



Medicina dela in športa
Varnost pri delu
Zdravo okolje

Report Nr: LOM 20220355-AK/D-ANG

Date: 23. 01. 2024

Noise report

Aviaton noise between 1 January 2023 and 31 December 2023

Executive summary

1. Traffic Data – Aircraft Movements

Continuous measurements of noise in the natural and living environment were carried out at measuring locations in Šenčur and Lokarje (part of the settlement of Vodice) in 2023. Measurements were conducted in the period from 15 July 2023 to 15 August 2023, when aircraft traffic density is highest compared to the annual average. Noise was assessed on the basis of measurements of noise exposure levels and noise indicator calculations. Input data were obtained from noise immission measurements carried out in 2023 at the measuring locations in Šenčur and Lokarje and from analyses of statistical data.

There were 22,749 aircraft operations in 2023, which is 73% of the 15-year average for the period 2009–2023, which amounts to 31,244 operations. The number of operations for each year is listed in *Table 1* and shown in *Figure 1*.

Table 1: Number of aircraft operations for the period 2009–2023

Year	2009	2010	2011	2012	2013	2014	2015	2016
No. of operations	45492	42569	39267	35019	33112	31405	32893	32701
Year	2017	2018	2019	2020	2021	2022	2023	
No. of operations	34444	35512	31489	12980	17461	21571	22749	

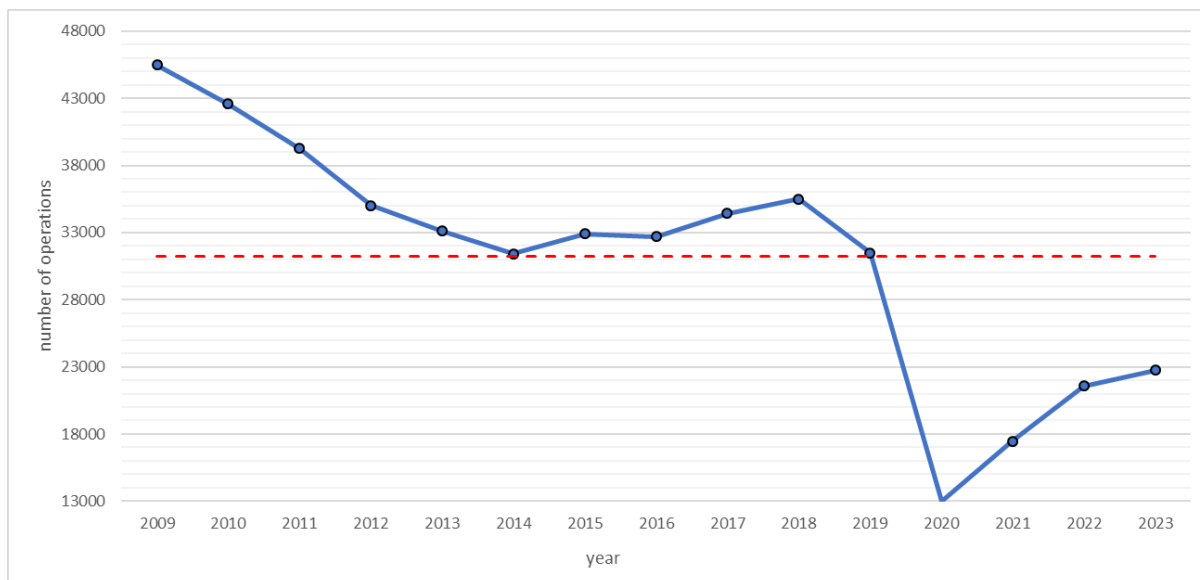


Figure 1: Number of aircraft operations for the period 2009–2023

Figure 2 shows the distribution of aircraft operations by month. The figure shows that the number of aircraft operations is highest in the period July–August. In order to produce an assessment of noise pollution from airport operation in 2023, measurements were taken in the period 15 July 2023 to 15 August 2023, corresponding to the peak period of aircraft operations.

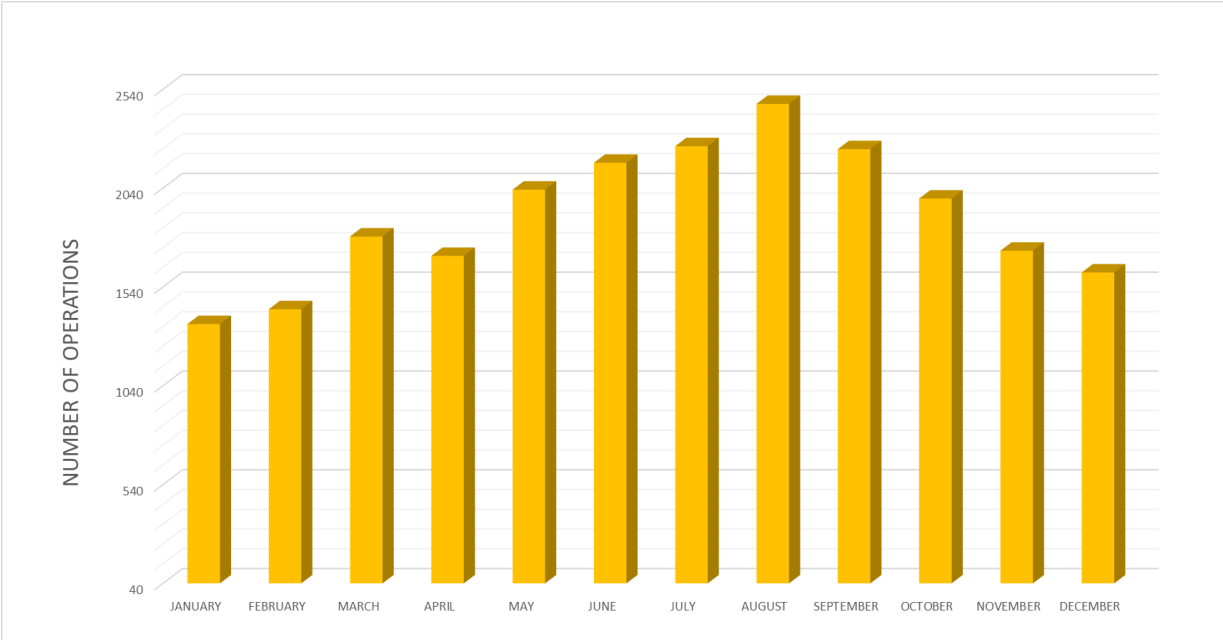


Figure 2: Distribution of the number of aircraft operations during 2023

2. Noise source data – measuring terminal data

During the measurement period (15 July 2023 to 15 August 2023), measuring terminals took into account 2,361 operations (1,188 take-offs and 1,173 landings). This figure excludes flight training flights and most military and police helicopter flights. Shares of take-offs and landings in/from the Šenčur direction were 49% and 8%, while shares of take-offs and landings in/from the Lokarje direction were 51% and 92%. A total of 2,479 operations were recorded during the measurement period. Of these, 677 (27%) were take-off and landing operations in/from the Šenčur direction and 1,684 (68%) were take-off and landing operations in/from the Lokarje direction. There were 118 (5%) other events related to flight training flights and police and military helicopter flights.

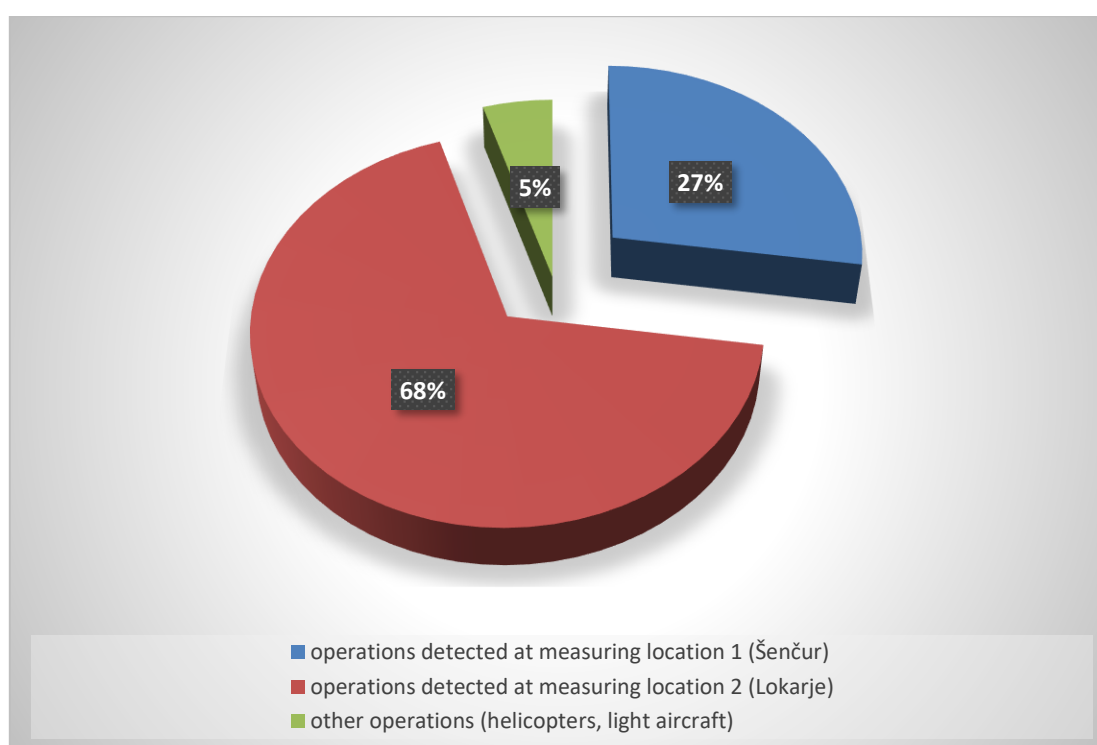


Figure 3: Number of operations in terms of noise events

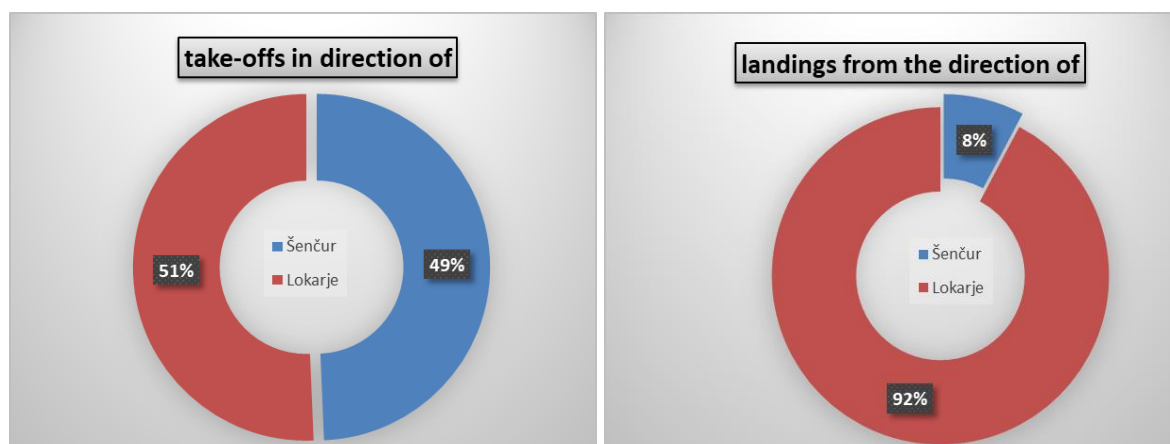


Figure 4: Take-offs and landings in/from the Šenčur and Lokarje directions

Measurements were taken at two measuring locations (Šenčur and Lokarje) in 2023 for the purpose of producing a noise pollution assessment. These measuring locations coincide with the take-off and landing routes of aircraft. The figures below show the shares of operations in an individual direction, determined on the basis of identification of sources in the period 2011–2023 and separately for the period 15 July 2023 to 15 August 2023. Identification was done on the basis of airport information system data and events recorded at an individual measuring terminal. Shares of aircraft operations in an individual direction for the periods in question are shown in *Figure 5*.

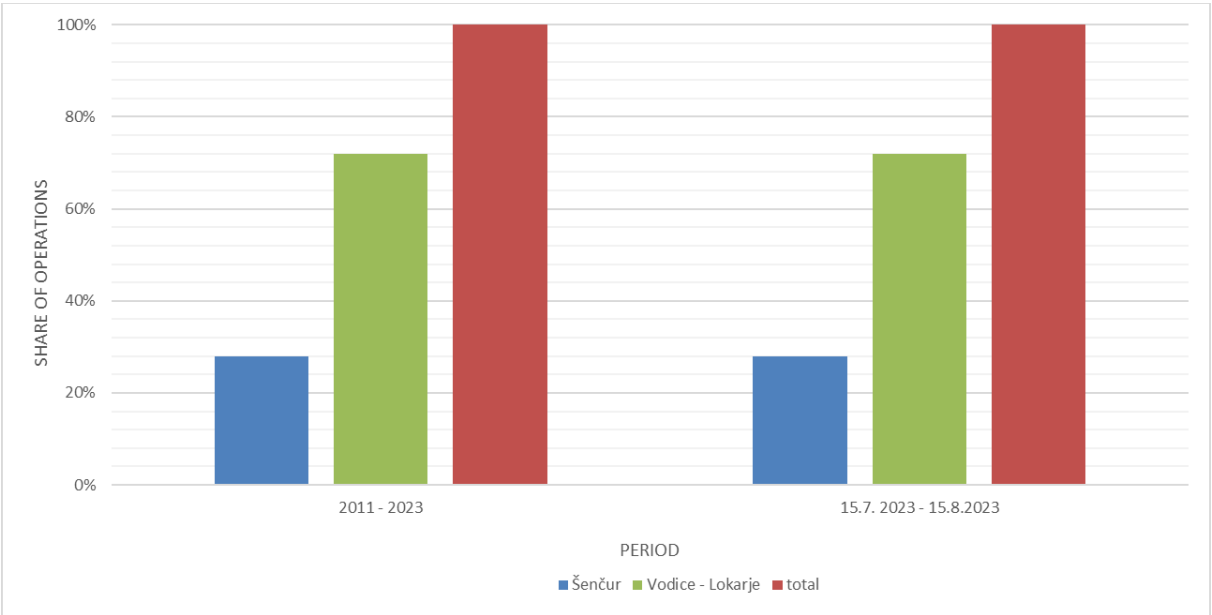


Figure 5: Shares of operations in an individual direction for the entire measurement period (2011–2023) and for the period 15 July 2023 to 15 August 2023

A comparison shows that approximately 72% of operations were in the Lokarje direction. The share of operations in the Lokarje direction in the period 15 July 2023 to 15 August 2023 was the same as for the 13-year average.

Identification of aircraft operations also served as a basis for determination of the shares of take-offs and landings at each measuring location for an individual period. *Figures 6 and 7* show the shares of take-offs and landings in an individual direction.



Figure 6: Shares of take-offs in individual periods for the Šenčur and Lokarje directions

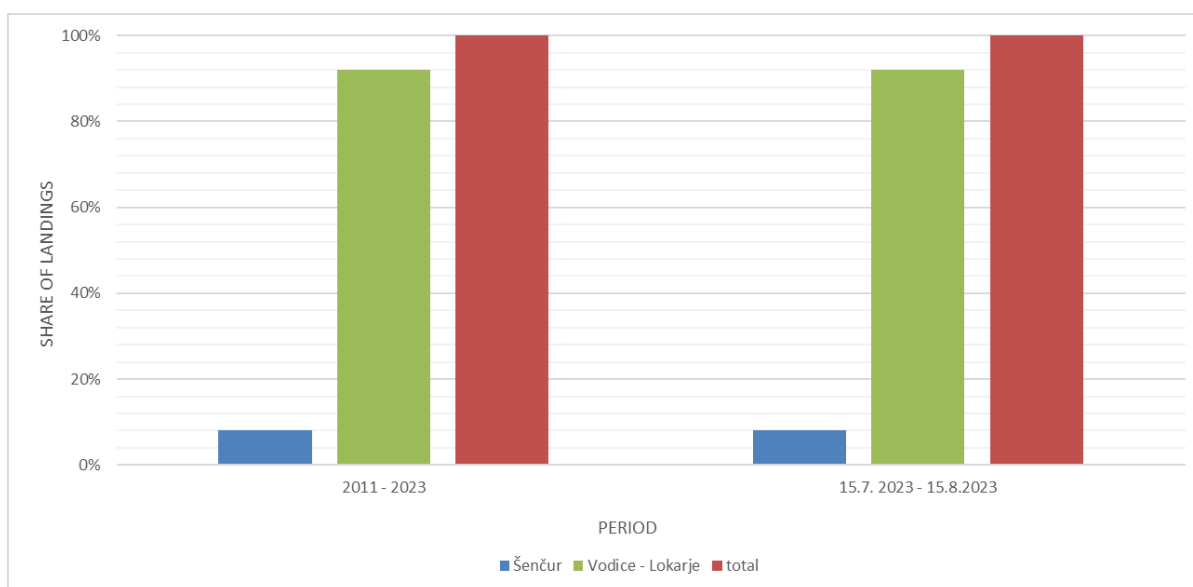


Figure 7: Shares of landings in individual periods for the Šenčur and Lokarje directions

Processing of the data reveals that the differences in the number of operations are largely the consequence of the greater number of landings in the Lokarje direction. The shares of take-offs in the Šenčur direction and the Lokarje direction are roughly equal (the difference is around 2%). Minor fluctuations occur both in the course of a calendar year and over a longer period.

From the point of view of environmental noise assessment, it is not only the number of aircraft operations that is important but the distribution of flights over the course of the day or individual times of day. The distribution of all operations, take-offs and landings in 2023 is shown in *Figure 8*. This figure shows that the majority of operations (73%) took place during the day, with 24% of operations in the evening and 3% of all operations at night.

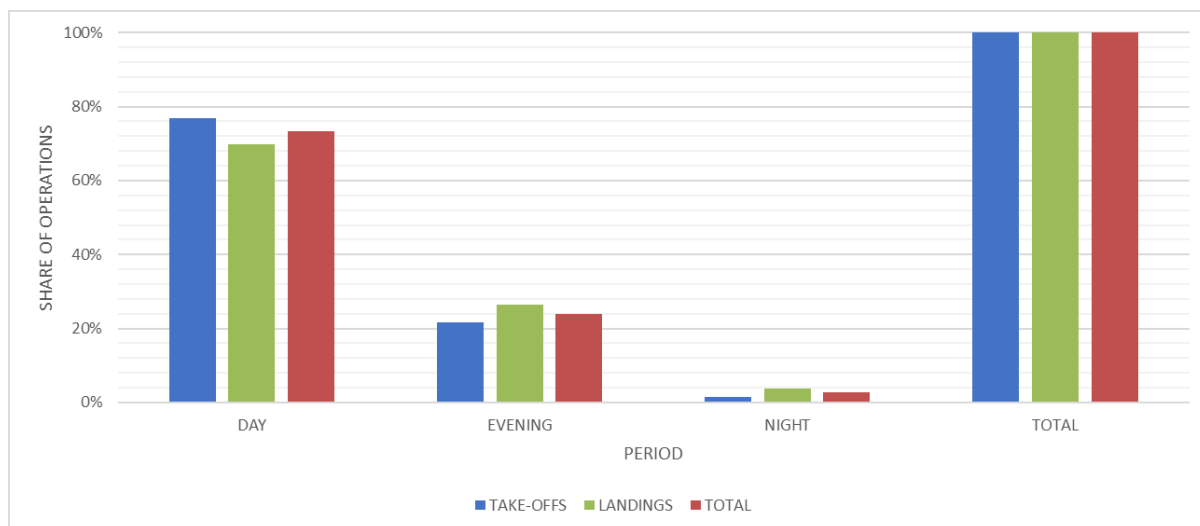


Figure 8: Shares of aircraft operations, landings and take-offs in 2023 at individual times of the day

3. Assessing noise

Noise indicators for 2023 were assessed on the basis of noise measurements conducted between 15 July 2023 and 15 August 2023. Measurements were taken at measuring locations in Šenčur and Lokarje. The average exposure level for an individual measuring location was calculated from all the measurements:

- measuring location 1, period 15 July 2023–15 August 2023: $\overline{SEL} = 89.2$ dB(A);
- measuring location 2, period 15 July 2023–15 August 2023: $\overline{SEL} = 79.9$ dB(A);

Taking the calculated \overline{SEL} values for the individual corridor and statistical data submitted by a representative of the contracting entity, in accordance with legislation, we calculate noise indicators as:

$$L_{r,TN} = \overline{SEL} + K + 10 \log n - 10 \log \left(\frac{TN}{t_0} \right) \quad [1]$$

where K is correction due to prominent impulses or pronounced tones, determined in accordance with the requirements of the Rules, n is the number of events in the period TN at the measuring location being investigated, t_0 is 1 second and r relates to the individual source in question. In this specific case $K=0$, since, in accordance with the requirements of the Rules, the noise source in question at the assessment point does not cause prominent impulses or pronounced tones.

The number of aircraft operations carried out in an individual period was determined on the basis of data supplied by a representative of the contracting entity. Calculations took into account the fact that, in 2023, 8% of landings and 49% of take-offs were from/in the direction of measuring location 1, while 92% of landings and 51% of take-offs were from/in the direction of measuring location 2.

All data used for the assessment of noise indicators and estimated values of noise indicators are given in *Table 3*.

Table 2: Data used in noise assessment

MEASURING LOCATION	\overline{SEL} [dBA]	PERIOD	NUMBER OF FLIGHTS [n]	CORRECTION FACTOR K
1	89.2	day	4,922	0
		evening	1,441	0
		night	121	0
2	79.9	day	11,773	0
		evening	4,008	0
		night	484	0

Noise indicators L_{day} , $L_{evening}$, L_{night} and L_{den} are evaluated in accordance with the requirements of the Decree on limit values for environmental noise indicators. The results are shown in *Table 4*.

Table 3: noise indicators L_{day} , $L_{evening}$, L_{night} and L_{den} . Limit values are shown in brackets. Limit values relate to level III noise protection.

LOCATION	L_{day} (dBA)	$L_{evening}$ (dBA)	L_{night} (dBA)	L_{den} (dBA)
MEASURING LOCATION 1: Šenčur	54.1 (58.0)	53.6 (53.0)	39.8 (48.0)	54.5 (58.0)
MEASURING LOCATION 2: Lokarje	48.6 (58.0)	48.7 (53.0)	36.5 (48.0)	49.6 (58.0)

The Regulation further limits peak noise immission values by way of a 1% peak limitation. In the case of one-hour averaging, this corresponds to a noise value exceeding the prescribed value for more than 36 seconds, which is a good characterisation of rare noise events. Peak values of one-hour averages are listed for the entire measurement period (without background exclusion). Data and the requirements of the Decree are given in *Table 5*.

Table 4: peak noise levels $L_{1,day}$, $L_{1,evening}$, $L_{1,night}$. Limit values are shown in brackets. The limit values relate to level III noise protection.

LOCATION	$L_{1,day}$ (dBA)	$L_{1,evening}$ (dBA)	$L_{1,night}$ (dBA)
MEASURING LOCATION 1: Šenčur	65.5 (85.0)	68.0 (70.0)	57.9 (70.0)
MEASURING LOCATION 2: Lokarje	66.2 (85.0)	63.7 (70.0)	56.7 (70.0)

Measurements and calculation of environmental noise allow us to state that day, evening, night and whole-day environmental noise levels and peak environmental noise levels resulting from aircraft operations are within the permitted limits at the selected measuring locations. The one exception is the evening noise level at the Šenčur measuring location.

This assessment applies to the situation as described in this report. A change in the noise source or source activity can affect the result of measurements. It should be emphasised that fluctuations in levels can be the consequence of various factors, such as the number of operations, the distribution of operations during the course of the day, aircraft types, overflight altitude, trajectories and meteorological conditions.

The number of aircraft operations in 2023 was lower than before 2019. Despite this, measurements were only taken in the period when the highest number of operations take place (maximum regime).

Operations take place in two directions: Šenčur and Lokarje. The share of operations in an individual direction has changed over the course of the 13-year period. Fluctuations are also apparent in the course of an individual year. Data on aircraft traffic from the period 2011–2023 were used in the calculations.

Statistical analyses and analyses of measurements were used to identify fluctuations in the distribution of measured equivalent noise levels during the course of a calendar year. Fluctuations can occur as a result of various factors, such as the number of operations, the distribution of operations during the course of the day, aircraft types, overflight altitude, trajectories and meteorological conditions.

4. Analysis of measurements – noisiest aircraft and noise trend

Using the data recorded at the measuring terminals, we compiled a chart of the noisiest aircraft for the measured period in 2023, taking into account all identified aircraft and classifying them on the basis of an EPNL indicator adapted for aircraft noise (in dB(A)). The latter shows the sound energy caused by the overflight of an aircraft and picked up by a microphone as a one-second noise event. Events for measuring location 1 (Šenčur) and measuring location 2 (Lokarje) are ranked separately.

Šenčur I. overflight measurements				Lokarje overflight measurements			
Aircraft type	arrival (ARR) depart. (DEP)	Date and time of the event	Current noise level EPNL in dB(A)	Aircraft type	arrival (ARR) depart. (DEP)	Date and time of the event	Current noise level EPNL in dB(A)
Airbus A320-214	ARR	10.08.2023 18:02 duration of the event 30 seconds	101	Boeing CH-47	DEP	11.08.2023 11:55 duration of the event 45 seconds	92
Airbus A321-231	DEP	25.07.2023 11:43 duration of the event 28 seconds	100	Airbus A321-231	DEP	08.08.2023 09:27 duration of the event 59 seconds	91
Airbus A319-112	DEP	15.08.2023 09:40 duration of the event 27 seconds	99	McDonnell MD-82	DEP	02.08.2023 10:53 duration of the event 59 seconds	90
Boeing 737-8Q8	DEP	16.07.2023 10:11 duration of the event 22 seconds	99	Airbus A320-232	DEP	16.07.2023 09:07 duration of the event 59 seconds	90
Airbus A321-231	DEP	01.08.2023 09:43 duration of the event 31 seconds	99	Boeing 737-8F2	DEP	17.07.2023 09:10 duration of the event 40 seconds	90
Boeing 737-3H4	DEP	17.07.2023 14:03 duration of the event 31 seconds	99	Airbus A321-231	DEP	05.08.2023 21:37 duration of the event 59 seconds	89
Airbus A321-231	DEP	13.08.2023 09:31 duration of the event 35 seconds	99	Boeing 737-8Q8	DEP	13.08.2023 11:54 duration of the event 39 seconds	89
Cessna 525	DEP	13.08.2023 12:10 duration of the event 18 seconds	99	Boeing 737-8Q8	DEP	30.07.2023 09:30 duration of the event 48 seconds	89
Boeing 737-3H4	DEP	21.07.2023 14:08 duration of the event 23 seconds	99	McDonnell MD-82	DEP	31.07.2023 13:11 duration of the event 59 seconds	89
Airbus A321-231	DEP	15.07.2023 10:12 duration of the event 33 seconds	98	Airbus A320	DEP	24.07.2023 23:19 duration of the event 59 seconds	88

Figure 9: Noisiest aircraft over measuring location 1 (left) and measuring location 2 (right)

EPNL (effective perceived noise level) is an indicator used to show noise caused by air traffic. Characteristics of aircraft noise taken into account include overflight duration and the frequency characteristic of aircraft noise (low-frequency noise is present).

Noise measurements were not carried out in 2020 because of the COVID-19 pandemic and the significant fall in traffic. Trends in noise levels over Šenčur and Lokarje between 2009 and 2023 are shown in *Figures 10 and 11*.

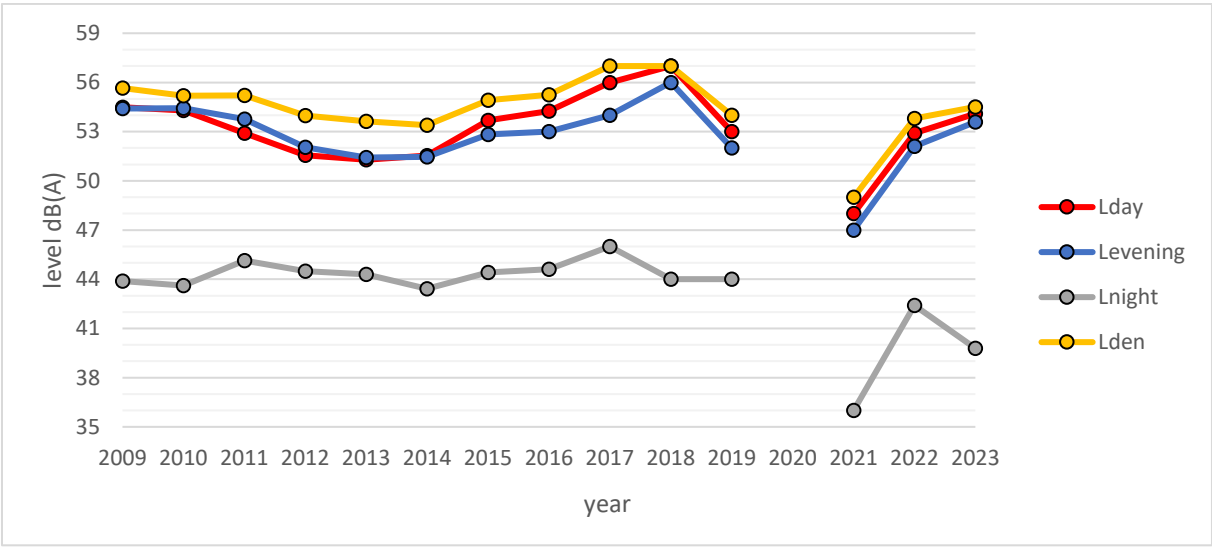


Figure 10: Trend of noise indicator levels over Šenčur from 2009 to 2023

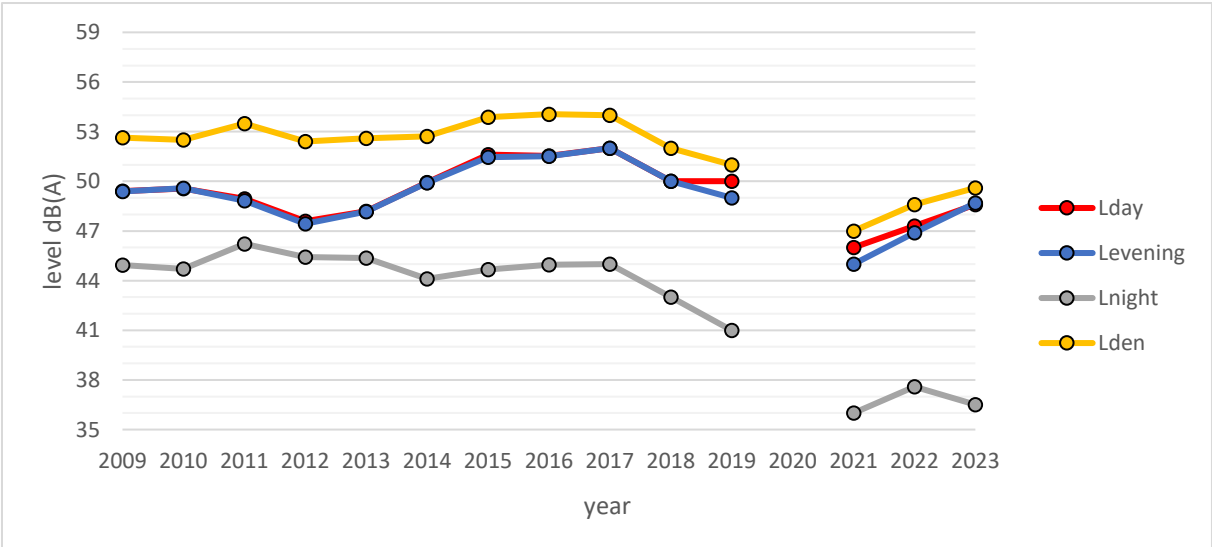


Figure 11: Trend of noise indicator levels over Lokarje from 2009 to 2023