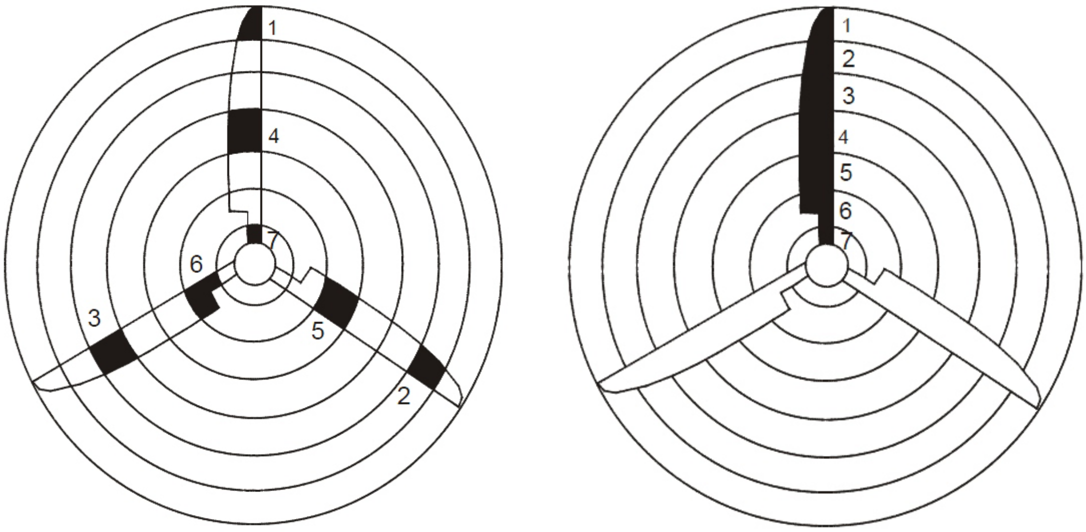

Figure VIII.2: Proposed patterns of painting turbine blades (according to HODOS 2003): a black bar on one blade is not repeated in the same location on the other two blades (left); a single-blade, anti-motion-smear pattern (right).

Scare or warning devices that emit sounds have been used at airports or agricultural fields to deter birds. Most studies of these devices have found that birds become habituated to the devices, reducing the long-term effectiveness of these techniques (JOHNSON *et al.* 2007). However, migrating birds are unlikely to habituate to sounds. Whether deterrent devices (see for instance www.dtbird.com) are an effective measure to reduce impacts for wind farms has yet to be examined.
Finally, for certain problematic turbines associated with unacceptable mortality due to their location or other factors, the only suitable form of mitigation may be removal of the these turbines.

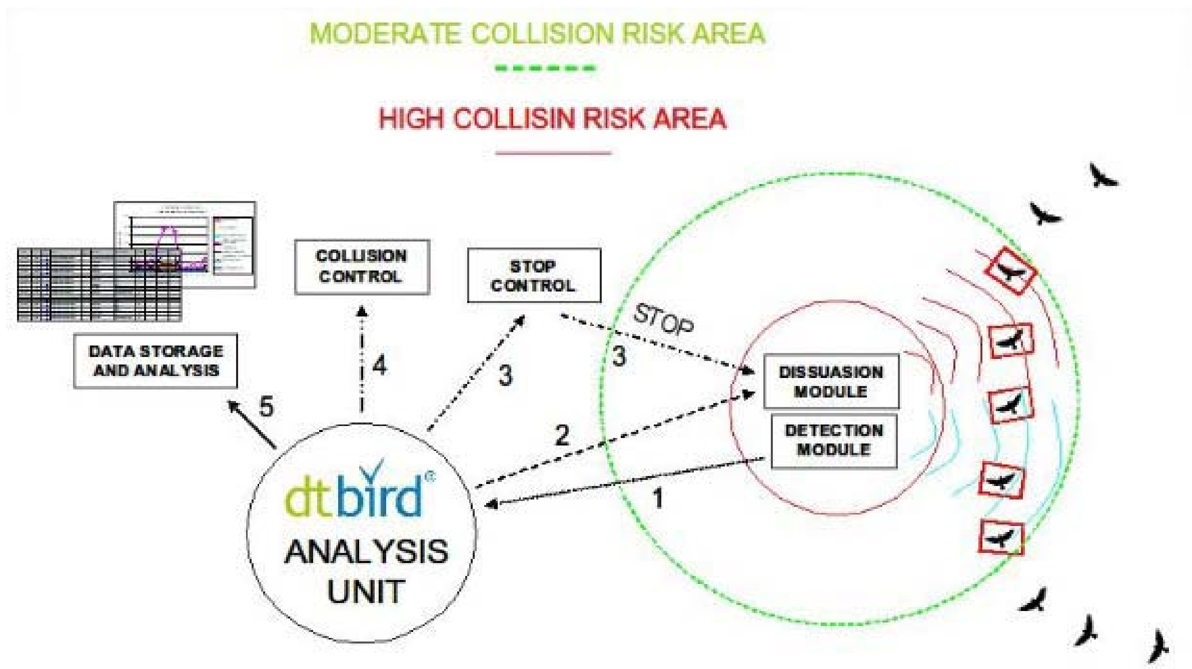

Figure VIII.2: Schematic illustration of a detection and dissuasion system.

Modification of operation of turbines

If there are a few critical turbines within a large wind farm or if collision risk is limited to certain (short) periods of time, a temporal shutdown of critical wind turbines might be another option to reduce or eliminate bird collisions (*e.g.* LANGSTON *et al.* 2006).

A relatively new attempt to prevent collisions is to use radar systems originally developed for NASA and the US Air Force (MCDERMOTT 2009). The intent is to detect approaching birds from as far as 6.0 km away, to analyze weather conditions, and to determine the risk of collision in real time. If a relevant collision risk exists, the turbines are programmed to shutdown, restarting once the birds have passed. This new radar technology is currently tested at the 202 MW large Peñascal wind farm in Texas. A successfully operating SOD programme was established in a wind farm in Mexico (La Venta II). Moreover, an effective shutdown programme controlled by observers is currently used at the wind farm "Parque eólico de Barão de S. João" in Potugal (TOMÉ unpubl.).

Modification of habitats

Several authors (*e.g.* JOHNSON *et al.* 2007, STERNER *et al.* 2007) recommend the following habitat modifications in order to minimize impacts:

- avoid natural or artificial perching sites;
- avoid establishing wind farms in areas with high natural food sources;
- avoid structures within a wind power plant that might attract birds (*e.g.* waste dump);
- reduce local food sources (as a management option in some wind farms).

Other mitigation measures

Apart from modification of turbines, DREWITT & LANGSTON (2006) recommend installing transmission cables underground (especially in areas of high bird concentrations) and to mark overhead cables using deflectors or so-called bird flappers.