MODELING TECHNIQUE FOR THE EVALUTAION OF ENVIRONMENTAL EFFECT OF FLIGHT-PATH NEAR AIRPORTS: THE CASE STUDY OF A NEW ROUTE AT NAPLES AIRPORT

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Abstract

In recent years, the issue of noise pollution in airport vicinities has garnered increasing attention due to its impact on the well-being and health of nearby residents. The continuous growth of air travel and airport infrastructure has led to elevated levels of noise exposure in these areas, prompting concerns about its detrimental effects on individuals' physical and psychological health. Within this contest, the present work presents the main results of an acoustic study related to the identification of a new climbing procedure to be adopted at Naples airport to reduce the noise impact on the population as well as to optimize some other pollutant and safety aspects. The rationale and the implementation steps of the simulation procedure are illustrated and discussed. The simulation results demonstrated a positive effect of the new procedure on the number of people exposed to noise, opening to the next operation stage, nowadays under test. The activity has also been the opportunity to discuss about perception of noise by people not used to noise as a topic for reflection between objective and subjective perception of noise.

Keywords: Airport, aircraft noise, AEDT, INM.

1. Introduction

The assessment of the noise produced by aircraft concerns the take-off and landing phases, which certainly represent the main sources of disturbance for the population residing in the proximity of an airport settlement, represents an activity of particular interest, especially for infrastructures located near urbanized areas for which it becomes it is difficult to have free areas of sufficient size to be used exclusively for airports. In view of this, the legislation on the regulation of noise emitted by air transport must cover several requirements:

- protection of the population;
- allow the development of air traffic, which is now constantly growing;
- allow the expansion of airport infrastructure;
- identify limitations to spatial planning in the vicinity of such infrastructures.

This activity is generally supported by the use of forecasting software able to estimate the isophones footprint on the ground as a function of the landing and take-off operations characteristic of the airport.

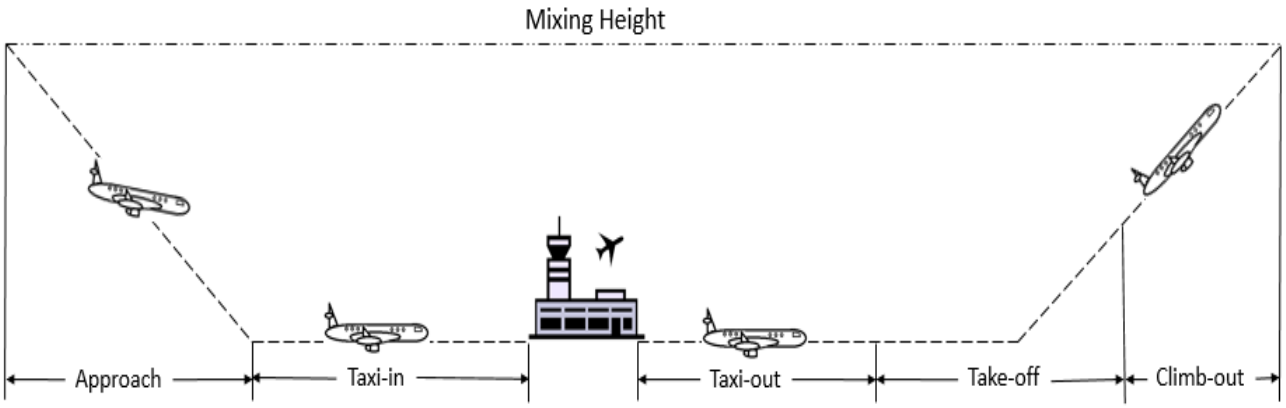


Figure 1 – A schematic overview of main flight operations

The forecast data must obviously be verified by means of punctual experimental measurements, which are functional to the verification and possible calibration of the numerical model.

The calculation of noise, emissions and fuel consumption we know to be influenced by the flight path of the aircraft, the local weather and the characteristics of the aircraft.

In the past, the INM (Integrated Noise Model) calculation code provided by the FAA (Federal Aviation Agency) has been represented the standard code for these simulation operations and widely used all over the international airports.

Anyway, in the last three years, a new code has been implemented by the FAA, to overcome some of the limitation of the INM. This new tool, named Aviation Environmental Design Tool (AEDT) present a new management of the acoustic parameters (as, for instances the implementation of innovative sound absorption model such as the SAE-AIR-5534) and a different management of the acoustic maps definition (as, for instances, the use of dynamic grids) . It also allow to a contextual management of acoustic and air pollution (CO2) problems.

AEDT also presents a catalog of aircraft updated and constantly updated, which INM did not have and for which equivalent aircraft should have been taken.

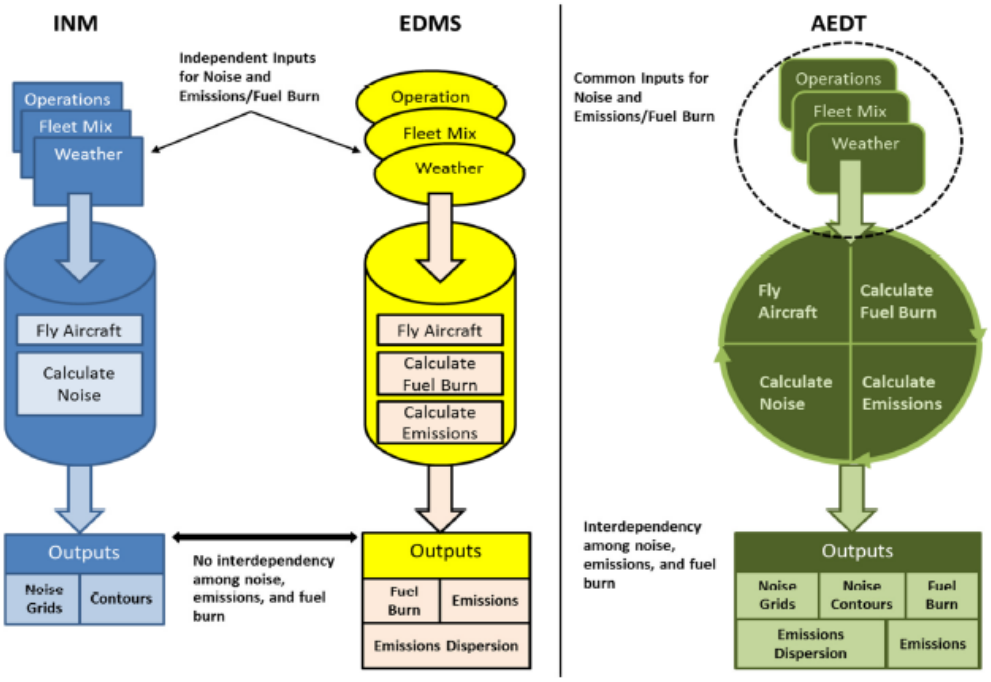
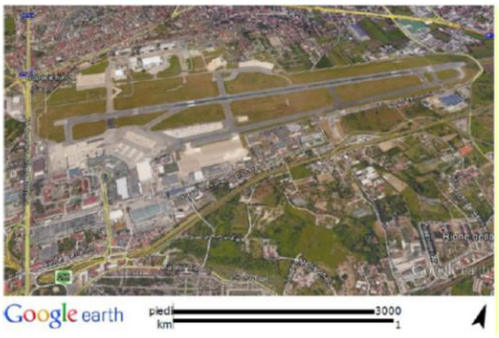


Figure 2 – AEDT Vs previous softwares

2. Assessment of a new route at Naples Capodichino Airport

A modeling activity has been related to the Naples Capodichino Airport whose overview data are reported in the following pictures, including the number of flight operation per year and one of the take-off flightpath.



Anno	Passeggeri	Movimenti
2000	4.136.508	61.918
2001	4.203.001	60.916
2002	4.132.874	63.600
2003	4.587.163	65.016
2004	4.832.388	59.962
2005	4.588.695	58.002
2006	5.095.960	61.708
2007	5.775.838	72.330
2008	5.842.266	68.548
2009	5.322.161	64.032
2010	5.584.114	63.564
2011	5.768.873	62.878
2012	5.801.836	61.115
2013	5.444.422	55.940
2014	5.960.035	58.681
2015	6.163.188	59.456
2016	6.775.988	63.093

Tabella 9: Traffico aeroportuale

Caratteristiche	
Nome aeroporto	Napoli Capodichino
Codice ICAO	LIRN
Codice IATA	NAP
Coordinate geografiche	40° 53' 04" N 14° 17' 27" E
Altitudine	90 m
Numero di piste	1
Superficie pavimentata complessiva	2.3 kmq
Tipo di gestione	diretta
Società di gestione	Gesac

Tabella 8: Caratteristiche principali dell'aeroporto

Runway Lenght: 2750 m

Runway Width : 45 m

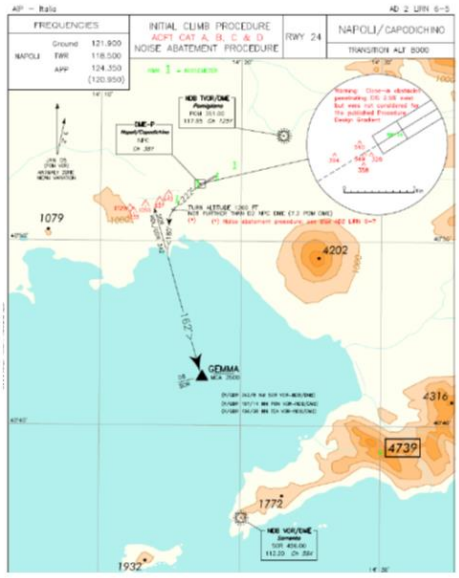


Figure 3 – Naples Capodichino Airport

Once defined the landing and take off flight routes, the flight mix has been defined in terms of single operation (type of aircraft, destination distance, time of the operation and others).

Model capodichino import:

- Operations;
- Flights;
- Broken;

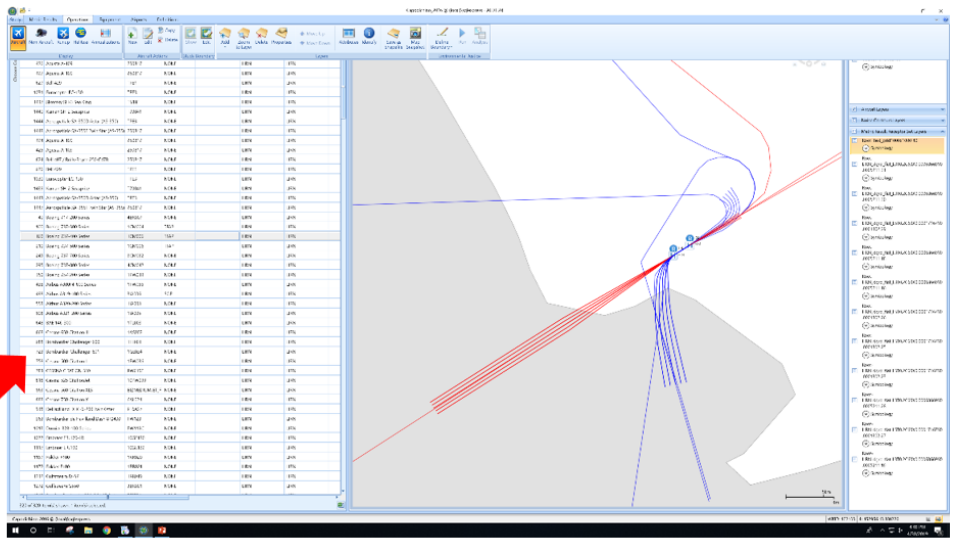


Figure 4 – Model definition

As a final result, the noise contours at ground can be computed.

Figure 5 – Example of actual noise contours at Capodichino airport

Due to specific environmental target, a new take-off path has been explored for the airport with the aim to avoid the overflight of the city center for aircraft directed to north europe routes.

The new take-off path (ICP RWY 24) , basically has been designed as specular to the actual one (referred to the airport runway) as represented with the green line in next picture 6 (white line represent the actual path).

Figure 6 – New take-off path (ICP RWY 24)

The new take-off path has been preliminary explored in terms of airworthiness by the competent institutions and once approved has been explored in terms of acoustic footprint and gaseous emissions for a direct comparison with actual situation.

The representation of the routes built for the SW AEDT is shown in figure 7, also shown in yellow the nominal route of the new ICP RWY 24.

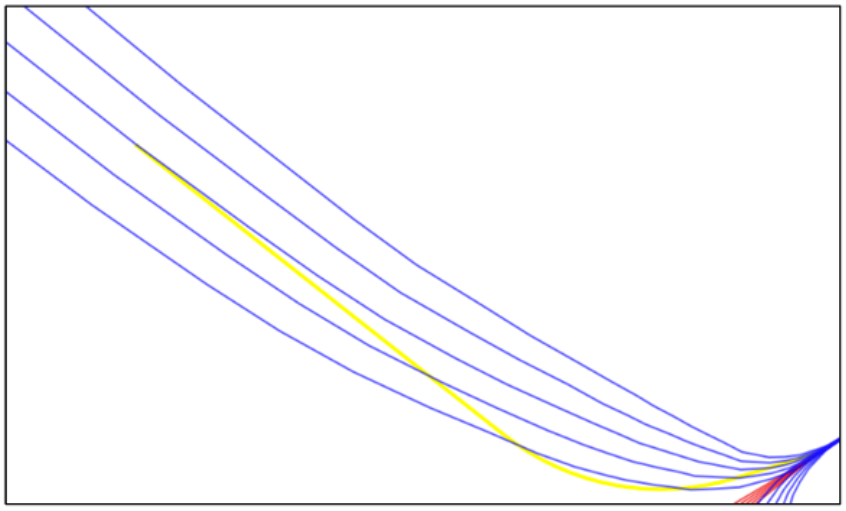


Figure 7 – Take off flight path definition (yellow: nominal – blue: available corridors)

In this contest, the best balance of take-off movement between different available paths has been evaluated to maximize the benefit in terms of pollutant effects.

After some consideration the new initial climb procedures will redistribute the take-off movements, as follow:

- The new KPI for RWY 06 would absorb 100% – replacing the current KPI – of the traffic departing from Runway 06;
- The new ICP for RWY 24 would absorb traffic bound for the North departing from runway 24.

An analysis of the three peak weeks of reference traffic model made it possible to determine that about 75% of the traffic departing from runway 24 would therefore be carried over to the new ICP4.

Therefore, the model built for the acoustic analysis SW provides, for departures from runway 24, respectively to 75% for the (new) northbound take-off procedure and 25% for the (existing) take-off procedures to the south.

As a result of these hypothesis, a direct comparison of ground isophonic can be performed.

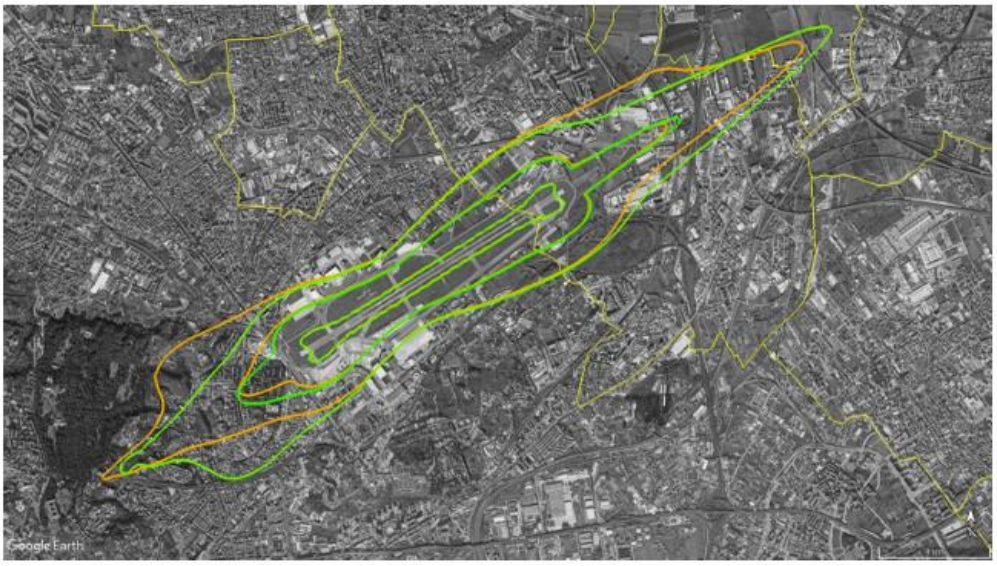


Figure 8 – Isophonic comparison (green: actual situation – orange: new climbing route situation)

The redistribution of isophonics leads to a reduction in the population exposed to noise due to reduced urbanization of areas to the north.

The new take-off procedures, with particular reference to the one to the city of Naples, also allow to obtain further important environmental benefits, linked to the reduction of climate-changing emissions (CO2).

3. Subjective and Objective Responses to Noise Pollution in Airport Vicinities

The background of the study on subjective and objective responses to noise pollution in airport vicinities is grounded in the increasing concerns over the adverse effects of noise exposure on human health and well-being. With the steady growth of air travel and the expansion of airport operations, communities living near airports are subjected to high levels of noise pollution, resulting in various physiological and psychological impacts. Previous research has primarily focused on either subjective assessments, such as annoyance and perceived noise levels reported by residents, or objective measurements, such as decibel levels and flight patterns. However, there is a gap in the literature when it comes to a comprehensive analysis that considers both subjective experiences and objective noise data simultaneously.

Research in the field of environmental psychology has, in-fact, highlighted the detrimental effects of noise pollution on individuals living near airports. However, there is a gap in the literature concerning the subjective and objective responses of individuals to noise pollution in airport vicinities. While many studies have focused on the physiological impact of noise pollution, such as increased stress levels and sleep disturbances, there is a lack of research exploring how individuals subjectively perceive and respond to the noise generated by airports.

It is evident that both objective and subjective responses play a crucial role in assessing the impact of noise pollution on individuals living near airports. Objective measurements, such as decibel levels and sound propagation analysis, provide quantitative data that can be compared across different studies and locations. However, these objective measures may not always capture the full extent of the impact on individuals' well-being and quality of life. Subjective responses, on the other hand, offer valuable insights into individuals' perceptions, attitudes, and experiences related to noise pollution. Studies have shown that subjective responses can vary widely among individuals, influenced by factors such as sensitivity to noise, coping mechanisms, and environmental awareness. Therefore, a holistic approach that combines both subjective and objective data is essential for a comprehensive understanding of the effects of noise pollution on airport communities. By synthesizing quantitative and qualitative data, researchers can better assess the true impact of noise pollution and develop effective mitigation strategies to improve the well-being of affected individuals.

The rationale of these consideration relies in the potential effect of the new climbing route on population response to noise, since it will impact groups of citizens that would not experience aircraft noise in the past. While the objective parameter “number of exposed people to noise” is significantly improved, it cannot be estimated a priori the number of potential claim due to people that will experience this pollutant condition for the first time.

By this, the target of a more detailed monitoring activity where these aspects will be deeply investigated.

4. Conclusions

The present work presents the main results of an acoustic study related to the identification of a new climbing procedure to be adopted at Naples airport to reduce the noise impact on the population as well as to optimize some other pollutant and safety aspects. The rationale and the implementation steps of the simulation procedure have been illustrated and discussed. The simulation results demonstrated a positive effect of the new procedure on the number of people exposed to noise,

opening to the next operation stage, nowadays under test.

Furthermore, a monitoring activity has been planned to check the real noise levels at ground and also to outline the perceived noise level with special reference in those area where people were not used to aircraft noise .

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6. Copyright Statement

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