BIRD COALITION PREVENTER: A GIS TOOL FOR ESTIMATING THE IMPACT ASSESSMENT OF LAND USE, TO AIRPORT WILDLIFE MANAGEMENT

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ABSTRACT

Even though coalitions between birds and aircrafts were a serious issue for aviation, its impact to air carriers and airport managers after the mid 60ies started revealing as a great factor. Nowadays the annual losses to the airline industry due to bird coalitions are estimated to US $ 2.1 billion, including the cost of damages and delays.

In order to minimize losses international and national aviation authorities and airport managers started seeking ways to prevent birds away from airport routes. Considering the fact that most of bird strikes occurre during approach or take off, prevention actions to be taken, focus to a zone of a few km range from the airports.

The measures that have to been taken are divided to two main categories.

1. Aggressive methods, which have to do with actions that will force birds to abandon the area under pressure caused by lethal or no lethal measures. Even though this kind of response had been successful in some cases (JFK), generally the effectiveness is lacking a life time perspective. In addition, these methods have a very small acceptance between the public and legal implications especially in cases of protected species.
2. Inhabitant management program. In this category every measure has to contribute in the elimination of the factors that make a certain area desirable for bird presence. As it is easy to understand it is a long term program which requires a full study of the bird population in the area of interest, analysis of the habits and determination of the attractive factors and finally the change in land use that will eliminate them.

In this study we try to define, form and applicate, an analysis methodology based to Information and Communication Technologies (ICTs). We develop B.C.P. (Bird Coalition Preventer). B.C.P. is a Geographical Information System created to analyze land use. In this study B.C.P., despite the fact there are no publications referring to bird population around Greek airports, is tested in the specific areas of 10 Greek airports with the most bird strike incidents for the year 2000. As a first step, the hazard zone characteristics relative to the airports' position and the "free of obstacles approach zones" are determined, as they are described in ICAO ANNEX 14.

The second step is to utilize Corine land cover data to determine bird friendly regions, their size and their position within the areas of interest. The out coming data are converted from vector to raster form, in order to become suitable for quantitative analysis and further processing. Additionally, taking under serious consideration the distribution time of the recorded incidents, which is significantly increased during the summer months, we propose and calculate a new factor that is relevant to the bird population of an area. That is the distance from wetland areas which are under protection as a result of EU's programme, "Natura 2000".

Keywords: Environmental Impact Assessment, Strategic Environmental Assessment, Algorithm, GIS**,** Aviation hazard, Bird strike, Land use, Risk, Airport planning

1. Introduction

From 1908, when the first bird strike incident took place, to 1925 when it was officially recognized as real danger that man should face in order to establish the conquer of the sky, it is almost a century. In spite of this fact, bird strikes are still a serious problem for aviation which cannot be solved easily. After WWII and the rise of the civil aviation as a safe and time saving mean of transport, the economic consequences of bird strikes became a real problem for Aviation Industry. According to Allan J.R and Orosz (2001) the cost of bird strikes to commercial aviation reaches 2.1bil US$ per year. In their calculation there are not included incidents relating to military and general aviation, because of the lack of data. Even if 65% of the incidents has no consequences of any type, we must mention that 0.5% cause total aircraft loss. The losses are located in damages of aircrafts, delays and cancellation of flights. Another budget consuming fact is that, aircraft manufactures design planes that will withstand bird strikes. According to FAA airworthiness requirements, catastrophic accidents following a component failure must be minimised to a probability less than 1 in 109 flying hours. As a result, heavier components are designed, which makes airplanes heavier and more fuel consuming.

2. Bird Strike Countermeasures

Considering the fact that the three dimensional areas where the most incidents take place are those when the aircrafts fly in height less than 200ft (70%) and between 200 and 800ft (15%), then the great action of prevention has to be done to the airports and their nearby areas (Maragkakis I.,2008). Although bird population control requires a detailed study for each case and depends on the bird species, their needs and their particular behaviour, the measures that are used for population control are the following:

2.1. Harassment and Repulsion

This kind of measures includes optical and/or acoustic stimulations that will make the birds leave the area. In this approach, harassment actions, like the destruction of the nests or even lethal actions are often used. In a more sophisticated way of action, the goal is to create an unpleasant psychological factor that will make the area of interest an undesired place for the bird population. For that purpose, specific stimulation is addressed to all the bird senses. Because every species has a unique response in the given stimulation, this is a methodology of high customization that can be applied after detailed study.

2.2. Habitat Management

In this kind of measures every action taken is focused in areas where airplanes' and birds' paths are crossed. In this case the goal is removing from that area every factor that makes it eligible for the birds during their life cycle. The first step is the identification of land uses that are suitable for birds' habitat. These areas that can provide suitable conditions, for avian species to breed, moult, and feed are designated as high risk source. The areas suitability for hosting a certain bird population and the impact factor of the characteristics of each species to the danger to aviation can help us determine how flight is affected safety. When we find that danger considerable, we are trying to control the population by deducting the factors that make the particular area eligible more than others. As a result, certain installations that are considered to be of great attraction to birds, like waste management facilities are forbidden near airports (FAA 2007, CAA/GR 2006). But it is something that cannot happen in cases such as protected wetlands. Between exterminating a bird population by vanishing a wetland which is under protection (as with Ramsar treaty) and operating an airport under a high risk of bird strikes, there is another approach. The creation of competitive wetlands, which will make a significant part of bird population move away from the danger zone. It is the combination of available methodological tools that will give us the desirable result with the minimum side effects and low cost.

3. Bird Coalition Preventer: Land use risk evaluation through GIS

3.1. Identifying the control areas

Bird Coalition Preventer is a GIS tool which uses available open data in order to quantify avian attractions which affect flight safety. Analyzing two buffer zones, proximity from wetlands and land uses overlapped by the approach routes we are able to identify hazards and plan a risk management. In this case study, we examined the areas of 10 Greek airports with more incidents per 10,000 flights in year 2000 (Nikolaidis E., 2005). According to the Greek Civil Aviation Authority Regulations, the control areas consist of two circular zones of 3.2km radius and 8km respectively, from the airport's point of reference (PoR). In addition to these officially defined zones we select to examine two more criteria. At first the free of obstacles approach surfaces, as they are determined in ICAO's ANNEX 14 (2002) and secondly the airport's proximity to wetlands that have a protected status, such as the Ramsar Convention. The reason of this selection is the significance of the area that includes the possible routes an aircraft is flying during approach, take off and other standard operational procedures and in height less than 800ft. This height level is the height in which the 85% of the incidents occurs. The character of wetlands as wildlife sanctuaries, ideal for hosting large population, is assessed as of great importance.

Table 1: Greek airports' birdstrikes for the year 2000 (Nikolaidis E., 2005) and their distance from Natura Network wetlands

Airport	Incidents per 10.000 flights	Distance from Wetlands of Natura 2000 Network (m)
Araksos	14.11	1391
Corfu	11.75	475
Kalamata	10.16	8487
Kavala	8.31	779
Aktion	7.19	2876
Naksos	5.02	150
Limnos	4.73	**635**
Zakinthos	2.34	1219
Kos	2.33	5655
Thessaloniki	2.17	1039

3.2 PCP as an Analysis Process GIS Tool

The first part of data processing has to do with the distance calculation between the PoR of the 10 airports and the nearest areas belonging to Natura 2000 Network (which are wetlands under protection according to the Ramsar Convention). This calculation was performed in the GIS environment. The results of this procedure are shown in table 2.

The next stage is the creation of buffer zones of radius 8km and 3.2 km respectively..The outcome areas are used as boundaries to crop the Corine data set. The final step is the transformation of the out coming vector data to raster, in order to become suitable for statistical analysis. The numeric results of this procedure are shown in table 3.

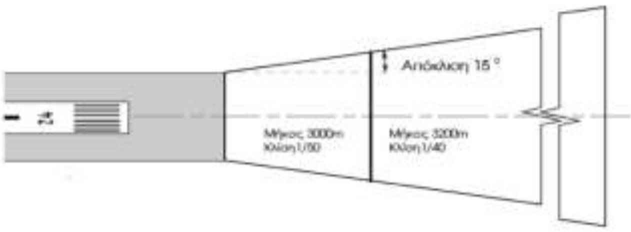

Figure 1: Airport approach surface (ICAO,1999)

Table 2: Level 2 Corine land uses of Greek airports with highest number of bird strike incidents per 10.000 flights

	Corine Code/Description	8 Km Zone	3.2 Km Zone
1.1	Artificial surfaces	2,17%	3,55%
1.2	Industrial, commercial and transport units	1,74%	8,26%
1.3	Mine, dump and construction sites	1,74%	8,26%
1.4	Artificial, non-agricultural vegetated areas	0,16%	0,50%
0.1	Arable land	20,87%	26,94%
2.2	Permanent crops	7,04%	3,08%
2.3	Pastures	0,12%	0,11%
2.4	Heterogeneous agricultural areas	17,13%	26,07%
3.1	Forests	1,03%	0,28%
3.2	Scrub and/or herbaceous vegetation associa	9.38%	7.25%
3.3	Open spaces with little or no vegetation	0.29%	0,16%
4.1	Inland wetlands	9,38%	7,25%
4.2	Maritime wetlands	0.29%	0,16%
5.1	Inland waters	1,40 %	3,63%
5.2	Marine waters	38,35%	19,92%

Additionally we choose to take a deeper look at Kalamata Airport in order to examine in detail the land use which interacts with bird strike hazards importing a new way area of interest. According to ICAO's Annex 14 requirements every airport must include a set of free of obstacles surfaces (fig.1) in order to be conspired suitable for usage. These surfaces are determined by the possible airplanes' routes during approach, take off or other standard operation procedures. We decide to include land use analysis for these zones in BCP during approach and take off when the aircraft moves in high speed and height below 800ft. It is where the the 85% of the incidents take place, and avian attractants just below aircraft routes are of great significance. . The numerical results are shown in table 3.

Focusing in preventing incidents caused by flocks of large migratory birds, which have Aviation Safety Ranking Value 5, we were able to locate, using BCP, the presence of Inland and marine water and wetlands. According to reports (FAA, CAA/GR) they are regarded as eligible areas for this kind of birds. Furthermore, proximity to Natura network wetlands suggests that the study area is next to a known migratory bird habitat

Table 3: Level 3 Corine land use analysis of Kalamata Airport.

Corine Code / Description	8Km Zone	3.2 Km Zone	Approach Zone
1.1.1 Continuous urban fabric	0.30%	6.81%	0.00%
1.1.2 Discontinuous urban fabric	3.12%	3.61%	0.00%
1.2.1 Industrial or commercial units	0.85%	2.21%	0.00%
2.1.1 Non-irrigated arable land	7.59%	19.53%	0.00%
2.1.2 Permanently irrigated land	8.25%	7.12%	57.88%
2.1.3 Rice fields	3.08%	8.10%	17.54%
2.2.2 Fruit trees and berry plantations	1.66%	11.33%	0.00%
2.2.3 Olive groves	33.18%	39.13%	24.56%
2.4.2 Complex cultivation patterns	22.07%	0.00%	0.00%
2.4.3 Land principally occupied by agriculture, with significant areas of natural vegetation	9.18%	0.00%	0.00%
3.1.1 Broad-leaved forest	5.00%	0.00%	0.00%
3.2.1 Natural grasslands	0.46%	0.00%	0.00%
3.2.3 Sclerophyllous vegetation	4.97%	0.00%	0.00%
3.2.4 Transitional woodland-shrub	0.20%	0.00%	0.00%
5.1.1 Water courses	0.09%	2.16%	0.02%

4. Conclusions

The analysis of land use and proximity to wetland, using BCP show us that the under investigation airports were built in an unfavourable position. As happened in many cases worldwide (Buurma, 2003) airports were built in cultivated wetlands. As a result the surrounding areas are still an attractive site for birds of different species.

Unfortunately the lack of more detailed data for bird strike incidents to establish a relation between land use and involving species, in order to calculate a safety ranking value for each airport surroundings. Although we can assume that the established land uses is not in favour of aviation safety. The results of this study can be used as a part of greater work which will combine the land use and the correlation of bird population with great impact factor in order a risk assessment will become possible.

Figure 2: Land use visualization in Kalamata airport's 8 km zone (1), 3.2Km zone (2) and approach zone (3)

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