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## The Issue of the Influence of Limited Use Areas on Real Estate Value<sup>2</sup>

**Abstract:** Comparative methods used in the valuation of real estate require the adoption of price-creating attributes, the number and type of which should take into account the specific conditions of the local real estate market related to the restriction of property rights. The subject matter concerns the legal and price analysis of real estate located in the areas of limited use of the Krakow-Balice airport. The paper is an introduction to the conducted research, the purpose of which is to construct models for the valuation of real estate located in these areas and assess the impact of such a location on the value of the property, taking into account their different purpose and use.

**Keywords:** aircraft noise, environmental factors, decrease in property

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## 1. Introduction

The development of transport infrastructure is one of the main factors affecting a country's economic development, hence the steps taken by the state to ensure the proper functioning of the road, rail and air transport networks also include appropriate strategies to increase the dynamics in the area of expansion and modernization of the communication system. The subject of the transport network is part of a broad legal framework regarding environmental protection, in particular regarding the occurrence of noise, which is an increasingly perceptible civilization problem.

Noise means [1] sounds from 16 to 16,000 Hz, being unwanted and harmful [2], caused by human activity in the open air, including noise emitted by means of transport, road, rail, airplane traffic and that from coming from industrial areas.

The article is the introduction to the undertaken research aimed at assessing the impact of the location of the Krakow-Balice airport on the prices of real estate located both in the envisaged areas of limited use and outside them, but still subject to adverse air traffic impacts.

Studies on the dependence of aircraft noise and property prices are the subject of hundreds of publications, mainly foreign, the conclusion of which is a decline in the prices of real estates located near airports. Among the negative effects of air traffic [3] one may mention such factors as:

- noise,
- pollution of the environment as a result of the emission of toxic substances present in fuels,
- increased traffic near airports,
- a threat to the health of people living in the vicinity of airports.

Among the benefits associated with the existence of a functioning airport there are:

- creation of new jobs,
- opportunities for economic development,
- improvement of communication with the city center through alternative forms of transport, such as railway lines,

which also increases the population around the airport. In the literature [4], we can also find the results of research which indicate that there is no significant impact of the airport location on real estate prices or even the positive aspect of buying property in such a neighborhood. This is the case, for example, with regard to airports located at smaller urban centers, which have unique demographic characteristics, where a large part of the population has employment associated with the airport's operations and for whom the proximity of the airport is one of the main criteria when choosing and buying a home. Real estate buyers who are not sufficiently informed or do not have any knowledge of the inconveniences related to the near vicinity of the airport, especially noise, pay prices above this market

level for this type of property, and dissatisfaction and disappointment appear only after residence.

However, in most cases, real estate buyers are divided into those who are able to tolerate higher noise levels and live in the vicinity of the airport but their decision to buy is associated with the payment of a correspondingly lower price for the property, and those who do not consider the possibility of buying property at the airport even at an attractive low price.

## 2. Literature Review

With regard to environmental noise, aircraft noise [5] has the largest impact on property prices, after the noise caused by rail and road communication. Most often its intensity [6] is determined by designating areas of limited use or contours of individual noise levels, which are different for individual airports, depending on their size, prevailing wind directions, topography and other factors. However, the adoption of common reference items when testing the impact of noise makes it possible to compare the results obtained for different airports. The decrease in the value of real estate [7] caused by aircraft noise is the difference in the value of two properties located in the same market, with identical attributes, where one of the properties is in the limited use zone, while the other is free from the airport's negative impact. This difference results from the expectations of potential buyers who expect a lower price for the second home due to the need to endure the nuisance, loss of privacy or possible health complications. Research on the impact of noise on the level of real estate values requires the adoption of a certain threshold value, which is considered as the level of loudness on other comparable real estate markets but not burdened with the impact of aircraft noise (quiet area in the agglomeration).

The discussed boundary assumes different values for individual communication networks. Legal regulations [8] specify permissible noise levels in the environment depending on the destination of the area, including the object or activity being the source of noise and the periods to which the noise levels apply (Tab. 1).

Permissible noise levels may or may not be threshold values beyond which a fall in the value of real estate is observed. This level is determined in relation to a specific airport and real estate market. In the case of aircraft noise, it is lower than in the case of road and rail communication due to the less permanent nature of the sound, which is felt primarily in the takeoff and landing of aircraft, which is more annoying for owners of surrounding properties. The author indicates that the noise level around airports is around 65–80 dB, while the standard noise level in residential areas (outside areas exposed to aircraft noise) is in the range of 50–60 dB during the day and 40 dB at night, and these values should serve as a reference when adopting threshold values.

**Table 1.** Acceptable noise levels in the environment  
(noise in the environment caused by takeoffs, landings and flights of aircrafts)

		The noise indicator			
		Permissible long-lasting average sound level A [dB]		Permissible noise levels in the environment expressed by $L_{AeqD}$ and $L_{AeqN}$ indicators	
No.	Type of the area	$L_{DEN}$ The reference time interval equal to all days in a year	$L_N$ The reference time interval equal to all times of the night	$L_{AeqD}$ The equivalent sound level A for the time of day (from 6 a.m. to 10 p.m)	$L_{AeqN}$ The equivalent sound level A for the time of night (from 10 p.m. to 6 a.m)
1	a) protection zone "A" of the spa b) areas of hospitals, nursing homes c) areas of buildings associated with permanent or temporary stay of children and adolescents	55	45	55	45
2	a) areas of single- and multi-family housing, as well as farm buildings and a collective residence b) recreation and rest areas c) residential and service areas d) areas in the downtown zone of cities over 100,000 residents	60	50	60	50

Source: [8]

The noise indicators [1] presented in Table 1 are noise parameters determined by the A-weighted sound level expressed in decibels, where:

- the  $L_{DEN}$  and  $L_N$  indices represent the long-term average sound level determined over the course of all days of the year, including the time of the evening and night ( $L_{DEN}$ ) and all nights of the year ( $L_N$ ); they are used to conduct long-term policy in the field of environmental protection against noise, in particular for the preparation of acoustic maps and environmental protection programs against noise;
- $L_{AeqD}$  and  $L_{AeqN}$  indicators being the equivalent sound level for the time of day and the time of the night respectively; they apply to setting and controlling the conditions of using the environment in relation to one day.

Other real estate market research [5, 9–13] confirms the adopted assumptions, with an acceptable noise level of 45–55 dB. Surveys conducted in the USA [6] indicate the acceptable sound levels depending on the type of real estate and the expected reaction of the public with the increase of noise above the approved one (Tab. 2).

**Table 2.** Acceptable sound levels for individual types of real estate and public reaction to them being exceeded

Real estate type	Acceptable level of sound intensity during the day [dBA]	
	during the day	at night
Agricultural	35–40	25–35
Municipal	40–50	30–40
Suburban	45–55	35–45
Commercial	55–65	45–55
Industrial	60–70	50–60
Surplus above the acceptable level [dBA]	Reaction of the society to the increase of noise above acceptable level	
0	lack	
5	sporadic complaints	
10	common complaints	
15	taking actions	
20	taking decisive actions	

Source: [6]

In the studies of the impact of noise on the value of real estate, the degree of dependence between noise level and the distance from the airport (availability), measured in a straight line, is also taken into account. Both these variables are often not significantly correlated. One of the methods of testing the noise and distance dependency [7] is based on the determination of areas in the form of circles with different radii, located at a fixed distance from the airport and contours determining different volume levels from the airport. On this basis, the relationship between the distance for a sample of real estate that have identical access to the airport (distance) and noise level, which for the analyzed real estate may be significantly different, is examined. The greater impact of aircraft noise is observed in areas close to the runways, while properties located closer to the airport but further from the runways are characterized by a lower noise load.

In the literature we even find postulates that a more important factor that affects the prices of real estates located in the vicinity of airports is their distance from the

airport rather than the noise level to which they are exposed due to this location. What is more, the results indicate that the proximity of the airport is positively correlated with property prices, which is the result of preferences of owners and users of real estate, who pay more attention to short travel time from home to work, which allows them to communicate better with the airport than to comfort due to lower noise. Other studies [14], which analyze the effect of noise on prices but in relation to the distance from the airport, indicate that the estimated decrease in property values due to noise is at a lower level as the distance from the airport increases, whereas in the case of only noise, without the factor, which is the distance, the received property value reductions are at a higher level.

The difference in real estate values, which are located at different distances from the airport and are located in the same range of noise impact (assuming no effect of other features), may result primarily from a better view or noticeably lower noise level than is apparent from the associated noise contours.

The majority of real estate market analyzes in terms of the impact of aircraft noise are focused on various types of residential real estate, as this segment of the market, unlike even commercial properties, is most susceptible to negative environmental factors. Survey results [15] carried out among property owners indicate that one of the main factors determining the location of a real estate, ranked second at a price, is a quiet neighborhood, rated on a scale from 0 (insignificant) to 3 (very important) as an important one (2). In the group of environmental factors affecting the quality of life, communication noise and air pollution were among the most important.

On the other hand, cost [16] related to aircraft noise, based on surveys where people surveyed were resident within a radius of 50 km from Amsterdam airport, indicates that the well-being of residents can be defined as a function of household income, family size, age of the person being surveyed, noise and their noise perception.

The variety of real estate [17] is manifested by the absence of two identical properties, which entails the need to include in the analyzes the decrease in the value of real estate caused by excessive noise of air traffic, also other factors – real estate features. The potential buyer makes the price that he is able to pay dependent on the physical parameters of real estate, but also location, neighborhood, transport accessibility and social infrastructure, and other.

Taking into account the nature of the real estate [6], smaller decreases in value refer to older and cheaper real estate, while the highest ones take place in the case of exclusive properties, which buyers have definitely higher requirements when deciding to buy real estate.

The exemplary results of the analyzes already carried out in other markets, mainly foreign ones, are varied and depend on, among others, the chosen research methodology. For example, [10] for Zurich airport, the recorded (NDI) decline in the value of residential real estate for 1 decibel caused by aircraft noise is 1%, for

the Amsterdam airport [5] NDI was 0.77%. When estimating aircraft noise in the Netherlands [11], which originates from civilian and military airports, the NDI ratio of 0.8% was adopted as the benchmark. In Poland, the NDI level [13] was estimated at 0.8% for the Warsaw airport in relation to the housing market. In the case of the airport in Poznan, the NDI index [12] for properties built-up with residential houses is at the level of 0.87% and for apartments it is equal to 0.57%.

### 3. Objectives of Planned Research

The article is an introduction to the planned research on the impact of noise generated by the Krakow-Balice airport on the prices of real estates located in its surroundings.

The beginnings of civil aviation in Balice date back over 50 years [18], when part of the airport was made available by the military authorities for civil use. The political and economic changes taking place in the following years and large-scale investments have led to the present state, where the airport ranks second in Poland in terms of the number of passengers served and is the largest regional airport in the country. The strong dynamic of the development of the airport is confirmed by statistical data, according to which in January this year, up to 20% more passengers were served than in the corresponding period of 2017. In January 2017, the number of passengers served was 21% higher than in January 2016.

In the coming years, further investments are planned in the area of the airport, which are to serve the correct service of growing passenger traffic, including in the form of construction of the next runway.

Due to failure to comply with the applicable environmental quality standards in terms of exceeding the acceptable sound levels in the environment, limited use zones (LUZ) were created for the Balice airport [19]. The isolation of noise emission is determined by three limited use zones: A, B and C, which basic characteristics are given below (Tab. 3).

**Table 3.** LUZ characteristics

	Zone A	Zone B	Zone C
Zone area [m <sup>2</sup> ]	844 807	4 490 625	2 260 423
Number of residential buildings in a given zone	70	135	140
Number of schools and public utility buildings	0	4 and 6	0 and 3
Estimated number of inhabitants in a given zone	300	600	750

Source: own elaboration based on the justification to [19]

The currently applicable limited use zones (Fig. 1) indicate areas where standards for acceptable sound levels have been exceeded and in relation to which a large

part of property owners applied for payment of compensation for a reduction in the value of real estate on this account. There are various methods for determining zones and contours of noise, as well as various units of noise measurement and its limits. These factors [20] have a significant impact on properties located near airports, allowing some owners to claim compensation or use other instruments to mitigate airport interactions. European standards indicate the use of the noise indicator  $L_{DEN}$  – for the day, evening and night time and indicator  $L_N$  – at night, to determine the disturbance of sleep.

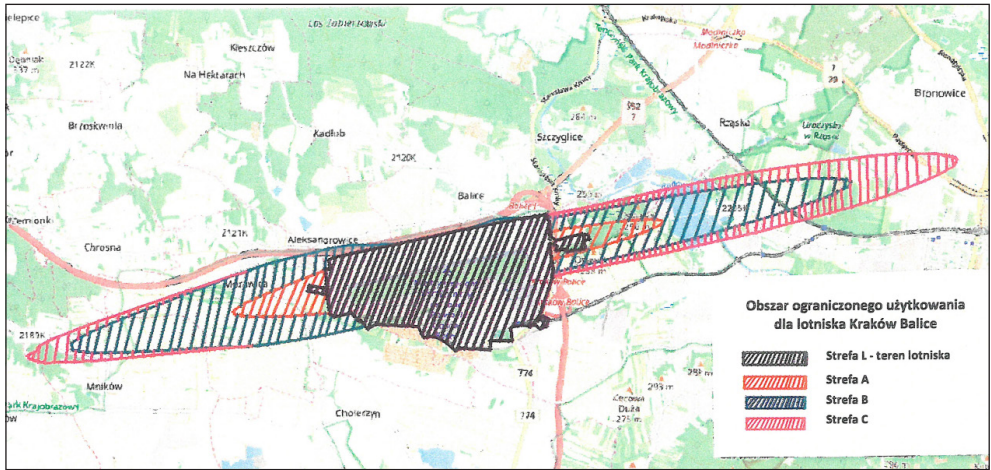


Fig. 1. LUZ for Krakow-Balice airport

Source: [20] and own work

The resolution defines the boundaries of each of the three limited use zones, restrictions in the allocation of land for various purposes and the rules for their development (Tab. 4).

It should be noted that the scope of particular limited use zones in the coming years will be adapted to the investments carried out, including the construction of another runway which will increase the LUZ.

However, it should be noted that other properties located outside the LUZ, but in areas adjacent to them, are also exposed to the negative impact of air traffic. These nuisances result even from the worse view characteristic for the properties located near the airport, air pollution, disruptions in the reception of radio and television stations or more noise caused by aircraft flights.

The boundaries of the LUZ include the area located partly in the city of Krakow, and partly in the districts of Zabierzów and Liszki near Krakow. For most LUZ, the development directions are defined by the Studies, the rest of the area is covered by current local plans or plans in the process of elaboration.



**Table 4.** Rules for land development in an individual LUZ

Zone	Method of zone indication	Restrictions and rules for the development of the zone
A	the boundary is set from the outside by the maximum range of night noise isolines $L_N = 50$ dB or $L_{DEN} = 60$ dB, the airport border from the inside	<ul style="list-style-type: none"> <li>- prohibition of land development for single- and multi-family housing development and farm buildings</li> <li>- prohibition of the creation of recreational and rest areas outside the city,</li> <li>- regardless of the current function of the areas, prohibition of the construction of single-family and multi-family housing buildings and farm buildings,</li> <li>- admission to use or extension of existing single-family housing and farm buildings while ensuring compliance with construction conditions that ensure compliance with noise standards in premises,</li> <li>- prohibition of the construction of hospitals, nursing homes, facilities related to the permanent or long-term stay of children and adolescents,</li> <li>- prohibition of changing the function of non-residential buildings into residential ones</li> </ul>
B	the boundary is set from the outside by the isoline $L_{DEN} = 55$ dB, from the inside the maximum range of isolines $L_N = 50$ dB, $L_N = 60$ dB or the airport border	<ul style="list-style-type: none"> <li>- prohibition of the construction of hospitals, nursing homes, facilities related to the permanent or long-term stay of children and adolescents,</li> <li>- admission to use of existing facilities related to long hours of stay of children and youth not functioning at night (schools not providing dormitories, youth hostels, colonies, etc.) while ensuring the required acoustic comfort indoors, and access of children and youth during classes to the sports areas</li> </ul>
C	the boundary is set by noise isolines $L_{DEN} = 45$ dB, from the inside the maximum range of isoline $L_{DEN} = 55$ dB	<ul style="list-style-type: none"> <li>- admission without restrictions of existing facilities associated with long-term stay of children and youth not functioning at night (schools that do not run dormitories, youth hostels, colonies, etc.)</li> </ul>

Source: justification to [19]

Objectives and directions of the undertaken research:

- 1) The subject of the analysis are all types of real estate, both built-up and undeveloped land, having different function and method of use. The research results presented in the literature refer to the vast majority of residential real estate (flats and single-family houses), as this segment of real estate shows the largest declines in value due to the impact of aircraft noise. The impact of harmful environmental conditions can also be noted on the market of undeveloped land. Research carried out in the Netherlands [11] indicates that the prices of undeveloped lands with a housing function, located in zones where,

due to the noise level, a prohibition on the construction of new facilities has been introduced, are 50% lower. In the case of areas for various purposes, where building development is possible, changes in price levels may vary depending on the purpose. Declines in the value of real estate can be noted in relation to housing plots, which are most often managed in a different way, approved by plans, which will eliminate or minimize the negative impact of noise. In the case of territories for other purposes, such as commercial or industrial land, one can even expect an increase in property prices due to the development of other transport networks due to the existence of an airport.

The scope of analysis will include transactions concerning real estates:

- located in each of the LUZ,
- located in the close vicinity of the airport but outside the adopted contours of the LUZ noise,
- located in areas that are not affected by air traffic and constituting comparable markets.

- 2) If it is not possible to reduce the negative impact of aircraft noise, it may be necessary to consider the optimal use of real estate, alternative to the current one, which gives better opportunities to use the property for purposes where the noise will not affect their value. In the case of some airports [6], the neighboring residential areas were bought by the city and then gradually leased. The conclusions drawn indicate that property owners and persons acquiring real estate react more negatively to the effects of excessive noise than to the tenant. The discussion on the use of real estate in other ways refers in particular to those with a residential function related to the permanent residence of people.
- 3) The vast majority of studies on the impact of aircraft noise on the value of real estate use all kinds of statistical models including regression models, where the dependent variable, representing transaction prices of real estates located in the vicinity of airports, is a function of independent variables including, among others, aircraft noise. First of all, the characteristics of a given property are analyzed (e.g. parameters of component parts, size of the plot, age of the building), location features (e.g. distance from shops, public facilities, transport accessibility) and environmental features (e.g. air pollution, noise). The final result is an estimate of the noise reduction in the property value expressed in the NDI index. In addition to standard valuation methods, there are also those based on the results of surveys conducted among airport residents [11, 21], who answer the questions: how much would they be willing to pay for the reduction of factors negatively affecting their living comfort? e.g. aircraft noise. Yet another approach used in research [7] is based on meta-analyzes using previously conducted research in a given area in the field of the impact of aircraft noise, to prepare a new statistical analysis allowing to draw new conclusions.

## 4. Conclusions

The impact of aviation noise on the quality of life and work which is reflected in real estate prices is an important issue that arises in many research projects. The changing market conditions and preferences of real estate buyers means that this subject remains a pressing one and the obtained results of the decline in the value of real estate may vary over the years. In addition, there are many areas for which no such studies have been conducted so far, such as the Krakow-Balice airport.

This article is an introduction to the planned research which will encompass all types of real estate located in the areas of impact of the Krakow-Balice airport. In addition to the use of valuation models based on data obtained from notarial deeds, the scope of the analysis will include surveys of residents.

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## **Problematyka wpływu obszarów ograniczonego użytkowania na wartość nieruchomości**

**Streszczenie:** Metody porównawcze stosowane w wycenie nieruchomości wymagają przyjęcia atrybutów cenotwórczych, których liczba i rodzaj powinny uwzględniać szczególne uwarunkowania lokalnego rynku nieruchomości powiązane z ograniczeniem prawa własności. Podjęta tematyka dotyczy analizy prawnej

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i cenowej nieruchomości zlokalizowanych w obszarach ograniczonego użytkowania portu lotniczego Kraków-Balice. Praca stanowi wstęp do realizowanych badań, których celem jest konstrukcja modeli wyceny nieruchomości położonych na tych obszarach i oceny wpływu takiej lokalizacji na wartość nieruchomości, z uwzględnieniem ich różnego przeznaczenia i sposobu użytkowania.

**Słowa**

**kluczowe:** hałas lotniczy, czynniki środowiskowe, spadek wartości nieruchomości