Pollution of the aviation industry and its effect near airports "Global challenges – local solutions"

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ABSTRACT

In this essay the reader will find more details and descriptions of the following:

The aviation industry's reliance on fossil fuels leads to emissions of CO2 and other pollutants, contributing to climate change and poor air quality. Budapest Airport serves as a focal point for air and noise pollution due to emissions from aircraft engines, ground vehicles, and infrastructure. Noise pollution from aircraft operations affects nearby residents, leading to long term health effects and disturbances during day and night.

Recommendations for solving the problem include collaborating with airlines to reduce emissions by promoting cleaner aircraft models and operational practices, investing in electric or hybrid vehicles for airport operations and ground support equipment, implementing infrastructure for electric vehicle charging and exploring renewable energy sources.

For Noise Mitigation Measures, promote quieter engine technology and incentivize the use of quieter aircraft models. Optimize flight paths to minimize noise exposure for communities. Adopt noise reduction practices during take-off and landing, such as reduced engine thrust and continuous descent approaches.

For Community Engagement and Support, expand support for community initiatives like window insulation programs to mitigate noise impacts on residents. Collaborate with local authorities to improve air quality through joint initiatives like tree planting and pollution control measures. Implement transparent reporting mechanisms to keep the public informed about air quality and noise pollution levels.

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1. Introduction

Air pollution occurs when gases, dust particles and smoke are released into the atmosphere, making it harmful to humans, infrastructure, and the environment. (European court of auditors, 2018)

Noise pollution is unwanted or excessive sound that can have deleterious effects on human health, wildlife, and environmental quality. (Britannica, 2024)

The World Health Organization identifies air pollution as the foremost environmental risk to health in Europe. In the EU, air pollution causes over 1,000 premature deaths daily, surpassing the toll of road accidents by more than tenfold. Some EU Member States experience lost years of healthy life comparable to countries like China and India, known for poor air quality. In 2013, the EU Commission estimated the annual health-related external costs of air pollution to range between €330 and €940 billion. (European court of auditors, 2018)

The aviation industry is singled out as a major culprit for pollution in tourism. (Harrison, Masiol, & Vardoulakis, 2015)

The aviation industry generates 87.7 million jobs globally, both directly in airlines and airports and indirectly through its economic influence. Aviation is an economic giant, contributing over $3.5 trillion to global GDP, which is on par with the combined economies of Indonesia and the Netherlands. This impact goes beyond airlines and airports, encompassing jobs in manufacturing, tourism, and the broader supply chain. By 2038, the aviation industry is predicted to soar, supporting 143 million jobs, and injecting a whopping $6.3 trillion into the global economy. (Air Transport Action Group)

I choose this topic because I recently started working for an airline in the field of digital marketing, however I was always interested and was driven by sustainability, as well as biology and chemistry, which from I took my upper-level graduation exams. I hope that this essay will enlighten the readers about the seriousness of air pollution by the aviation in Hungary.

In this essay I will give more detail of the global air- and noise pollution of aviation in the skies and near airports, the health effects of the latter, and the local impact with focus on Budapest Airport.

2. Evaluation and statements

2.1 Pollution itself

The air transport industry, pivotal in global socioeconomic development, has historically overlooked its environmental impact. However, addressing and managing its environmental costs has become increasingly relevant. Despite technological advancements, the industry remains heavily reliant on fossil fuels, leading to a significant rise in CO2 emissions. While aviation's contribution to climate change is relatively small compared to other sectors, its fast expansion poses a substantial challenge, with CO2 emissions projected to increase by 300-700% by 2050. This growth contrasts with emissions reductions in other sectors, prompting calls for more robust environmental measures. International air transport, vital for social and economic development, is a significant CO2 emitter, with emissions forecasted to rise by 70% by 2020, even with a 2% annual improvement in fuel efficiency. (European commission, 2016)

„Aircraft emissions consist mainly of water vapour (H2O) and carbon dioxide (CO2). They further contain oxides of nitrogen (NO), carbon monoxide (CO), oxides of sulphur (SOx), unburned hydrocarbons (HC), and particulate matter (PM)." (M.O. Köhler, 2015, p.2.)

Aircraft emissions are released mostly at high altitudes (9-13 km) where the upper troposphere and lower stratosphere meet. This is important because these atmospheric layers have different chemical properties and how they affect emissions is different. Some emissions, estimated at 20-60%, end up in the stratosphere, which is further complicated by the ever-changing border between the two layers. (M.O. Köhler, 2015)

Based on Köhler's (2015) publication, I'll try to explain how these emissions contribute to air pollution. Imagine the lower atmosphere (troposphere) as a giant outdoor chemistry lab. Sunlight is the main source of energy for most reactions in this lab. But before sunlight reaches the troposphere, it gets filtered by a layer of ozone gas up high (stratosphere). This filtering acts like a giant UV shield, only letting through the weaker kinds of sunlight (longer wavelengths). Certain molecules in the troposphere, like ozone (O3) and nitrogen dioxide (NO2), are sensitive to this weaker sunlight. When they absorb this sunlight, they break apart, like triggered dominoes. This breaking apart is the first step in a series of reactions, kind of like a chemical chain reaction. One important chain reaction involves a super reactive molecule called a hydroxyl radical (OH). There aren't many OH radicals floating around, but they're good at grabbing onto and breaking down things like pollution (organic substances) and carbon monoxide (CO). This process is like a slow-burning fire at low temperature, cleaning up the air. At night, with no sunlight, another molecule called the nitrate radical (NO3) takes over a similar role, but it's not quite as good at cleaning things up. The passage goes into more detail about how these cleaning reactions work during the day, using examples like CO and methane (CH4). It also talks about how some of these reactions can affect the amount of ozone in the atmosphere. (M.O. Köhler, 2015)

„At wavelengths λ of less than 310 nm the photolysis of O_3 can produce an excited-state oxygen atom, $O(^1D)$. This high-energy oxygen atom can overcome the stability of the H_2O molecule and, upon reaction with water vapour, result in the formation of OH." (M.O. Köhler, 2015)

$$O_3 + h\nu \rightarrow O(_1D) + O_2$$

$$O(_1D) + H_2O \rightarrow 2OH$$

$$(\lambda < 310 \text{ nm})$$

Formulas from publication by M.O. Köhler, 2005

The compounds nitric oxide (NO) and nitrogen dioxide (NO2), when available in sufficiently large concentrations, have the ability to interfere in the above described reaction process. During day time atmospheric NO rapidly inter-converts with NO2 in the presence of ozone such that both species usually are in chemical steady state and are together referred to as the NOx chemical family (nitrogen oxides). (M.O. Köhler, 2015)

$$NO + O_3 \rightarrow NO_2 + O_2$$

$$NO_2 + \mathbf{h\nu} \rightarrow NO + O$$

$$O + O_2 + M \rightarrow O_3 + M$$

$$(\lambda < 400 \text{ nm})$$

Formulas from publication by M.O. Köhler, 2005

The catalytic-like agent "M" in the reaction O+O2+M→O3+MO+O2+M→O3+M is typically a third body, which can be any molecule (often nitrogen or oxygen in the atmosphere) that absorbs excess energy from the forming ozone molecule, stabilizing it and allowing the reaction to proceed.

The main purpose for including these formulas is to show the elimination of ***hv***. The term "***hv***" in the context of atmospheric chemistry refers to a photon of light energy, specifically ultraviolet (UV) radiation. UV radiation itself is not inherently harmful; in fact, it is essential for life on Earth as it drives photosynthesis in plants and helps produce vitamin D in humans. However, excessive exposure to UV radiation, particularly UV-B and UV-C, can be harmful to living organisms. (WorldWideScience)

The combustion of kerosene or fossil fuels emits water vapor and carbon dioxide, both potent greenhouse gases affecting Earth's radiative balance. Water vapor emissions in the troposphere have minimal impact due to high natural concentrations and control by physical processes. However, in the stratosphere, water vapor emissions contribute to ozone destruction. While current subsonic aircraft have negligible impact, potential future supersonic aircraft could significantly affect ozone loss. Carbon dioxide emissions from aviation accumulate globally, interacting with the biosphere and hydrosphere, persisting for over 100 years. (M.O. Köhler, 2015)

Nitrogen oxides (NOx) from aviation influence tropospheric and stratospheric chemistry, affecting ozone and methane levels. NOx emitted at cruise altitudes interacts with other compounds, potentially leading to ozone loss. The impact of aviation NOx on ozone varies regionally, with models indicating both increases and decreases in ozone levels, along with enhanced methane destruction. (M.O. Köhler, 2015)

Sulphur oxide emissions from aircraft, primarily SO_2, affect sulphate aerosol formation, leading to heterogeneous chemical processes. This can result in the loss of reactive nitrogen, reducing ozone increases caused by NOx emissions. Additionally, reduced reactive nitrogen levels may impact halogen nitrate compounds, affecting ozone depletion via catalytic cycles. Model studies suggest that at high latitudes, aerosol effects can decrease stratospheric ozone levels, partially offsetting ozone increases caused by NOx emissions. (M.O. Köhler, 2015)

As for the airports, the International Civil Aviation Organization (ICAO) acknowledges air pollution as a concern, particularly near urban airports. Various pollutants are emitted, including Carbon Monoxide (CO), Oxides of Nitrogen (NOx), Hydrocarbons (HC), Particulate Matter (PM), Sulphur Oxides (SOx), Ozone (O_3), Lead (Pb), Hazardous Air Pollutants (HAPs)

The primary culprit is aircraft engine emissions. However, other airport activities contribute including ground vehicles (cars, trucks), ground support equipment, fuel storage and handling, construction, heating and cooling systems, aircraft engine emissions. (ICAO)

Most countries regulate air quality to protect public health. Airports must comply with these regulations, which establish thresholds for various pollutants. Permits may be required for specific operations, and new construction often undergoes air quality impact modelling. Regulations may categorize emissions by type, such as hazardous air pollutants (HAPs), volatile organic compounds (VOCs), greenhouse gases (GHGs). (ICAO)

Aviation is not only polluting the air with harmful gases, but also with noise. Aircraft noise, generally unwanted, comes from engines (especially during take-off) and airframe turbulence. Engine noise mainly originates from the fan, compressor, turbine, and exhaust, while airframe noise comes from turbulent airflow around various parts. Pinpointing the exact source during flight is difficult due to the merging of these noises. (I.B. Zimmer, 2001)

Day-night sound level (**DNL**) accounts for night-time noise impact by adding 10 dBA between 10 p.m. and 7 a.m. It's useful when sleep disturbance is a concern and is commonly used for community noise assessment, including near schools. It's straightforward to understand, compares noise control methods, and is backed by scientific data on human reaction to noise. However, its accuracy depends on data quality, and factors like aircraft operations and human subjective response can affect its reliability. A study near Heathrow Airport found a strong linear relationship between the percentage of annoyed residents and the DNL (day-night sound level). (I.B. Zimmer, 2001)

To demonstrate the calculation of DNL, I would add the formula for it from source I.B. Zimmer, 2001:

$$DNL = 10 \cdot \log\left(\sum_{i=1}^{N} 10^{\frac{E_i}{10}}\right) - 49.4$$

(1)

Formulas from publication of I. B. Zimmer, 2001.

Where E_i is

$$E_i = SEL_i + 10 \cdot \log(d + 10 \cdot n)$$

(2)

Formulas from publication of I. B. Zimmer, 2001.

SEL represents the Sound Exposure Level for the specific event type. "d" denotes the count of events occurring between 7 a.m. and 10 p.m. within a typical 24-hour period, while "n" signifies the count of events between 10 p.m. and 7 a.m. within the same timeframe. (I.B. Zimmer, 2001)

By including these formulas, I wanted to show the possibility of a fair and relatively simple calculation of noise pollution, which then could further contribute to noise reduction focusing on residents, given the linear relationship result of the Heathrow Airport experiment.

2.2 Impact on Hungary

From the previous chapter, we can see that the air pollution is relevant to Hungary based on these data, therefore the air is being polluted by the same processes that were mentioned before (please refer to chapter *Pollution itself)* by the airplanes passing through, above the country.

Airports are a focal point for air quality concerns due to the various stakeholders' activities, including aircraft operations. While aircraft engine emissions are a major source of pollution, this passage focuses on how airports can collaborate with stakeholders to manage other emission sources. Airports are at the centre of aviation's environmental impact, and air quality is a key concern. Diverse activities at airports generate various pollutants affecting air quality.

Airports can partner with airlines, air traffic control, and others to reduce emissions. Regulations and resources exist to guide airports in managing air quality. (ICAO)

The Budapest Ferenc Liszt International Airport, situated just 16 kilometres from the centre of Budapest, holds a license for a capacity of 6 million passengers per year. In 2023, Budapest Airport handled 14.7 million passengers. This was already twice the original capacity. (Morina, 2024)

With plans for expansion, the goal is to increase passenger turnover to 21 million, more than twice the population of Hungary. This expansion will impact approximately 1 million people, including families residing in houses constructed decades before the airport's growth began. Unfortunately, the quality of life for local inhabitants has been declining in proportion to the rise in air traffic. (A. Roggenbuck & T. Dönsz-Kovács, 2021)

The European Investment Bank loaned Budapest Airport €200 million to expand its capacity by 50%. This €463 million project includes a new pier, terminal, cargo city, and baggage system upgrades. However, the project avoided a full environmental review by splitting it into smaller sections, raising concerns about increased pollution from the higher passenger volume. The airport also plans a new cargo facility, rail connection, and general service improvements. (A. Roggenbuck & T. Dönsz-Kovács, 2021)

As the Budapest Airport had 340 operations per day during its peak operation, take-off and landing during this period must have resulted in the emission of at least 700 tons of CO2 and microdust particles per day. (A. Roggenbuck & T. Dönsz-Kovács, 2021)

Also, I wanted to gather some research for other effects of the pollution of the aviation industry in Hungary.

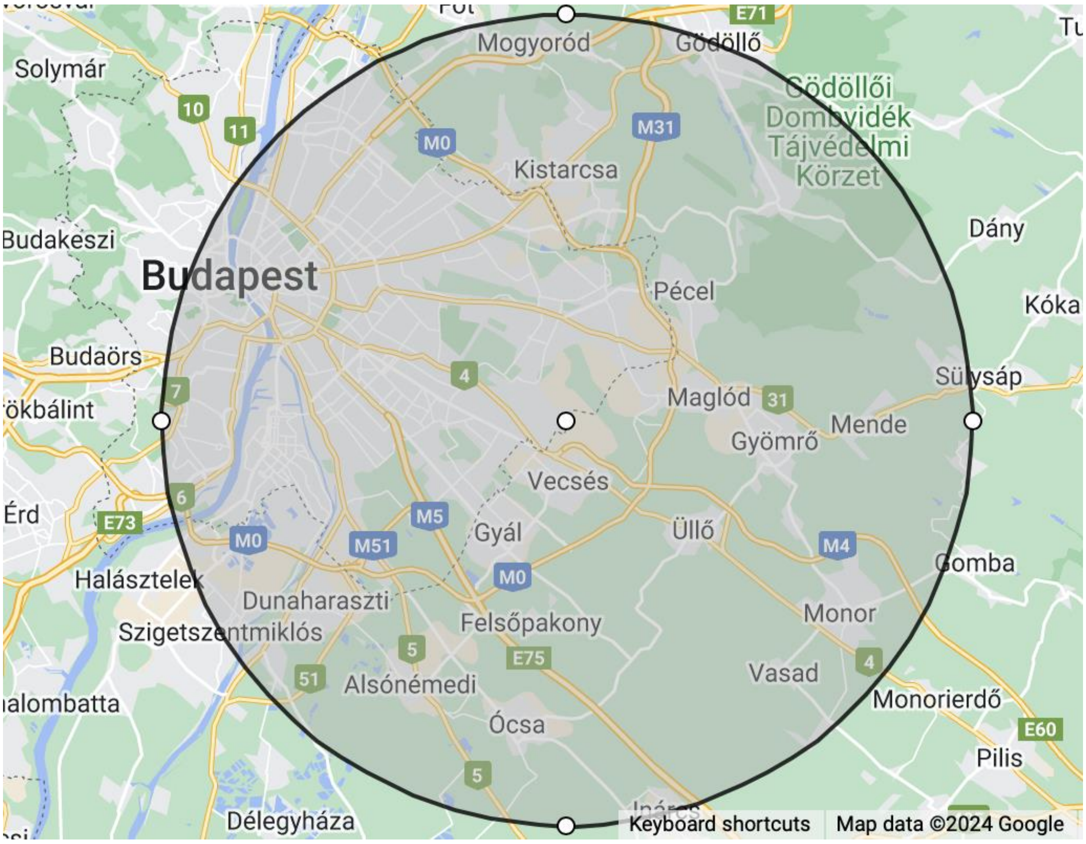
Specifically, studies have observed increased concentrations of UFPs (Ultrafine Particles - These are microscopic particles suspended in the air, less than 100 nanometres in diameter. They are so small they can easily penetrate the lungs and enter the bloodstream, potentially causing health problems), PM2.5 (Particulate Matter 2.5 - These are fine inhalable particles, with a diameter of 2.5 micrometres or less. They are a major component of air pollution and can also cause respiratory problems), PM10 (Particulate Matter 10 - This refers to coarse inhalable particles, with a diameter of 10 micrometres or less. While not quite as concerning as PM2.5, they can still irritate the respiratory system), BC (Black Carbon - This is a component of PM2.5 that comes from the incomplete burning of fossil fuels and biomass. It is a major concern because it can absorb sunlight and contribute to warming the planet), and gaseous criteria pollutants (Gaseous criteria pollutants are specific air pollutants regulated by authorities based on their health and environmental impacts) such as carbon monoxide (CO), nitrogen dioxide (NO2), and sulphur dioxide (SO2) near airports, with some studies indicating contributions extending up to 12 kilometres from the airport. The presence of hazardous air pollutants (HAPs), particularly polycyclic aromatic hydrocarbons (PAHs), has also been documented, although fewer studies have specifically addressed these pollutants. (K. Riley et al., 2021)

12 kilometre radius from Budapest Airport. Own editing, based on Google Maps data. 2024

I would like to add here, that some buildings and faculties of Budapest Business University (for which I'm currently writing this essay to), therefore it's students and teachers are with high chance impacted by the followingly described effects and pollutions-

A 2015 study by Yim et al. estimated: 16,000 premature deaths globally each year due to civil aviation emissions. 87% of these deaths attributable to PM2.5 exposure. Around a third of these deaths attributable to PM2.5 exposure within 20 kilometres of an airport. Studies since 2015 haven't quantified health impacts but found elevated UFP concentrations downwind of commercial airports and increased particle number concentrations in residences near airports. (K. Riley et al., 2021)

Please see the 20 kilometre radius from Budapest Airport.



20 kilometre radius from Budapest Airport. Own editing, based on Google Maps data. 2024

A 2013 study by Rissman et al. found a positive correlation between: Minority population percentages and aircraft-derived particulate matter concentrations. (K. Riley et al., 2021)

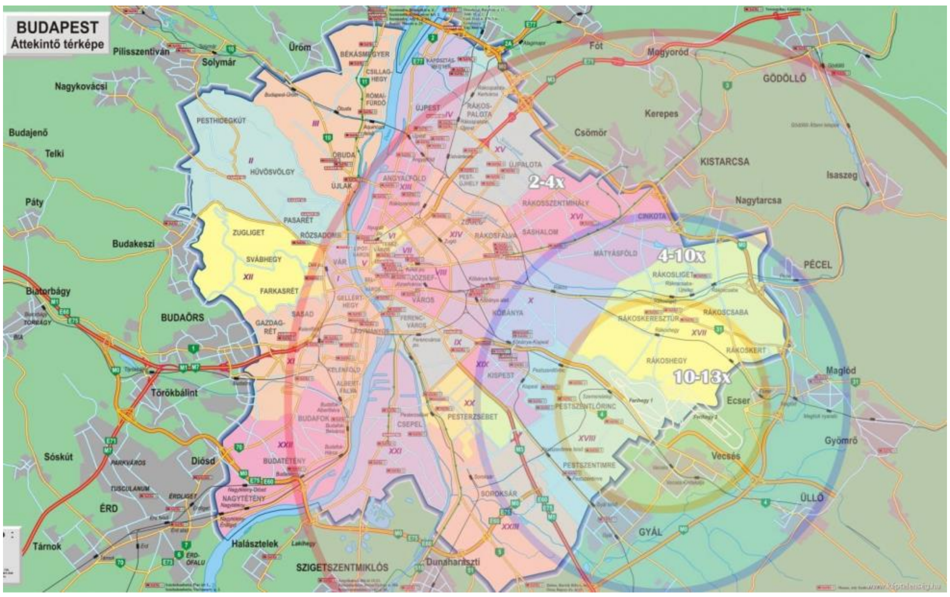
The health effects of aviation air pollution have been extensively studied over the past two decades, with numerous investigations focusing on various pollutants and their impacts on human health. Studies conducted primarily in the United States but also internationally have consistently shown elevated concentrations of ultrafine particles (UFPs), PM2.5, PM10, black carbon (BC), and gaseous criteria pollutants in the vicinity of airports. These pollutants are often found to be significantly higher under landing approach paths and extend several kilometres downwind from airports. While some variability exists in the findings, particularly regarding PM2.5 levels, overall, the evidence suggests a notable impact of aviation activities on local air quality. (K. Riley et al., 2021)

The health effects associated with exposure to aviation air pollution include respiratory and cardiopulmonary outcomes, such as decreased lung function and increased risk of pre-term birth. Additionally, exposure to jet engine emissions has been linked to adverse biological responses, including cytotoxicity, oxidative stress, and inflammatory mediator release in human bronchial epithelial cells. Studies have also shown genotoxic and oxidative effects in airport personnel exposed to PAHs (Polycyclic Aromatic Hydrocarbon), suggesting potential long-term health risks associated with chronic exposure to aviation-related pollutants. (K. Riley et al., 2021)

Ultrafine particles (UFPs) are much smaller than larger particle pollutants and can be absorbed directly into the lungs and bloodstream, posing health risks. High-performance air purifiers with special filtration technology can be used to remove UFPs from the air. (IQAir, 2016)

Air pollution in Hungary is a major health concern, with the **second highest death rate globally** (after China). This translates to roughly 10,000 premature deaths annually due to pollution-related illnesses. (Euronews, 2019)

In Budapest, harmful substances in the air often exceed official limits, but ultrafine particulate matter (UFPs) pose a major, overlooked threat. UFPs, smaller than 100 nanometres, are hard to measure due to their tiny mass. Recent technology reveals UFP concentrations in busy areas are 10-20 times higher than in cleaner zones, reaching peaks of 470,000 particles per cubic centimetre. Despite their abundance, their minimal mass means they don't breach air quality limits. This highlights the need to address UFP pollution for public health. (Levegő Munkacsoport, 2019)



Estimated micro-dust concentrations around Budapest Airport. Based on data measured at Schiphol Airport in the Netherlands and applied to Budapest Airport based on 2018 and 2019 traffic data. Source: Association for Civil Aviation (KLKE / CATA) and Magyar Természetvédők Szövetsége

The above map shows the micro-dust concentrations around Budapest Airport. The latter are also called as Particulate Matter.

While the literature on health effects associated with aviation air pollution remains limited, recent systematic reviews have highlighted the similarities between jet engine emissions and diesel exhaust particles in terms of physicochemical properties and adverse health effects. Overall, these findings underscore the importance of further research into the health impacts of aviation air pollution and the implementation of measures to mitigate its effects on both airport personnel and nearby communities. (K. Riley et al., 2021)

As for the noise pollution, contours for Budapest Airport from 2012 to 2019, available on the airport's website, show a notable increase in noise exposure over both day and night periods, as depicted by the expanding coverage of the noise contours. With the airport being the city's sole airport, the situation may worsen due to increasing air traffic and potentially growing population of the impacted areas. (T. Elliff et. al, 2020)

2.3 Economic decisions to solve air pollution

Various strategies can be employed to mitigate adverse aircraft emissions, encompassing economic mechanisms, regulatory measures, research initiatives, and shifts in fuel usage and transportation habits. (N. Cottis & P. Morell, 2001)

Economic mechanisms, while theoretically viable, face challenges due to the complexity of emissions' adverse effects and equity concerns regarding revenue distribution. Proposed community objectives for the International Civil Aviation Organization (ICAO) include taxes on fuel and emissions trading, aiming for revenue neutrality to address distribution issues. Regulatory mechanisms ensure compliance with emissions standards, including stricter certification for new engines and interim rules for non-compliant engines. Research sponsorship, exemplified by programs, targets reducing uncertainties in environmental impacts and operational efficiency improvements. Biofuels offer a potential solution with no net CO_2 emissions, but face challenges in scalability due to land requirements. Non-carbon fuels like hydrogen present opportunities, but infrastructure changes are needed, and emissions of nitrogen oxides and water vapor persist. Inter-modal transport promotion could reduce air travel demand for shorter distances, though significant investment is required. Teleworking and improved communication technologies may reduce business travel but might also encourage it, making significant reduction unlikely. (N. Cottis & P. Morell, 2001)

Unlike the Kyoto Protocol, the Paris Agreement applies to all countries and their entire economies, including aviation, even though not explicitly mentioned. Countries are expected to include aviation emissions in their national climate pledges (NDCs) to encourage action at national and international levels. (Transport & Environment)

The International Civil Aviation Organization (ICAO) is working on global measures like long-term emission reduction goals and offsetting schemes, but their effectiveness might be limited.

The EU includes outbound aviation emissions in its 2030 target (though not yet implemented in legislation), and some countries like the UK are taking the lead in accounting for aviation emissions in their carbon budgets. (Transport & Environment)

Beyond CO_2, aviation significantly impacts air pollution through contrails (condensation trails) and cirrus cloud formation. These high-altitude clouds trap heat more effectively than CO_2, potentially doubling the total warming effect of aviation. There are currently no global measures to address these non-CO_2 effects. (Transport & Environment)

E-fuels, particularly e-kerosene, hold promise for reducing carbon emissions but require substantial renewable energy and raise concerns about the source of CO2 used in their production. Zero-emission aircraft using hydrogen or electricity are a future possibility for shorter routes but require significant funding for development. One of the major disadvantages of e-fuels is the lack of viable industrial-scale technology for their production. Currently, the production of e-fuels is not yet feasible on a large scale, making it a less practical solution compared to other alternatives. (Transport & Environment)

Based on the information I found, there are at least 3 airfields within 100km of Budapest: Hármashatárhegy airfield, Budaörs Airport, Budapest Ferenc Liszt International Airport, and the average distance from the city centre of these, compared to other European countries capital cities are one of the lowest in the list. (Eurocontrol, 2007)

Among other sectors, the forecasting of demand for passenger air transport is difficult because historical passenger-km data are not available in the statistics, only airports provide passenger number data. We therefore accepted the estimates of the PRIMES model, which, similarly to the current trend, forecasts significant growth; demand for air transport (passenger-km) will triple by 2050 over the year 2015. (Hungarian Ministry of Innovation and Technology)

2.4 Actions of Budapest Airport

Based on Budapest Airport's website, the airport monitors air quality around the facility to track various pollutants and their sources. These sources include on-airport sources: aircraft engines, boilers, vehicles on airport roads. Off-airport sources related to airport operations: vehicles used by staff, suppliers, and passengers. Unrelated sources: nearby traffic, industrial facilities, and Budapest itself (due to wind patterns).

The airport takes steps to reduce emissions through practices like taxiing aircraft at lower engine power, using external power for grounded planes instead of auxiliary engines, providing air conditioning and electricity via external units at gates, encouraging the use of cleaner aircraft and vehicles on the airport grounds, operating an internal bus system for employee transport.

As for the noise pollution, Budapest Airport employs several strategies to reduce noise pollution and mitigate its impact on nearby residents. This includes noise monitoring system, which operates for continuous noise measurement and flight tracking, correlating flight data with noise levels to ensure compliance with legal thresholds. Also, a public flight tracking system, that provides residents with a user-friendly application to monitor arriving and departing flights and environmental noise impacts in real-time. Noise Protection Zones designates noise protection around the airport to assess and manage aircraft noise emissions' impact on residents. Night Curfew imposes restrictions on night-time flights to minimize disturbances during sleep, with limited commercial flights allowed during the night, subject to prior authorization. A window insulation program offers a passive acoustic protection program for residential properties within noise protection zones, providing window insulation options either free of charge or through cost-sharing. Air Traffic-Related Regulations adhere to stringent aviation regulations governing noise protection, with comprehensive provisions outlined in legal decrees and manuals. Engine Test Stand operates an engine test stand with noise protection measures to conduct aircraft engine tests without causing excessive ground noise. Protection for Rákoshegy implements environmental restrictions on runway use to minimize noise burdens on residents, with transparent information provided on air traffic movements over the area. Settlement of Roof Damage Cases addresses damage to residential roofs caused by aircraft vortexes through appropriate measures and compensation where necessary. (Budapest Airport)

2.5. Proposals

As for the air pollution I used mainly ICAOs *Air Quality Management at Airports* publication as well as all the previous literature to make some proposals.

Budapest Airport could work with airlines to reduce aircraft emissions, encourage airlines to use cleaner, newer aircraft models that meet the latest ICAO emission standards. Also, support operational practices that reduce fuel burn during taxiing and landing, such as using low-power taxiing techniques and continuous descent approaches.

Reduce ground vehicle emissions by investing in electric or hybrid vehicles for airport operations, including ground support equipment and buses used to transport passengers and employees. Encourage airlines and ground handling companies to transition to cleaner vehicles. Implement infrastructure to support electric vehicle charging at the airport. Optimize energy use by investing in energy-efficient heating and cooling systems for airport terminals. Explore the use of renewable energy sources like solar or wind power to meet the airport's energy needs.

Minimize other sources of pollution by implement stricter measures to control dust and emissions from construction activities. Explore ways to reduce emissions from fuel storage and handling. Partner with local authorities to improve air quality in surrounding areas, potentially through joint initiatives like planting trees.

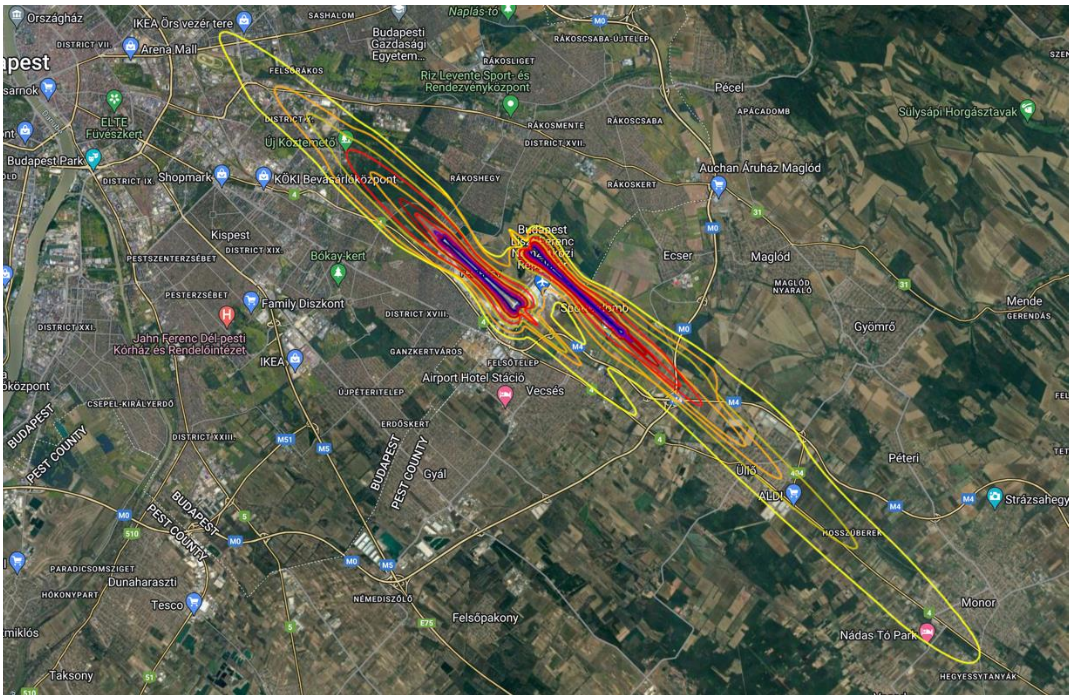
Monitor and report on air quality by maintaining a robust air quality monitoring program to track pollution levels and identify areas for improvement. Regularly report air quality data to the public and relevant authorities. By taking these steps, Budapest Airport can demonstrate its commitment to environmental responsibility and contribute to cleaner air for the surrounding communities.

As for the noise pollution, with the help to global solution ideas by Aviation Benefits Beyond Borders I gathered some proposals.

Quieter engine technology could mean newer aircrafts are quieter by design, meeting stricter noise reduction standards set by ICAO (International Civil Aviation Organization). Research focuses on minimizing noise from engine components like fan blades and air intake. Budapest Airport could encourage the use of these new aircraft by for example a fee for the louder planes. This fee could be taken to further support the noise reduction support for the residents in the area.

Air traffic management could be optimizing flight paths to avoid populated areas during take-off and landing, which could significantly reduce noise exposure for communities. Also, pilots landing and taking off from Budapest could familiarize themselves with the populated area locations and sizes near the airport. Newer navigation systems allow for precise flight tracks, but this can concentrate noise over fewer areas. Collaboration between airlines, air traffic control and communities is crucial.

Operational procedures would mean that airlines and pilots can adopt noise reduction practices during take-off and landing. This includes using less engine thrust, starting take-offs from further down the runway (displaced landing thresholds), and maintaining a continuous descent for landing to minimize loud engine noise.



Noise map of Budapest Airport, 2021 day and night. Source and edit: Budapest Airport

The mapping of the noise related to the airport could help in the previously described proposals. Also, the support for the window insulation program could be widened to every resident in the impacted areas (from IKEA to Monor, as shown).

In conclusion, while these proposals offer a comprehensive approach to addressing air and noise pollution at Budapest Airport, it's important to note that I do not have information of the actual implementation status of these measures. Without access to direct, specific information regarding the airport's initiatives, it's challenging to ascertain whether any of these proposals have been put into practice in the past or are currently being implemented. Therefore, further research or direct inquiry with Budapest Airport authorities would be necessary to determine the extent to which these proposals have been adopted. Nevertheless, these suggestions serve as a proactive framework for potential future actions that Budapest Airport could consider to enhance its environmental sustainability efforts and mitigate the impact of air and noise pollution on surrounding communities.

3. Conclusions and recommendations

Air pollution from aviation is a significant environmental concern globally, with adverse effects on human health and the environment. Budapest Airport, like many others, faces challenges related to air and noise pollution due to its operations and expansion plans. Various pollutants emitted by aircraft and airport operations contribute to air and noise pollution, affecting local communities' health and well-being.

The aviation industry's reliance on fossil fuels leads to significant emissions of CO_2 and other pollutants, contributing to climate change and poor air quality. Airports, including Budapest Airport, serve as focal points for air pollution due to various activities and emissions from aircraft engines, ground vehicles, and infrastructure. Noise pollution from aircraft operations impacts nearby residents, affecting their quality of life and health.

The global challenge of air pollution from aviation manifests locally at airports like Budapest Airport due to emissions from aircraft engines and airport activities. Factors certifying this problem at the local level include the expansion plans of Budapest Airport, increased air traffic, and the resulting emissions affecting nearby communities.

Proposals for Budapest Airport include collaborating with airlines to reduce emissions, investing in cleaner vehicles and infrastructure, optimizing energy use, and implementing stricter measures to control pollution. Strategies to reduce noise pollution involve promoting quieter engine technology, optimizing flight paths, adopting noise reduction practices during take-off and landing, and supporting community initiatives like window insulation programs.

It's acknowledged that there's uncertainty about the actual implementation status of the proposed measures at Budapest Airport. Further research or direct inquiry with airport authorities is necessary to determine the extent to which these proposals have been adopted.

The suggestions provided serve as a proactive framework for potential future actions, demonstrating a commitment to enhancing environmental sustainability efforts and mitigating the impact of pollution on surrounding communities.

References

ATAG (no date). *Supporting economic & social development.* Air Transport Action Group (ATAG). View source.

European Court of Auditors. SR 23/2018. *Air pollution: Our health still insufficiently protected.* View source.

Harrison, R.M., Masiol, M., & Vardoulakis, S. (2015). *Civil aviation, air pollution, and human health.* Environmental Research Letters, 10(4), 041001. View source.

Aviationbenefits (no date). *Economic growth.* Aviation Benefits Beyond Borders. View source.

Roggenbuck, A., & Dönsz-Kovács, T. (2021). *Trouble in the air: EIB ignores environmental and social burdens caused by Budapest Airport expansion.*

European Parliament (2001). *Environmental and health impact of aviation.* View source.

Digital Commons NJIT (no date). *Airplane noise pollution.* View source.

Drenusha Morina (2024). *Budapest Airport Welcomed 14.7 Million Passengers in 2023, Reaching 91% of 2019 Levels.* View source

Budapest Airport (no date). *Noise protection measures.* View source.

Britannica (no date). *Noise pollution.* View source.

Transport & Environment (no date). *Airplane pollution.* View source.

WorldWideScience (no date). *Ultraviolet (UV) radiation.* View source.

IQAir (no date). *Ultrafine particles near airports cause concern.* View source.

Euronews (2019). *Air pollution in Hungary accounts for thousands of premature deaths a year.* View source.

Eurocontrol (2007). *A Place to Stand: Airports in the European Air Network.* View source.

Gathering the relevant data and insights from these authors and publications I used Google's Gemini (AI) to fact-check all the data and correct grammar where applicable.