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Technical Note

Assessment of environmental noise due to aircraft operation at the Athens International Airport according to the 2002/49/EC Directive and the new Greek national legislation

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ABSTRACT

Athens International Airport "Eleftherios Venizelos" (A.I.A.) is one of the most modern, functional and safest airports in the world and constitutes the largest hub of air travel in south eastern Europe. Environmental noise from aircraft movements at the airport is a crucial environmental factor of urban environment and quality of life especially in Southern European countries where climatic conditions favour outdoor activities and night life. A.I.A. under the auspices of the Ministry of Environment, Energy and Climate Change, the Hellenic Civil Aviation Authority, and in collaboration with the University of Thessaly has completed a comparative Study on Aircraft Noise – according to the European Directive 49/2002 (ED 2002/49, 2002) – based on both 2006 and 2011 Strategic Noise Maps (SNM) and Noise Action Plans for the EU indicators L_{den} and L_{night}. A full statistical analysis of predicted vs measured noise levels based on the existing A.I.A.'s Noise Monitoring System (NOMOS), is also completed in order to evaluate accuracy of both SNM's and the relevant comparative data. The comparison analysis for both SNM's clearly states the efficiency of the introduced Noise Action Plan taking also into account the latest traffic operation data.

1. Introduction

1.1. Environmental noise and health

Environmental noise annoyance – especially from airport operation – is widely accepted as an end-point of environmental noise that can be taken as a basis for evaluating the impact of noise on the exposed population. People annoyed by airport noise may experience a variety of negative responses, such as anger, disappointment, dissatisfaction, withdrawal, helplessness, depression, anxiety, distraction, agitation or exhaustion. There is sufficient evidence from large-scale epidemiological studies linking population exposure to environmental noise with adverse health effects. Therefore, environmental noise should be considered not only as a cause of nuisance but also a concern for public health and environmental health. Noise from all sources may be relevant to the assessment of risk, and hence it may be appropriate to assess the exposure of the population of interest to all of these sources [1]. Furthermore community surveys have found that high percentages of peopled reported "headaches", "restless nights" and "feeling tense and edgy" in high level aircraft noise areas [2–4]. WHO defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity, and recognizes the enjoyment of the highest attainable standard of health as one of the fundamental rights of every human being [5].

As regards aircraft noise, most of the exposure to relevant events occurs mainly during the day and evening period. Therefore day time exposure is likely to have greater effects than night time exposure and relates mainly to disturbances in communication. However, in South European airport during summer periods night exposure to aircraft noise may have a greater impact on sleep disturbances and stressful conditions due to heavy traffic volume arriving from Northern European or overseas destinations.

1.2. Airport characteristics

The "Athens International Airport S.A." (A.I.A.) [6], one of the largest transportation infrastructure projects in Greece (Fig. 1), is one of the most modern, functional and safest airports in the world and is considered to be the southern gateway of Europe, with the following characteristics (Table 1).

Eleftherios Venizelos' is located 33 km northeast of Athens city centre and carries the Code Name **ICAO: LGAV** and **IATA: ATH**. The description of the main natural and technical/operational

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Fig. 1. Athens International Airport [6].

Table 1
Airport Characteristics [6].

Commencement of operation	March 2001
Runways	2, approximately 4 km each
Main terminal building	4 levels, 14 passengers' embarkation bridges, 1,50,000 sqm.
Satellite terminal building	10 gates for passengers embarkation
Aircraft traffic (max capacity)	65 landings and take-offs per hour
Passenger traffic 2006	15.1 million passengers
Passenger traffic 2011	14.4 million passengers
Cargo traffic 2006	120.200 tones
Cargo traffic 2011	86,000 tones
Aircraft traffic 2006	1,91,000 movements
Aircraft traffic 2011	1,73,000 movements

characteristics and particularly the General Runway Data of A.I.A.' is given summarized below. The **Airport's Reference Point** and relevant runways are as follows:

- Geographic latitude/longitude: 37.56.12.12N/23.56.40.20E.
- Altitude: 94 m MSL.
- 2 Runways 03R/21L and 03L/21R: 4000 m, and 3800 m, respectively.

2. Strategic noise mapping and Noise Action Plans: 2006–2011

In the framework of implementing the relevant European Directive 2002/49/EC [7] and the relevant Joint Ministerial Decision (JMD) 13856/724-28/3/06, A.I.A. in close collaboration with the Greek Ministry of the Environment, Energy and Climatic Change (YPEKA) and the Hellenic Civil Aviation Authority (H.C.A.A.) completed the Strategic Noise Map for 2006 (SNM 2006) and the relevant update of the Noise Action Plan (NAP) for aircraft noise [8,9]. In this framework the tasks concerning both Strategic Noise Map and Noise Action Plan for 2006 were completed.

According to the relevant legislation, Strategic Noise Maps need to be updated every 5 years. Therefore A.I.A., YPEKA and H.C.A.A. finalized the relevant technical specifications for the execution of the SNM 2011 which was awarded to the Laboratory of Environmental Transportation Acoustics (L.T.E.A.) of the Dept. of Civil Eng. of the University of Thessaly (Research Committee) as a research project. The execution of the new Strategic Noise Map was based on 2011 actual data. The tasks completed were also [10]:

- Strategic Noise Map 2011.
- An updated Noise Action Plan 2011 according to the relevant max limits as per the newest JMD 211773/27-4-2012 of the Greek Ministry of the Environment.

With the above JMD, the management and abatement of environmental noise is expected to be fulfilled according to article 14 of Law 1650/86, and articles 2, 3 and 5 of the relevant Joint Ministerial Decision (JMD) 13586/724/GGG/384/B/28-3-2006 which implements the European Directive 2002/49/EC. The recent maximum permissible limits for both noise indexes, L_{den} (24 h) and L_{night} (8 h), for airport environmental noise are defined as follows:

a. For the noise index L_{den} (24 h): 70 dB(A).
b. For the noise index L_{night} (8 h): 60 dB(A).

2.1. The study area: land use and population data

Taking into account the needs of both 2006 and 2011 SNM within the immediate and greater area of A.I.A. 'Eleftherios Venizelos', a three-dimensional model of the greater "Mesogaia" area was formed with the use of a Geographical Information System, with a minimum geographical unity of a block of residences.

The study area focused on a zone upwind and downwind of the airport runways. The limits of which were defined taking into account the preliminary effects of aircraft noise as presented in Fig. 2.

All urban areas and municipalities in the greater study area (urban–suburban and sheer rural areas) are presented in Table 2, with reference to the recent distribution of municipalities according to "KALLIKRATIS" initiative (Table 2) which introduced important merging actions for many of the pre-existing municipalities on a national level [11].

In the framework of the research for the institutionalized town planning zones (boundaries of general town planning, "Residential Control Zones", approved land use settlement boundaries, protected area boundaries, etc.) of the greater "Mesogaia" greater area, all the standing decrees and decisions as well as the corresponding maps were collected from the relevant town planning authorities of the Prefecture of East Attiki and the Technical Services authorities of the relevant municipalities.

The noise "sensitive" types of land uses, were recorded and depicted in inventory maps. More specifically, 146 updated locations of "sensitive" types of land use, grouped in six categories, were detected and inserted at the relevant geographic thematic level e.g. Churches, Schools (primary, secondary and tertiary), Community centres, Health centres, Nursery schools and Camps. The statistical data which was taken into account for the needs of the present study and comprises the basic material from which the statistic tables have been derived in both the long term and short term, is population data (collected every decade) per block of residencies at the settlement level of all municipalities and communities within the study area. The assignment of the population to each unit-block of residencies of the affected residential areas, was completed by using detailed maps from the Geographic Data Base of the Hellenic Statistical Authority