

## Wild birds and Macedonia International Airport: a risk analysis for possible bird strikes on aircrafts

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### *Abstract*

One of the aircraft flight safety risks is the disturbances caused by wild birds during takeoff, landing, or, less often, in another phase of the flight of the aircraft. The so called in the literature bird strikes, give cause for many accidents, some of which are fatal. This research presents preliminary results of a project of recording wild birds' species that were tracked in the Macedonia International airport of Thessaloniki. For the purposes of this program six count points of wild birds were placed near the airport runways. The bird species, their abundance and their flight height was recorded. By using correspondence analysis it was found which bird species can cause problems to aircrafts, and which parts of the airport can be considered "dangerous".

### *Introduction*

Aviation safety is a very significant research issue with several dimensions. One of these dimensions is the danger occurring from the wildlife collisions with aircrafts. This dimension has been little studied in the literature and scientists are not aware of all the aspects concerning these human-wildlife conflicts (Dolbeer, 2009). According to Wenning et al. (2004) the possibility of a collision of wildlife to aircrafts, which is known as wildlife strike, has expanded because of the expansion of the flights worldwide and the population increase of some mammals, and

especially birds (Bird Life International, 2004). This has resulted in the death of 219 individuals and the destruction of 200 aircrafts worldwide since 1988, while in USA there have been more than 82 thousand wildlife strikes since 1990 (Dolbeer & Wright, 2008).

Most common collisions of wildlife to aircrafts come from birds. Bird strikes can be defined as the collision of a bird species with a human made vehicle (usually aircraft). Birds, concerning the USA, are responsible for the 97.5% of the total wildlife strikes for the last twenty years. Although such a good database is not available in Greece (Nikolaidis, 2005), there are some data which show that Greece is influenced by this aviation safety problem, taking into consideration that it is a migratory bird passage (Nikolaidis & Koloka, 2005). According to Nikolaidis (2003) in 1999-2000 there were 110 bird strikes in Greece, a number that is considered significant compared to the total flights in Greece. Most of the bird strikes occurred in Kerkyra (Corfu) airport, while second was Macedonia International Airport of Thessaloniki with 21 strikes.

The present research is focused on the latter airport. Macedonia International Airport presented a 0.01% probability for a bird strike (Nikolaidis, 2005) and it has never been researched about the bird species and their abundance that live at it. Therefore, the research objective was to observe the birds, and to estimate possible hazards about the flights of Macedonia International Airport. This research focuses on the animal behaviour towards such events, and it is one of the few which takes such an ecological approach (Soldatini et al., 2010; Kitowski, 2011). The following sections present some preliminary data from a scientific project which took place on Thessaloniki's Airport in 2008.

## *Methods*

For the purposes of the research, the runways of Macedonia International Airport were used. Macedonia International Airport is the second largest airport in Greece, located 14 km far from Thessaloniki city center, and serves more than 3.5 million passengers annually (thessalonikiairport.gr, 2011). Six count points were installed in 2007 on systematically selected points of the runways; these points are considered as crucial for the operation of the airport and are the most possible for bird strike occurrence. The six points are shown in Figure 1.

Waterbird surveys were conducted every 15 to 30 days during the period from February, 1<sup>st</sup>, to November, 22<sup>nd</sup>, 2007. In total 13 censuses were carried out. Surveys were conducted from 8 a.m. to 10:00, although few censuses took place at afternoon. All bird species were identified and counted with the use of a 10 × 50 binoculars in a radius of 500 m for 15 minutes duration (Bibby et al. 1992). Given

the open space of the study area, these counts were expected to lead to accurate assessments of abundance for most species (Davis & Smith 1998). Species not likely to be detected with this census method, due to spreading over the whole area and the difficulty to be seen in vegetation, are not considered here (e.g. *Gallinago gallinago*).

On every experimental point, four variables were recorded. The first variable was a nominal one, “bird species”, referring to the species of wild birds that were observed by the researcher. The second was a continuous one, “species abundance”, referring to the observed number of each bird species. The third one was the continuous variable “height of bird flight”, referring to the height that the researcher observed the birds to fly. “Height of bird flight” was then transformed in an ordinal variable with five categories: i) 0-99 m, ii) 100-199 m, iii) 200-299 m, iv) 300-399 m, and v) more than 400 m height of bird flight. Finally, the nominal variable “Points” referring to the experimental points of the research was used.

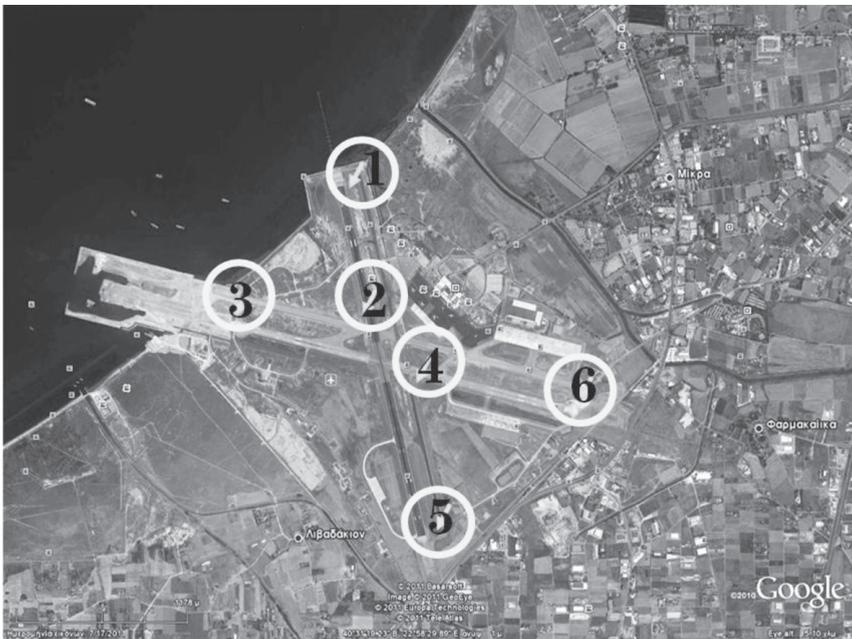


Figure 1. Experimental points on Macedonia International Airport (Map source: Google maps 2011)

The four variables (two nominal, one continuous, and one ordinal respectively) were the data that were used in the present research. These data were recorded in a Microsoft Excel File, and, after suitable manipulation, they were analyzed with

SPSS 19.0 statistical package (Kinnear & Gray, 2011) and CHIC Analysis (Markos et al., 2010).

The statistical analysis was performed using basic descriptive statistics (Bradley et al., 2007) and Correspondence Analysis. According to Markos et al. (2010) “Correspondence Analysis is a multidimensional data analytic method, suitable for graphically exploring the association between two or more, non-metric variables without a priori hypotheses or assumptions”. The theoretical foundations of this method can be found in Papadimitriou (2007) and Tabachnick and Fidell (2007). The nominal variable “Points” and the ordinal one “Height of bird flights”, weighted by the “species abundance” variable was used in Correspondence Analysis. The reason for using this method was that it could possibly reveal a pattern of birds’ behavior in the six points, which could show the existence of danger for the aircrafts.

## Results

At the first stage, some descriptive statistics from the observations were extracted. It was found that thirty (30) different bird species were observed in Macedonia International Airport with a total abundance of 17,230 individuals. In Table 1, the main species of wild birds are presented, together with their absolute and relative abundance.

*Table 1. Main wild bird species and their abundance in Macedonia International Airport of Thessaloniki during the period 1/2/2007 - 22/11/2007 (n=13)*

Bird species	Absolute abundance	Relative abundance (%)
Larus ridibundus	8,832	51
Larus sp.	4,700	27
Larus cachinnans	2,197	12
Anas platyrhynchos	545	3
Pica pica	388	2
Vanellus vanellus	172	1

**Table 1** shows that 90% of the bird species observed in Macedonia International Airport are gulls. This is something that was expected since the airport is located by Thessaloniki’s sea (Thermaikos gulf). Additionally, other species include also waterbirds like ducks and lapwings.

**Table 2** shows the distribution of the wild birds’ abundance in the five categories of the variable “heights of bird flights”.

*Table 2. Distribution of birds' abundance in height categories*

Categories of height	Absolute bird abundance	Relative bird abundance (%)
0-99 m	12,794	74
100-199 m	253	1
200-299 m	3,084	18
300-399 m	600	4
> 400 m	500	3

It is shown that most of the birds fly relatively low (0-99 m). Indeed, 12,250 out of 12,794 of the birds were observed on the ground (0 m height). This is the 71% of the total birds observed. However, there are also a significant percentage of birds in the third category (200-299 m).

The spatial distribution of the birds on the runways of Macedonia International airport is shown in Table 3.

*Table 3. Distribution of birds' abundance in the experimental Points*

Count Points	Absolute abundance	Relative abundance (%)
Point 1	10,853	63
Point 2	3,234	19
Point 3	2,536	15
Point 4	240	1
Point 5	182	1
Point 6	185	1

It is shown that most of the birds (78%, Points 1 and 3) were present by the sea (as shown in Figure 1), but most of them (Point 1) were observed on the runway 16-34 (name of one of the two airport runways). This reveals that aircrafts "feel" birds' pressure mostly when they arrive or depart from the Thermaikos Gulf side instead of when they fly from the opposite side (Kardia village side).

The application of the Correspondence Analysis revealed that most of the information (variance) of the model is explained at the first dimension, thus the one-dimension solution is the best one. More than 90% of the total variance is explained, giving a good picture of the relation of "Points" against "Height of bird flights", weighted by the "species abundance". Table 4 shows the inertia value of the first two dimensions, the variance explained, and the chi-square statistic. Because of the big inertia value and variance explained of the first dimension, the results concerning this dimension are presented next.

Table 4. Results of Correspondence Analysis application

<b>“Points” x “height of bird flights” (weighted by species abundance)</b>				
Dimension	Inertia	Variance explained	Chi-square	p-value
First	0,944	90,9	17.881	0.000
Second	0,092	8,8	(df=20)	

Figure 2 shows the discrimination of the points in the first dimension. Point 2 discriminates from all the other points, which are very close to one another. Figure 3 shows the discrimination of height of bird flights in the first dimension. The category 200-300 m discriminates clearly from all the other categories of heights, which are very close to one another.

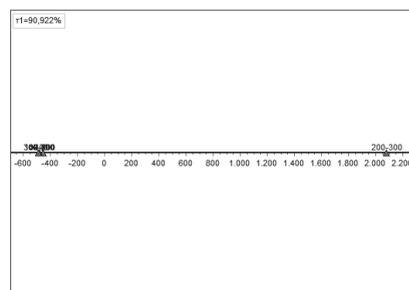
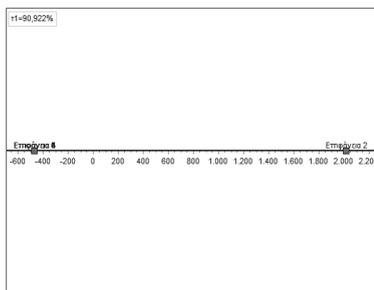


Figure 2. Points in the first dimension

Figure 3. Heights in the first dimension

Finally, Figure 4 shows the interaction of the two variables in the first dimensional level. As it was expected from the previous figures, Point 2 is strongly related to the height category of 200-300 m, while there seems to be no pattern among the other Points concerning the height of bird flights.

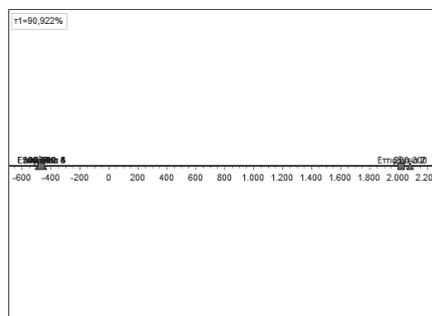


Figure 4. Interaction of Points and height categoriesDiscussion

Correspondence analysis revealed a pattern for Macedonia International Airport that has never been revealed previously in the literature. A point (Point 2) located close to the centre of the airport runways appears to be completely different compared to all other points. In this point the wild birds fly at a height of 200-300 m. In all other points most of the birds are grounded close to the runways, or a small percentage of them fly to various heights. Point 2 is close to the airport terminal where the aircrafts park. Considering that the aircrafts which use the airport are not taller than 30 meters, it can be assumed that there is no danger for them at this Point. On the other hand, Point 1, which was located next to Thermaikos Gulf, appears the highest species abundance. However, the fact that the majority of the birds on this point are on the ground may make Point 1 not dangerous to the aircrafts. Point 3, which was located next to Thermaikos Gulf, too, shows less species abundance, and the birds on the ground, too. Not dangerous to the planes may also be the points that were located close to Kardia village side, since there is very small species abundance on this side.

Two facts can be considered as dangerous and attention must be paid in the future for bird strikes avoidance; firstly, the fact that most of the observed birds are gulls. According to Anagnostopoulos (2004) gulls are considered to pose very high potential danger for the aviation, as they are graded at the highest group of the five hazard groups of the Aviation Safety Ranking Value. In USA 23% of the bird strikes are caused by this bird species (Cleary et al., 2006). In Macedonia International Airport they represent 90% of the total bird species abundance. This increases the potential danger of a bird strike in the airport. Secondly, most of the observed birds are on the ground. In USA 42% of the bird strikes take place at zero height (Dolbeer & Wright, 2008). In Macedonia International Airport most of the birds (71%) are at this height. This is another situation which could become dangerous in the future.

Of course, this research presents some preliminary results of the experimental design at the Macedonia International Airport. It is possible that more variables are needed to cover all the issues arising from the presence of a significant number of birds at the airport. Interesting additions would be data from the frequency of aircraft flights from every point, the wind direction, or a correlation of birds' seasonal presentation and flights seasonal pick.

### *Conclusions*

The previous analysis tried to find the possible risks from the presence of wild bird species for the aircrafts flying from Macedonia International Airport of Thessaloniki. Using Correspondence Analysis it was revealed for the first time a special

pattern of birds' behavior for the airport. However, there are significant indications which make the current situation possibly no dangerous to the aircrafts. On the other hand the fact that most of the bird species at the airport are gulls and most of them are at zero height may cause some problems, since the literature reveals that bird strikes are strongly related to gulls and zero height. This implies that some management practices have to take place at the airport concerning the bird species abundance (see for example Linnel et al., 2009). A possible future research has to enter more variables in the model for a better understanding of the problem of bird strikes risk at Macedonia International Airport. This will lead to the reduction of possible human, bird, social and economic losses.

## Άγρια πτηνά και αεροδρόμιο «Μακεδονία»: ανάλυση των κινδύνων από πιθανές προσκρούσεις πτηνών σε αεροσκάφη

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### Περίληψη

Ένας από τους κινδύνους ασφάλειας των πτήσεων αεροσκαφών είναι οι οχλήσεις που προκαλούν είδη της άγριας πτηνοπανίδας κατά την απογείωση, προσγείωση, ή, λιγότερο συχνά, σε άλλη φάση της πτήσης των αεροσκαφών. Τα ονομαζόμενα στη βιβλιογραφία bird strikes, δηλαδή οι προσκρούσεις πτηνών με αεροσκάφη, αποτελούν αιτία για μεγάλο αριθμό ατυχημάτων, μερικά από τα οποία είναι θανατηφόρα. Στην παρούσα έρευνα παρουσιάζονται προκαταρκτικά αποτελέσματα ενός προγράμματος καταγραφής των ειδών άγριας πτηνοπανίδας που απαντώνται στο αεροδρόμιο

«Μακεδονία» της Θεσσαλονίκης. Για τις ανάγκες του προγράμματος τοποθετήθηκαν έξι σημεία απογραφής της άγριας πτηνοπανίδας πλησίον των διαδρόμων του αεροδρομίου και έγινε καταγραφή του είδους πτηνού, της αφθονίας και του ύψους πτήσης του. Με τη χρήση της παραγοντικής ανάλυσης αντιστοιχιών διαπιστώθηκε ποια είναι τα είδη πτηνών που μπορεί να προκαλέσουν προβλήματα σε αεροσκάφη και ποια σημεία του αεροδρομίου θεωρούνται «επικίνδυνα».

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