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## Methods of Imposing Restrictions on Land Management in Planning of an Airport's Transport Infrastructure

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# Methods of Imposing Restrictions on Land Management in Planning of an Airport's Transport Infrastructure

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**Abstract.** Aviation transport can have a significant impact on the environmental conditions of land adjacent to the airport. To achieve the purpose of the article, a set of general scientific and special methods of research was used, in particular: monographic analysis, abstract-logical, systematic approach, calculation and graphical, mathematical. The concept of ecological and economic assessment of land management restrictions for airport infrastructure is analyzed, since the legal regime and the specificity of their use are strictly regulated by legislative norms and standards. The assessment of constraints on the functioning of airport infrastructure should reveal the impact of transport accessibility on the environment of the airport and the growth of the economic development of the neighboring region. The need to model the future demand for motor transport around airports is justified, which requires the accuracy of forecasting any future trips to airports, for example, due to economic profit after the increase in local traffic, driven by population growth, demand for real estate ownership and business development. The principles of open space preservation and integration with adjacent transport routes are considered, taking into account the aesthetic expediency and meeting the needs of the population when forecasting, planning and designing the airport infrastructure. Preservation of the open space around the airport shall be controlled constantly to ensure proper functioning and development of the approach roads thereto. The results of the study are proposals for the implementation and application of the following principles of environmental and economic assessment of design solutions in the context of the interconnected operation of the aviation enterprise and territory around the aerodrome.

## 1. Introduction

A famous British expert Sir Howard Davis, who studies the matters of airport infrastructure development, emphasizes that limited infrastructure meant to ensure transport availability to the surface of an airport could inhibit the economic growth and force the passengers, staff and cargo operators to look for alternative ways to reach their destinations. It sharpens ecologic problems and causes the occurrence of a notion of “ecosystem overload.” Instead, a good transport approach to airports is, perhaps, one of the most important means to facilitate tourism development in a region [8].

M. Janic', N. Hirst consider the economic, legal and technological issues of the development of each element's aviation transport system separately, while highlighting the



resource and land potential of the aviation industry as the only indispensable basis for the functioning of aviation.

Among the scientists who have contributed their scientific potential to the development of ways of implementation and improvement of the processes of environmentally friendly, regulatory-regulated land use and development of aviation transport infrastructure, it is necessary to note L. Novakovsky, N. Bondarchuk, I. Novakovsk, M. Stetsyuk, Yu. Dorosha, K. Marintsev.

Investments in the development of aviation transport infrastructure form a basement for reliable financial results and wider economic opportunities for the aerodrome environs' functioning. Thus, first of all, one should invest in transport infrastructure to satisfy contemporary demand.

Using investments to develop transport infrastructure around an airport and to improve its approach roads is a great economic stimulus for aerodrome environs' land management. Such well-balanced land management facilitates shortening distances, improvement of approach roads and reduction of the period to wait.

The planning and design of transport infrastructure to ensure an approach to airports is possible only upon the condition of proper ecologic-economic evaluation of restrictions on land management for airport infrastructure, for instance – aerodrome environs, legal regime and peculiarities of use whereof shall be regulated accurately by legal norms and standards.

## 2. An airport-approach transport infrastructure

Net present value (NPV) of investments into transport infrastructure is calculated according to the equation [4]:

$$NPV = -I + \sum_{t=1}^T (\Delta CS_t + \Delta PS_t)(1+i)^{-t} \quad (1)$$

where, I – investment funds;

T – lifecycle period of a project;

$\Delta CS_t$  – change of consumer surplus for a year t;

$\Delta PS_t$  – change of producer surplus for a year t;

i – discounting rate.

Change of consumer surplus is evaluated according to the “Rule of Half” [6]:

$$\Delta CS_t = \frac{1}{2}(g_{t0} - g_{t1})(q_{t0} + q_{t1}), \quad g = p + \tau \quad (2)$$

where:  $g_{t0}$  – the total of spendings in a year, except for investment flows;

$g_{t1}$  – the total of spendings in a year, investment flows included;

$q_{t0}$  – number of service consumers in a year except for investment flows;

$q_{t1}$  – number of service consumers in a year, investment flows included;

p – the cost of a trip considering airport taxes, expenditure for approach and exit;

$\tau$  – the value of the total time of a trip (flight, approach, exit and waiting).

The change of forecasted consumer surplus due to possible accidents, for instance, flight accidents or negative atmospheric changes in the zone of the investment flows are calculated according to the equation [4]:

$$\Delta PS_t = p_{t1}q_{t1} - p_{t0}q_{t0} + C_{t0}(q_{t0}) - C_{t1}(q_{t1}), \quad (3)$$

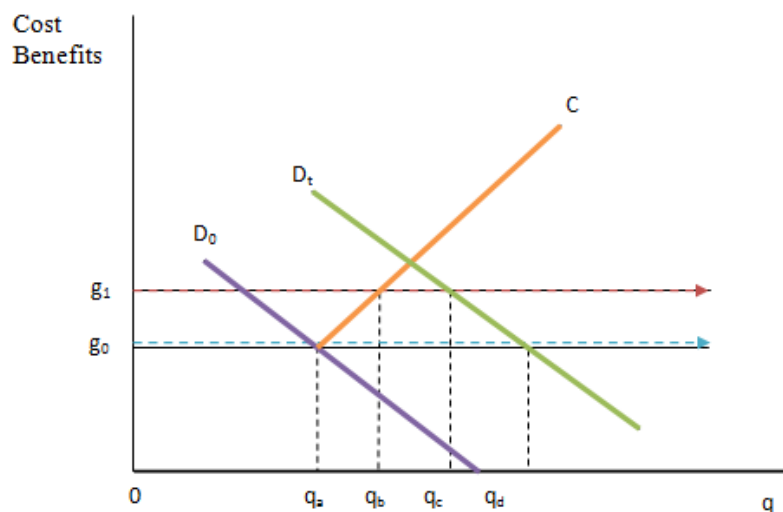
where:  $C_{t0}(q_{t0})$  and  $C_{t1}(q_{t1})$  – shared variable without a project and with the one, respectively.

In any case, a market of approach to an airport is rather competitive. At that, the economic profit of investments could be defined at the account of decreased spendings for resources. Consider a project of an airport's infrastructure, stipulating reduction of total time on a trip ( $\tau_1 - \tau_0$ ) upon condition that the prices remain unchanged (Figure 1).

Investments into a project of transport infrastructure "approach roads to an airport" shall finally increase land management intensity. The value of generalized spendings and readiness to pay for services are indicated on the vertical axis, while values of demand in a time unit (e.g. an hour, a peak period, a day, a year) – on the horizontal one. The initial values of intensity of the land management provide a possibility to service a maximum of users,  $q_a$  during a certain period for a constant generalized cost, equal to  $g_a$ . This causes new growth of the traffic within the limits of the present land management intensity upon the condition of preserving the average cost.

Modeling the future demand for motor transport around airports requires accuracy regards the forecasted future trips to the airport, for instance, calculation of economic benefits for increase in the local trips, stipulated by the growth of population, demand for real estate and development of business.

A project of transport approach to an airport both for motor and railway transport could be implemented exclusively upon the condition of high-quality ecologic-economic assessment of restrictions on land management for an airport's infrastructure, as legal regime and specific features of use thereof shall be regulated accurately by legal norms and standards.



**Figure.1.** The benefits of aerodrome environs' land management as a transport infrastructure project "approach roads" [4]

Evaluation of restrictions in the functioning of the infrastructure of airports shall disclose the influence of transport accessibility upon conditions of aerodrome environs and growth in the economic development of the adjacent region as a whole (Figure 1). Indeed, future payments for trips reflect the gross economic benefit thereof. Non-aviation activities at aerodrome environs could exemplify meeting the basic ecologic-economic principle of land management.

### **3. Restrictions on land management in planning transport approach to an airport**

To ensure obtaining well-balanced values, resulting from the assessment of restrictions in aerodrome environs' land management and airport infrastructure as a whole, it is expedient to refer to the experience of *the Landside* project.

The *Landside* project is a world-recognized method for economically efficient planning of airport infrastructure and safety of the environment [6].

Final solutions of the project leave some space for changes in the future, and ensure meeting the restrictions in land management of aerodrome environs:

1. Placement of takeoff runway apron;
2. Allocating land sites for public needs;
3. Reasonable land management;
4. The increasing level of the airport's capacity for aircraft maneuvering above the aerodrome environs;
5. Designing new takeoff runways or extending, reconstruction of the existing ones at the account of land sites of aerodrome environs;
6. Increasing intensity of the land management at the account of cargo or passenger terminals;
7. Improving the approach to terminals through car parking or railway stations.

According to article 66 of the Air Code of Ukraine, an airport operator is responsible for the conditions of aerodrome environs and any production, economic works thereon, as well as for activities of subjects [9]. That is why it must be clearly defined, which of activities of an airport affect ecologic-economic conditions of aerodrome environs.

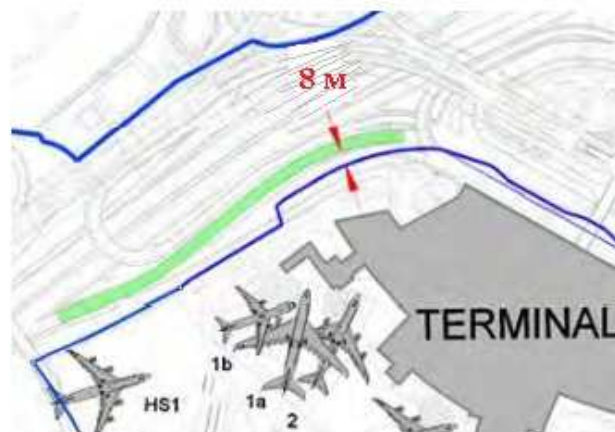
Developing dummy-diagrams of the new objects of air transport, the airport operator must be conscious that the existing aerodrome environs, for instance, transport infrastructure, will change depending on the type of the airport. That is why it is so necessary to leave a certain space around an airport while building the new one. It is required to preserve open space, for integration with adjacent transport ways, for consideration of esthetic expediency and fulfillment of demands of the population. Consequently, this is the way to follow the restrictions on the use of aerodrome environs. The basic purpose thereof is to provide the accurate instructions for subdividing the territories into certain zones, namely – to regulate the height of houses or other building nearby the airport, the interaction of the airport with objects of the natural environment, meeting the principles of transport accessibility, as they constitute the ecologic-economic value of the territory.

If lines of highways/motorways/road arteries had been constructed on aerodrome environs before the airport began to be constructed, the minimal deviation (displacement) up to 30 m shall be considered (Figure 2).



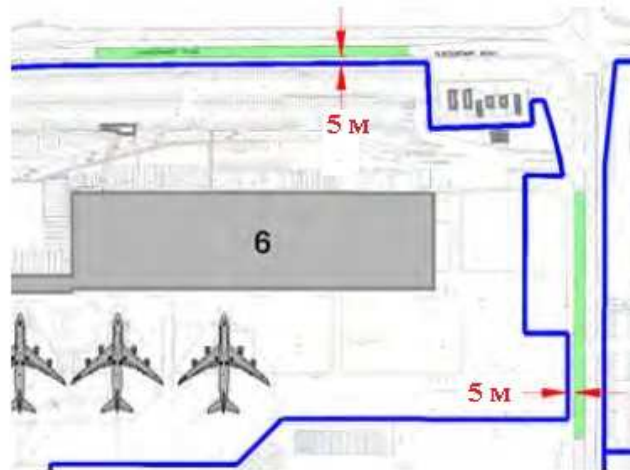
**Figure 2.** Restrictions on the lines of the internal transport connections, which are not the main approach roads to an airport

While planning lines of the main approach roads to an airport to be located on aerodrome environs, the minimal deviation (displacement) up to 8 m shall be considered (Figure3).



**Figure 3.** Restrictions on the lines of the internal transport connections, which are the main approach roads to an airport [10]

While planning lines of the secondary approach roads to an airport to be located on aerodrome environs, the minimal deviation (displacement) up to 5 m shall be considered (Figure 4).



**Figure 4.** Restrictions on the lines of the internal transport connections, which are the secondary approach roads to an airport [10]

While planning lines of the internal engineering-service connections, a component of airport infrastructure, the minimal deviation (displacement) of up to 3 m shall be considered (Figure 5).



**Figure 5.** Restrictions on the lines of the internal engineering-service connections of an airport [10]

#### 4. Conclusions

Every day thousands of passengers, employees, suppliers travel to airports. The transport they travel can have a significant impact on the environmental conditions of the land adjacent to the airport.

Many airports have already developed the most reasonable, environmentally friendly airport transit routes available on their official websites.

To ensure compliance with the restrictions imposed on the operation of air infrastructure, served airports are advised to update their strategic plans to develop transport accessibility every 5 years. For example, the conservation of open space around an airport is constantly monitored to ensure its proper functioning and development of access roads.

In turn, public policy should support the development of national transport networks, as well as the general provisions of airports and the strategic principles of access to them.

The process of ecological and economic assessment of aviation transport lands should be considered in the context of the interconnected functioning of the infrastructure of the aviation enterprise and its adjacent territories. As the experience of specialists and experts of the international level in this case, it is necessary to evaluate the design decisions and investigate how they relate to the tasks of environmentally friendly land use and the needs of effective territorial development of objects of the aviation industry.

The results of the study are proposals for the implementation and application of the following principles of environmental and economic assessment of design solutions in the context of the interconnected operation of the aviation enterprise and territory around the aerodrome: the ecological and economic effect resulting from the interconnected operation of the airport infrastructure and land use of the airfield; the use of the Landside project guidelines to ensure a balanced environmental and economic assessment of land use restrictions of the aerodrome area; ecological and economic principles and assessments of restrictions on land use of the airport infrastructure (at the airport area).

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