



A study of the site selection of a civil airport based on the risk of bird strikes: The case of Dalian, China



Qiang Fu, Nuo Wang^{*}, MingQi Shen, NanQi Song, HuaKun Yan

Transportation Management Institution, Dalian Maritime University, Dalian, 116026, China

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ABSTRACT

Bird strikes are a potential danger to aviation security. The threat of birds to the flight security of civil airplanes is hard to solve if the existence of birds in nature is ignored. An in-depth study on the living habits of birds and the request for a harmonious coexistence between birds and civil airplanes seems to be an effective way to relieve this contradiction. Taking the case of the site selection of the civil airport in Dalian of China, this paper comprehensively analysed the bird strike assessment of various species of birds near the sites of Zhoushuizi Airport and Jinzhou Bay Airport. The assessment of the risk of bird strikes demonstrated that the site of the Jinzhou Bay airport would have a smaller risk of bird strikes, which could greatly reduce collisions between birds and airplanes and promote aviation security. Such results provide a valuable reference for the site selection of the civil airport in Dalian. As bird strikes are a common problem in the field of civil aviation, the analysis and methods in this paper are a needed reference for the planning and land use of civil airports in other cities.

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1. Introduction

In recent decades, bird strikes have become more frequent, which have not only caused huge economic losses for airline companies but also become a potential danger to aviation security (ICAO, 2007). Fundamentally, the cause of bird strikes is rooted in the wanton expansion of the scope of human activity, constantly invading and occupying the living spaces of birds. Based upon instinct, birds will not quickly change their former activity patterns and living habits, especially migration routes, in response to the emergence of airports and the more frequent departure and arrival of airplanes. Accordingly, the effective solution to bird strikes is to find a harmonious coexistence between human aviation and the activities of birds in nature, not to drive birds away from airports as far as possible or even make these animals disappear from the airport surroundings.

China's civil aviation transportation is growing rapidly in recent years, and tremendous changes have taken place in the past 30 years. With the growing routes, more frequent takeoff and landing, trend of larger-sized airplanes, and the improvement of airplanes'

speed, Chinese civil aviation transportation is facing more challenge on security management (Chow et al., 2010; Chow and Fung, 2012; Zhang et al., 2013). Related statistics report shows: China airport bird strike events showed a trend of increasing year by year, which has increased from 2004 in 119–2013 in 3124, increased by 25 times in 10 years (CAAC, 2004–2013). There are some studies on bird strike security management, mainly on birds' activity survey and measures to prevent birds from living near civil airports. Givoni and Rietveld (2009) studied the management under the background of increasing traffic volume. Sieges et al. (2014) used weather-surveillance radar to conduct broad regional assessments of bird responses to Migratory Bird Habitat Initiative activities within the Mississippi Alluvial Valley and the West Gulf Coastal Plain, and offered the opinion that the change in the climate and landscape will have a great impact on birds activities; Bergin et al. (2000) evaluated the influence of the composition and configuration of the surrounding landscape on nest predation and found that wooded habitats were associated with greater nest predation, whereas herbaceous habitats (except alfalfa/pasture) either were associated with less nest predation or had no effect. This result is of great importance to studies on birds activities near civil airports; Smith and Moore (2003) tested the hypothesis that migrants arriving at breeding grounds with more body fat have a higher rate of reproductive success than birds arriving with little or no fat, and the results indicated that the huge foraging activities during

^{*} Corresponding author.

E-mail addresses: fuqiang@dlmu.edu.cn (Q. Fu), wangnuo@dlmu.edu.cn (N. Wang), shenmingqi@163.com (M. Shen), snq900126@dlmu.edu.cn (N. Song), yhk@dlmu.edu.cn (H. Yan).

migration are a survival instinct that explains why birds stay around an airport for weeks; Brown et al. (2001) argued that efforts to reduce bird strikes at the Jamaica Bay laughing gull colonies were ineffective, including habitat alterations and increasing the capability of the bird control unit to eliminate bird flocks at the airport using nonlethal bird dispersal techniques. Kitowski et al. (2011) found that when the frequency of particular species of birds present at the airport was calculated, the best outcome was achieved by using trained raptors of the European starlings and the Northern lapwings to disperse the birds. Hesse et al. (2010) surveyed 38 airports in British Columbia, Alberta and Saskatchewan, Canada to document and explore differences in the use of Airport Wildlife Management Plans, common wildlife attractants, wildlife countermeasures and their outcomes, and animal strike record keeping systems, and reported that maintaining long grass was the most routinely used countermeasure. Some researchers work in bird strike risk analysis. The common practice is to evaluate the risks of different bird species on different aircraft types based on bird strike historical data. Allan (2006) demonstrated a risk assessment method, by which he estimated the risk levels of different bird species, and generated a matrix to grade bird strike risk. Shaw concluded bird strike frequency of different bird species and bird strike frequency of different aircraft types based on data from nine airports in Australia. Blackwell et al. (2009), Tedrow (1998) obtained the bird strike probabilities of different aircraft models for different airports and used these analyses to predict bird strike risk.

In the studies above, airport wildlife management is usually based on the relationship between the existing airport and birds, and bird strike risk is rarely evaluated before site selection. Actually, investigating bird activity, try to avoid potential bird strike is of great importance before chosen an airport site. So how to assess bird activities' potential threat to aircraft security, and choose a minimum bird strike site is an imperative necessity.

Taking the site selection of the planned civil airport in Dalian of China as an example, this paper investigated the bird activity situation, carried out a detailed analysis on the activity patterns and living habits of various birds, assessed the risk of bird strikes for the existing and proposed sites of the airport and then obtained valuable results. The analysis and method mentioned in this paper can be a reference for the site selection of other airports.

2. Case background

2.1. Current situation and problems

Dalian is one of most important ports and tourism cities in China. The existing Dalian Zhoushuizi Airport occupies an area of 284.46 ha, holding one 3300 m runway and one 3186 m parallel taxiway (as shown in Fig. 1). The throughput is 16 million person-times, and 150,000 flights depart and arrive. This airport is the largest international airport in Northeast China.

In recent years, the passenger throughput and the number of flights at Zhoushuizi Airport have been increasing rapidly. In the past decade, the yearly growth in passenger throughput was 12%. By 2020, the passenger throughput is expected to be 22 million person-times, with 200,000 flights departing and landing, which will far exceed the airport's capacity. In this context, the Dalian authority has long argued how to enhance the throughput of the airport in recent years.

2.2. Two optional schemes

To solve the inadequate throughput of civil airports, there are two optional schemes: one is the in-place expansion, which means adding a new runway and expanding other auxiliary facilities

around the existing airport, and this practice is commonly adopted by most airports. The other option is to retire the present airport and select a new site in another place to build. Despite the large amount of construction, such a practice can improve the urban environment and provide new opportunities to enhance the overall performance of the airport. Existing practice shows that in a rapidly developing place with an intense contradiction between the existing airport and the needs of the urban environment, abandoning the existing airport and relocating to a new site can be more reasonable. For instance, Hong Kong launched the new Chek Lap Kok Airport and abandoned the former Kai Tak Airport in 1997, which greatly improved the environment of the main urban zone in Hong Kong and also enhanced the security of airport operations. This decision is internationally recognized as a smart decision.

Presently, the existing Zhoushuizi Airport has a similar problem that the Hong Kong airport had that year, namely, to improve the throughput of the airport, should an in-place expansion commence or a new site be chosen? For the in-place expansion, the airspace of the airport and the peripheral related factors will basically remain unchanged. The only consideration is relocating the surrounding residents to obtain more land for construction. However, the biggest problem with relocation is that the construction and development in recent decades has surrounded Zhoushuizi Airport with an urban living area. From the viewpoint of the long-term development of civil aviation in Dalian, this opportunity to expand the throughput, abandon the existing airport and relocate the airport to a new site needs to be seized as soon as possible.

After much investigation and evaluation of site selection, the preferred place to relocate the airport would be Jinzhou Bay (as shown in Fig. 2). Factors to consider when evaluating if the site selection is feasible are extremely complicated, such as the airspace, marine hydrology and ground transportation. Additionally, a serious study of the probability of bird strikes must also be considered because this factor is also one of the key factors for the site selection of the new airport.

3. Investigation of bird activities

Compared with other cities in the world, Dalian possesses an extremely unique geographical location and ecological environment. One of most significant features is that Dalian is located on an important migratory route in Northeast Asia (as shown in Fig. 3). National Conservation of Snake Island and Laotieshan Mountain is located in the south of Dalian, and this reserve is an important stopover for the spring and autumn migration of birds in Northeast Asia. According to statistics, there are 307 bird species (covering 19 orders and 57 families) flying through this area every year, which includes 23% of bird species in China and 70% of bird species in Northeast China. Because of the significance of Laotieshan Snake Island Nature Reserve for bird migration, both the International Coordinating Council (ICC) of the Man and the Biosphere Programme of UNESCO decided to include Laotieshan Snake Island Nature Reserve of Dalian, China in the Man and the Biosphere Programme (MBP) network as a biosphere reserve. The implementation of such a protection program is good news for the protection of the ecological environment, which will be favourable for the migration route of Gruiformes and Anseriformes in Northeast Asia and Charadriiformes in East Asia–Australia. However, with the protection of the ecological environment, the threat from birds to the security of departing and landing airplanes at the existing airport in Dalian will be greatly increased.

The bird migration route is the result of natural selection after millions of years. The route encompasses the birds' adaptations to natural climate, geographic barrier and natural environment. The bird migration routes through Dalian can be divided into the west

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