RISK ASSESSMENT MODEL
CASE STUDY HELLENIC AIRPORTS

Anastasios Anagnostopoulos[1], Elias Nikolaidis, Capt.[2], Eugenios Koumantakis[3] & Michael Katsaris, Maj.,[4]

[1] Environmental Department, Aviation Services Division,
Athens International Airport S.A., 190-19 Spata, Hellas
Tel.: +30 210 3536 671, Fax: +30 210 3537 800
Email: tasos.anagnostopoulos@aia.gr
[2] Olympic Airways, Quality Audit, Flight Operations Subdivision
203 Grigoriou Lambraki Ave, 118 20 Koridallos, Hellas
Tel: +30 210 4952 767, Fax: +30 210 4974 780
Email: en@attglobal.net
[3] Hellenic Civil Aviation Authority Airports Division, Operations Department
1 Vassileos Georgiou Str., 166 04 Ellinikon, Hellas
Tel: +30 210 8916 399, Fax: +30 210 8947 101
Email: d3b@hcaa.gr
[4] Hellenic Air Force, General Staff,
General Inspectorate, Flight Safety Directorate,
136 Messogion Ave. 155 61 Cholargos, Hellas
Tel.: +30 210 6591 022, Fax +30 210 6463 276
Email: fsd@haf.gr

Abstract

The paper contains details of all known bird concentration areas near Hellenic airports and the relevant bird strike statistics. With the use of this information a case study of a comprehensive Risk Assessment Model for the Hellenic Civil Aviation, is provided, combining the most known risk assessment approaches included in the international bibliography with a Geographical Information System (GIS).

Key words: Hellas, bird strike, bird strikes, risk assessment, Hellenic airports, avifauna habitats, civil aviation, mishap investigation, Geographical Information Systems

1. Introduction

The establishment of the majority of the Hellenic airports in the vicinity of wildlife sites and the interactions between their operation and the activities of the birds foraging in these sites have been presented in another paper during these proceedings.

The risk of a bird strike is greatest when an aircraft is operating on the ground or in the lower altitudes, in the vicinity of an airport. Therefore the presence of significant numbers of birds close to the airport increases all three components associated with risk: exposure, probability and severity.

Following the global safety certification requirements, the Hellenic Civil Aviation Authority has established procedures for the implementation of safety management systems at all airports in the country.

Within this framework the objective of this paper is to attempt a first approach to combine bird strike hazards with environmental data (wildlife sites and their management).

The scope of the paper is to:

1. identify the potential Risks related to Bird Strikes on national level especially in connection with the bird species and population numbers recoded in the wildlife sites adjacent to the airports;

2. identify the stakeholders and their contribution to the risks;

3. contribute to the identification of areas where additional data are required concerning the avifauna (e.g. sites where avifauna records are poor or incomplete);

4. increase national awareness on the issues related to bird strike hazards and promote the cooperation of the stakeholders towards the completion of the procedures for the establishment of a National Bird Strike Committee.

2. Methodological approach

Definitions and methodology concerning Risk Assessment have been included in many recent papers presented during various meetings of the International Bird Strike Committee either in Europe or in N. America. Much helpful information can also be found in the Internet under the sites of the Bird Strike Committee USA, and Transport Canada under the form of web pages, as in the form of publications that are made available worldwide.

The Risk Management Formula [*Figure 1*] provided by TRANSPORT CANADA (2001) is a very useful visualization of the Risk Assessment Equation (risk=exposure X probability X severity). Further to a view of the components of the bird strike risk management and the magnitude of the effort that must be applied for the reduction of each one of them, this formula can also be used for assigning the responsibilities to the stakeholders of the risk management.

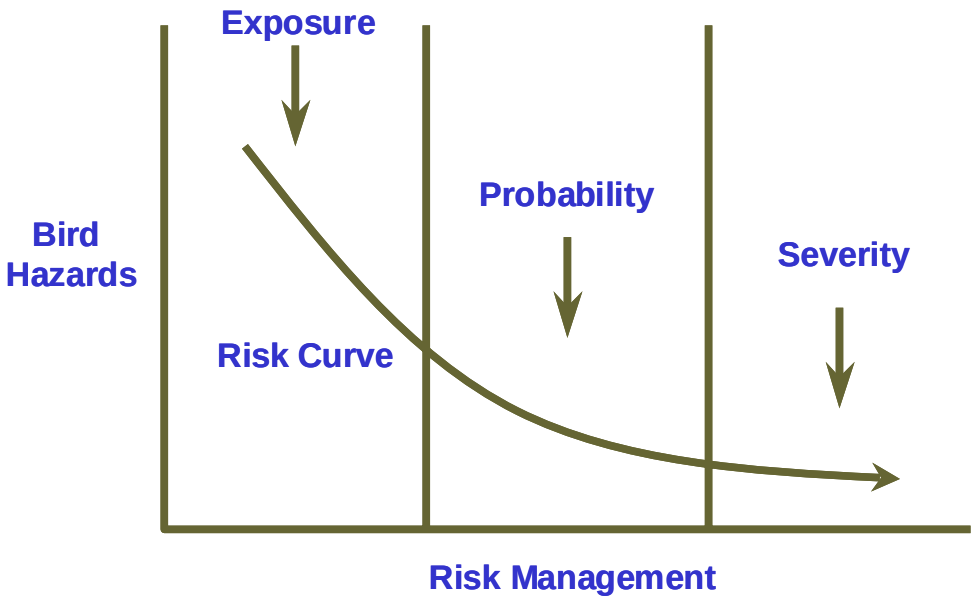

***Figure 1**. The Bird Strike Risk Management Formula (according to Transport Canada 2001)*

Data about the wildlife sites in the vicinity of the Hellenic airports and avifauna attributes that are recorded on them have been extracted from the NATURA 2000 databases, and are partly presented in another paper included in these proceedings.

The operator of each airport has provided some rough information about the bird species that are common visitors on them, together with the Bird Strikes that occurred in the vicinity of the Hellenic civil aviation airports. The Flight Safety Directorate of the Hellenic Air Force has provided the respective data for the military airfields. The statistical analysis of the bird strikes has been provided through other papers included in these proceedings. For the purposes of this paper the flight and bird strike data of the years 1999 and 2000 have been used (NIKOLAIDIS 2003), since more recent data requested from ICAO had not reached the authors by the time the presentation was concluded. The bird strikes in this paper are expressed either in the absolute number of strikes (**No. of Bird Strikes)** or as a rate of strikes per 10,000 flights (**Bird Strike Rate**).

An Aviation Safety Ranking Value (ASRV) has been assigned to each of the bird species included in the NATURA 2000 Network list. The ASRV classifies birds in five levels that represent the potential danger that each of them can pose to aviation and is based on the Flight Safety Relevance of bird species proposed by MORGENROTH (2002). The lowest level, “1” represents the species which pose no danger to aviation, while the highest level, “5” represents bird species that may pose very high danger for aviation. Since the reports from each airport mentioned above confirm the presence of species that are included in the NATURA 2000 lists for the adjacent wildlife sites, the ASVR values provided by Morgenroth have been considered valid for our study. However, it will be useful in the future to perform a further re-assessment of these values based on more detailed data concerning the numbers of birds visiting each airport and their activities.

A list of the wildlife sites that are adjacent to airports and the number of bird species recorded on them, classified in each to the 5 ASRV levels, is provided in Table 2 later in this paper. Since the NATURA 2000 database includes frequently quantitative data about the population numbers of some species (e.g. common, rare, present, etc.) such numbers have not been included in our study. However, for the major wildlife sites the population numbers of the species classified in the ASRV levels 3 to 5 constitute a significant bird mass density, given that these are medium to large size birds, gathering in large flocks.

3. Results and discussion

Bird Strike Data Analysis

The civil aviation traffic load for the Hellenic airports is illustrated in Map 1 in the Appendix. The higher numbers of strikes have been recorded on the airports of Kerkira, Thessaloniki, Athinai (Hellinikon), Iraklio and Kavala (Chrisoupolis) (see Map 2 in the Appendix and NIKOLAIDIS 2003).

Based on the estimation of risk according to the bird strike rate per 10,000 flights, the highest rates are recorded for the airports of Araxos, Kerkira, Kalamata, Kavala (Chrisoupolis) and Preveza (Aktio) as illustrated in Map 3 in the Appendix. However, the airports of Araxos, Kalamata and Preveza (Aktio) had very low air traffic during the 1999-2000 period and this fact combined with the small number of strikes produced a high bird strike rate (compare Map 3 with Map 1 in the Appendix).

Further to the number of strikes or the bird strike rates recorded for the period 1999-2000, the respective data from previous periods must be taken into account. According to the available data (NIKOLAIDIS 2003) the following must be noticed:

1. For the airport of Kerkira the number of bird strikes is higher than in previous periods. The reasons can vary from the increase of the traffic to the increase of bird hazards or even to the actions of the operators. In any case the bird collision risks must be reviewed.

2. The bird strikes at the airport of Thessaloniki are doubled during the 1999-2000 period in comparison to the 1997-1998. The reasons of this increase must again be assessed.

3. The bird strikes recorded at Athinai (Hellinikon) are higher during the 1999-2000 period compared to those of the previous biennium. However, since the bird strike rate is lower than the one recorded in previous periods, it is obvious that the increase of bird strikes can be attributed to the respective increase of air traffic. No further measures should be applied since this airport stopped operating in 2001.

4. For the airport of Kavala (Chrisoupolis) the number of strikes and the bird strike rate recorded in the period 1999-2000, are lower that those reported in previous periods. This is actually very positive since the number of flights for this airport has increased.

5. Significant increase of bird strikes has also been reported at the airport of Iraklio and in comparison to the previous available data, although the birds strike rate is low.

6. The airport of Preveza (Aktio) shows stability, while for the rest of the airports Rodos, Zakynthos and Limnos show a small increase in the number of birds strikes. For the airport of Chania the number of strikes is stable, for the airport of Mitilini the strikes recorded have been reduced, while for Araxos, Kalamata, Naxos, Kos, Chios, Mikonos, Samos there are no comparative data from previous periods.

Concerning the bird strikes recorded during the same period (1999-2000) on military aircraft, the respective numbers are provided in Table I.

Table I. *Bird Strikes involving military aircraft recorded in the period 1999-2000*

Aerodrome	No. of bird strikes
Aktio-Preveza	1
Chania-Souda	2
Chios	1
Kalamata	14
Larisa	9
Tanagra	9
Thessaloniki	1

The airport of Kalamata is used for training with very frequent take-offs and landings, and therefore the number of strikes of military aircraft recorded on this airport can be attributed to this factor. The airfields of Larisa and Tanagra are also frequently used, and this provides partly an explanation of the numbers of birds strikes recorded.

Bird activities on and in the vicinity of the airports

As mentioned in another relevant paper included in these proceedings (DELICHATSIOU, ANTONIOU, ANAGNOSTOPOULOS 2003), the majority of the Hellenic airports are established near the sea, while a significant number of them is close to protected wildlife sites. Details on these airports and the adjacent wildlife sites and their avifauna are provided in the above-mentioned paper.
According to the data obtained from the bird strikes (NIKOLAIDIS 2003) it is obvious that this presence of birds in the airport vicinity is affecting its operation, as some of the birds collide with aircraft.

As mentioned above the data included in the NATURA 2000 Network database cannot provide us a clear view of the population numbers of the bird species recorded in each site. Therefore, we cannot use such numbers combined with the average weight of each species in order to have a first approach to the assessment of bird strike risks for the vicinity of each airport by the use of the mean bird mass density. Instead of the mean bird mass density we studied the allocation of the of bird species for each wildlife site according to the five ASVR levels. The results are provided in Table II and illustrated in Map 4 in the Appendix.

As discussed in the paper of DELICHATSIOU, ANTONIOU AND ANAGNOSTOPOULOS (2003) and is obvious from Table II and Map 4 there are airports adjacent to wildlife sites for which the data are incomplete or even missing. As examples we can refer the airports of Kerkira and Kalamata, which are adjacent to sites sustaining significant numbers of birds, however, no data are available.

It must also be noticed that the birds included in NATURA 2000 records, represent only birds listed in ANNEX I of the CD 79/409/EEC and regularly occurring migratory species not included in the above-mentioned Directive. Bird species that are common (i.e. not protected) and resident have not been recorded (like doves, corvids, etc.). Therefore a significant piece of information concerning avifauna is still missing even in the case that the NATURA 2000 records are considered complete.

From the study of the Table II and Map 4 it is obvious that in the major wildlife sites adjacent to airports there is a significant number of species classified in the levels 3 to 5 that are expected to contribute significantly to the risk assessment. Therefore, any approach to assess birds strike risks in the vicinity of these airports must include comprehensive avifauna surveys.

Table II. *Site names, adjacent airports and number of species per ASRV level for each of the wildlife sites*

SITE NAME	Adjacent Airport	Numbers of species classified according to Aviation Safety Ranking Value*				
		Level 1	Level 2	Level 3	Level 4	Level 5
DELTA EVROU	Alexandroupoli	78	60	36	9	20
DELTA NESTOU & LIMNOTHALASSES KERAMOTIS	Kavala (Chrysoupolis)	19	16	19	5	12
DELTA AXIOU-LOUDIA-ALIAKMONA	Thessaloniki	72	52	32	7	14
LIMNOTHALASSA ANGELOCHORIOU	Thessaloniki	67	37	27	3	7
LIMNI KASTORIAS	Kastoria	53	31	21	2	11
AMVRAKIKOS KOLPOS, DELTA LOUROU KAI ARACHTHOU (EVR	Preveza (Aktion)	154	112	68	14	36
LIMNES VOULKARIA KAI SALTINI	Preveza (Aktion)	4	3	6	4	4
LIMNOTHALASSA KALOGRIAS, DASOS STROFILIAS KAI ELOS	Araxos	74	51	28	6	10
LIMNOTHALASSA KOTYCHI	Andravida	63	40	25	4	9
OROS PARNITHA	Tatoi	28	10	11	1	5
LIMNOS: CHORTAROLIMNI - LIMNI ALYKI	Limnos	14	4	3	2	1
LESVOS: KOLPOS GERAS, ELOS NTIPI KAI OROS OLYMPOS	Mitilini	1	0	1	1	1
KASOS KAI KASONISIA	Kasos	5	4	1	1	2
KOS: AKROTIRIO LOUROS - LIMNI PSALIDI - OROS DIKAI	Kos	6	6	1	1	5
DIKTI: OROPEDIO LASITHIOU, KATHARO, SELENA, KRASI,	Kastelli (Irakliou)	9	6	1	1	5

Aviation Safety Ranking Value separates birds in 5 levels according to the potential hazard to have a collision with an aircraft: (1) without significant relevance for air traffic safety, (2) low potential danger, (3) intermediate potential danger, (4) high potential danger, (5) very high potential danger. These levels evaluated based on the size of each bird species (mainly weight), the social pattern and behaviour of the species, and its movements (short and long distance) and the activities in the area.

Definition of the Stakeholders and assignment of Responsibilities

In Table III, the stakeholders according to the three components of the risk equation are illustrated. Airport authorities, Air Traffic Control, the Hellenic Civil Aviation Authority (HCAA) and the Hellenic Air Force (HAF) are the stakeholders that can undertake the main actions to reduce collision risks on the airport site and the vicinity. The contribution of the pilots and their companies is also important, while Planning Authorities play also a significant role. Finally the Wildlife Site Management Agencies and the scientific community should also be involved.

Table III. *The Stakeholders of the Bird Strike Management on National Level and their responsibilities*

Stakeholder	Exposure	Probability	Severity
Airports	X	X	X
ATC		X	X
Airlines		X	X
Pilots	X	X	X
HCAA	X	X	X
HAF	X	X	X
Wildlife Site Man. Agencies	X		
Planning Authorities	X		
Ornithological Societies	X		

Reduction of Exposure

All civil aviation airports and military airfields have organised bird control programmes, more or less effective for reducing all potential bird strike hazards from the airport site. Long-term measures designed to exclude the top bird attractants (food and shelter) from airport site contribute significantly to the reduction of the exposure.

Pilots can overfly areas where bird activities posing collision hazards are reported, or they can reschedule aircraft movement in order to give time to bird controllers to disperse birds.

The HCAA and HAF as regulatory bodies responsible for aviation safety issue procedures and documents for all the airports on national level, while auditing the proper implementation of these procedures.

However, the actions of the airports are not enough as long as bird attractants are still in the vicinity of the airport. Therefore, the Agencies responsible for the Management of the Wildlife Sites can carry out management plans that will apply control of bird activities close and over the airport. In a similar manner Planning Authorities can exclude from future development land uses that should attract birds in the vicinity of the airport (e.g. waste management facilities). Finally the scientific community, and mainly the Ornithological Societies can generate and forward to the airports or the aviation regulatory bodies reports on avifauna activities from which important trends can be derived (e.g. increase of population numbers due to environmental changes).

Reduction of Probability

Long-term measures applied either on site or in the vicinity for the exclusion of the top bird attractants may not be fully effective for various reasons. Therefore, a number of birds will still forage on the airport sites. Short-term (active) bird disperse measures, designed by the airport authorities according to the species that must be deterred from the airport site, reduce bird strike probability.

By reporting bird activities observed during aircraft movement Pilots also contribute to the reduction of probability. The same also applies to the ATC and Airlines, which forward the information about bird activities to other pilots or to the airport authorities.

The contribution of the aviation regulatory bodies (HCAA and HAF) in the reduction of probability consists in issuing procedures and distributing information on a national level.

Reduction of Severity

Active control, through short-term measures, of the activities of the birds that pose the highest collision hazards (e.g. big size birds, or birds in large, dense flocks) contribute to further reduction of the risks. Pilots interpreting the information received by ATC can arrange the attitude of the aircraft in a manner that will reduce the impact of a possible strike with a bird (e.g. reduction of speed). The Airlines do also contribute to the reduction of Severity providing to the Pilots the appropriate training and rescheduling their flights according to the diurnal movements of the birds.

4. Conclusions

The increased number of bird strikes recorded on some of the Hellenic airports during 1999-2000, in comparison to previous years provides a first indication that review of the Risk Assessment and Management programmes must be considered.

However, risk re-assessment should not only be restricted on airport site, and should not only involve the aviation community. As the majority of the airports are established close to important protected wildlife sites that sustain significant numbers of birds, an initial approach to study avifauna in these sites clearly indicates that bird concentrations in the vicinity of the airports plays or will play significant role to the bird strike risks. As a result all agencies involved in the management of the land in the vicinity of an airport should cooperate with the aviation authorities in order to reduce risks.

The contribution of the scientific society is important, as there are still areas where the existing data are incomplete, while the agencies responsible for the management of wildlife sites should apply measure that will reduce bird population close to airport sites.

Finally, although a separate risk assessment must be conducted for each airport, the establishment of a National Bird Strike committee will facilitate the implementation of these studies by increasing awareness and promoting cooperation among the stakeholders.

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APPENDIX

MAP 1. *Traffic load of the civil aviation airports in Hellas during 1999-2000*

MAP 2. *Distribution of Bird Strikes on civil aviation airports in Hellas during 1999-2000*

MAP 3. *Bird Strike Rates on civil aviation airports in Hellas during 1999-2000*

MAP 4. *Distribution of species according to ASRV levels for each of the wildlife sites close to Hellenic airports and airfields*