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MACEDONIA BOULEVARD LINEAR PARK DESIGN FOR REDUCED TRANSPORT NOISE POLLUTION

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Abstract

The modern urban life is characterized by the concentration of large masses of people in territories with a dynamic infrastructure. This requires ensuring and maintaining a higher ecological standard for the urban population. One of the axes of such standard is the provision of acoustic comfort to the urban environment, through decorative vegetation for noise dust and gas protection. An urban design should plan and provide eco-zones for every public space in the city, including boulevards and streets. The considered project offers specific solutions with sustainable plant species to achieve acoustic and aesthetic comfort of the environment, taking into account the adjacent environment and the status of the object - a monument of the garden - park art. By means of linear compositions, with physiologically resistant and long-lasting types of vegetation planted in a heavy urban environment, a good result for noise and dust protection was achieved. At the same time, decorative vegetation affects habitus, texture, color and aromas. Through a "Green Tram" additional horizontal vegetative area is provided a microclimate and low noise pollution level. The research and analysis in the project also formulate the need for an urban planning strategy for ecological planning and organization in order to ensure long-term acoustic comfort for the city's inhabitants.

Keywords: ecological landscaping, plants in an urban environment, noise protection, ecological infrastructure

INTRODUCTION

A long-term exposure to environmental noise is a widespread problem in large cities. Around 18 million people in the EU suffer from severe irritation due to transport noise from road, rail and air transport. One of the main goals of every municipality in a large city is to achieve a zero noise pollution thus reducing the number of people with chronic disorders due to traffic noise.

The goals set in the EU plans are about reducing noise pollution by 30% by 2030. However, according to the results indicated in the report of the Joint Research Center (JRC), there is no prospect of achieving this goal. The optimistic scenario suggests a reduction of only

19% in the number of people chronically impaired by the constant traffic noise. This is because the predicted growth of the population and the transport, respectively, exceeds the benefits of the implementation of the arrangements. Regardless of the scenarios, the Metropolitan Municipality makes an effort to support projects related to the reconstruction of urban spaces, which leads to an increase in the quality of the urban environment, a reduction of the acoustic discomfort, dust and gas pollution.

According to Ordinance No. 6 to the Environmental Noise Protection Act (Environmental Noise Protection Act) the limit values for equivalent noise levels in decibels are given in Table 1

Table 1. Limit values for the equivalent noise levels, decibels dB(A)

Territories and development zones in the urbanized territories and outside them	L day dB(A)	L evening dB(A)	L Night dB(A)
Territories subject to the impact of heavy car traffic	60	55	50
Territories affected by rail, railway and tram transport	65	60	55
Areas affected by aircraft noise	65	65	55
Production and storage territories and zones	70	70	70

Source: Ordinance No. 6 to the Law on Environmental Noise Protection (Environmental Noise Protection Act)

The project for a linear park along "Macedonia" Blvd., Sofia, incorporates modern trends in the design of green areas for recreation through the use of decorative vegetation that serves to reduce the increased levels of traffic noise in the urbanized area. The problem of reducing vehicular traffic noise levels in urban areas has several aspects, and the present report deals primarily with the urban planning approach. The aim of the study is to reduce the noise pollution through the planning approach of vegetation selection and design of the urban environment.

MATERIALS AND METHODS

Four points for noise measurement were selected. The time for the measurements was at the peak traffic hours and the point for measurement was at the middle of the site equidistant from the two roadway noise sources. The noise was measured with a noise level meter SL300 which complies with DIN EN 616721 standard for measuring the noise level and controlling its quality in a variety of locations. Technical data:

- Accuracy: +/- 1.4 dB
- Range: 31.5 Hz – 8 kHz
- Dynamic range: 50 dB
- Reaction time: FAST - fast 125ms / SLOW - slow 1s
- Microphone: electret, condenser
- Display: indication with 0.1dB extension
- Operating temperature and relative air humidity: 0-40°C, 10-90 % RH

- The following parameters were recorded:
- Traffic flow
- Type of flooring
- Type of road
- Meteorological situation
- Measurements – start and end time
- Measurement duration
- Noise levels
- Number of motor vehicles
- Average vehicle speed

After a thorough survey of the terrain, the existing tree species were described, analyzed and categorized in a tabular form and graphically illustrated in a scheme of tree vegetation under Article 19 of the Law on the Organization and Development of the Metropolitan Municipality (ZUZSO) as follows:

- Name of the plant species
- Height of the plant species
- Age
- Stem diameter at 1.30m,
- Status:
 - "Bad" - withered - red circle with a hatch;
 - "Medium" - dry tops, diseases, stem breakage - orange circle with hatching;
 - "Good" – with aesthetic flaws – bright green circle with hatching;
 - "Very good" - solid with preserved decorative value - dark green circle with hatching;
- Origin
- Phytosanitary status

RESULTS AND DISCUSSION

Data on the existing vegetation

For the purposes of the design decision, an expert assessment was prepared under Art. 19 of the Law on the Organization and Development of a Metropolitan Municipality /ZUZSO/. Before it, a geodetic survey of the existing perennial tree vegetation was carried out along the existing rail tram route within the scope of the tram track along Macedonia Blvd. and Alabin St. from Russian Monument Square to the Court House tram stop. During the on-site inspections, it was found that the characteristics of the vegetation and its location, as well as the species composition, can be systematized as follows: the existing tree vegetation has the

character of street plantings, located linearly on both sides of the sidewalks on "Macedonia" Blvd.; street trees are an element of planned improvement and landscaping during the primary construction of the street network and the tram line, as well as the buildings. According to historical data, the vegetation that is planted on this site was uniform - *Tilia cordata*, *Tilia tomentosa*. Over the years, with the park development activities, poor management and non-application of rules and norms for cultural and historical sites, the vegetation was replaced by *Robinia pseudoacacia*, *Acer negundo*, *Acer pseudoplatanus*, *Fraxinus ssp.* and even *Ailanthus altissima* at a young age.

Table 2 - Measurements of noise pollution

Traffic Flow - Constant	Surface – Smooth Asphalt	Road - Bidirectional	Weather - Dry, No Wind
Measurement			
Start time 8.00	End time 8.30	Duration 30 min	
Noise level			
Average dB(A) – 74.7	Average dB(A) - 72.7	Lowest levels dB(A) - 70.1	Highest levels dB(A) 75.3
Measurement			
Start time 12.00	End time 12.30	Duration 30 min	
Noise level			
Average dB(A) – 73,6	Average dB(A) - 72,4	Lowest levels dB(A) - 71,5	Highest levels dB(A) - 73,4
Traffic count 8h			
No. of vehicles/h		Vavg. km/h	V avg. km/h
652		20	40

The section from "Macedonia" Square to "Russian Monument" Square along "Macedonia" Blvd. is characterized by a more complex profile of the road section - two local lanes, two green dividing lines and a tram route. The existing tree vegetation-street plantings are located linearly on both sides of the sidewalks and are mainly linden trees. In the dividing strips there are single plant species from various park development activities in the past years. The new landscaping consists of saplings of different types of lindens and chestnuts, about

10-12 years old, 2-4 m high, generally in good condition. Total number of plant species according to the recording - 172 pcs., of which:

- Small-leaved linden - 83 pcs.;
- Silver-leaved linden - 60 pcs.;
- Ash-leaved sycamore - 9 pcs.;
- Common sycamore - 7 pcs.;
- Horse chestnut - 7 pcs.;
- Ash - 4 pcs.;
- Paulownia - 1 pc.;
- Acacia - 1 pc.

"Macedonia" Blvd. is a central boulevard in the "Krasno Selo" district, Sofia. It stretches between "Russian Monument" Square and "Macedonia" Square. The total area of the project development is about 16,300m². The landscaping site is an open parking lot with slanted two-sided parking on an asphalt surface, two-way traffic lanes and a tram track in the middle on an asphalt surface. The surrounding development has residential functions in planning zone T2 - Zone of the old city center.

According to the Noise Map of the city of Sofia, the development site falls into an area of acoustic discomfort with around and over 75 dB(A) noise load. The boulevard is a Class IV street, with a total width of 40 m. From the limit values for urbanized areas in Table 2, the high increase in the noise pollution in the scope of the project is clearly visible.

PROJECT SOLUTION

Historical and urban planning commentary

On January 1, 1901, traffic was opened on six routes, a single track with interchange tracks at the main stops, and at the end stops whatmans changed the cabins and turned the roller pantograph, since there were no turning wheels. Thus, Bulgaria ranked among the few European countries that used electric public transport. Until then, the people of Sofia knew only the "horse tram" from "St. Nedelya" Church to the station, Gorna Banya and Kniazhevo. In 1898, the capital municipality granted a concession for the construction of tram lines to the Belgian joint-stock company "Electric Trams - Sofia". Initially, the concession was for 40 years, but in 1927 the enterprise was bought by the municipality and DTO - Directorate of trams and lighting. Over the years, the new lines have been built, and the old ones were extended or modified. This type of transport is of particular importance for the capital, as it pollutes the air slightly, carries many passengers and has opportunities for continuous modernization. The route passes

through built-up neighborhoods with a different architectural vision, created during different periods of the urban development of Sofia since the beginning of the last century. From the point of view of the cultural and historical heritage, according to the letter No. 4458/26.09.1988 of the Committee for Culture and the National Institute of Culture, "Macedonia" Blvd. has been designated as "B" - conservation regime. On this basis, this section has been marked with a protected regime in the General development plan of the Sofia municipality.

Design solution

The main approach in forming the park planning solution is to preserve the historically formed volumetric-spatial image in relation to the vegetation - a frame of tall tree vegetation on the sidewalks and green dividing strips on both sides of the tram route with the character of a "green boulevard" with places for short-term recreation. /Appendix 5 – Project situation/.

The project envisages a two-way bicycle lane on the northern side, which makes the connection between the built part near the Russian monument and the quiet central area starting at "Macedonia" Square. The pavement provided for the bike lane is anthracite with dimensions of 10/10/6 cm of visible concrete without chamfer. The project decision does not envisage a change or an expansion of the tram route, but its grassing with grass and the creation of a "Green Tram" in the section from "Macedonia" Square to "Russian Monument" Square. Two pedestrian crossings were planned on the tram route. One is at the intersection with "Ivaylo" Street, and the other - at the intersection with "20-ti April" Street. The flooring of these areas is provided by granite pavers 10/10/10 cm. The paving of the pedestrian walkways is uniform and monochrome in order to serve as a background to the surrounding facades. The concrete pavers in a gray tonality with dimensions of 10/10/6 cm /unipavage/ with a chamfer and flush surface were also planned.

To facilitate the orientation of people

with impaired vision, in the accessible pedestrian spaces, specialized relief /tactile stripes/ were implemented, which serve for information and for the attention of citizens in order to facilitate and support their movement. The tactile plates are of two types: with three embossed strips oriented in the direction of movement and tactile strips with a relief of beveled hemispheres for attention to danger (roadway, obstacle, etc.). The sizes of the specialized concrete slabs are - 30/30/5 cm. The tactile flooring was designed in accordance with REGULATION No. 4 of 1.07.2009 for the design, implementation and maintenance of constructions in accordance with the requirements for an accessible environment for the population, including the disabled, which guarantees the precise sizing of a comfortable and safe environment for the blind and partially sighted in the newly designed park area. Along the entire length of the developed territory, on both sides of the railway, alleys with a width of 2.5 m are provided for pedestrian walks with extensions for rest. The designed recreation areas are scaled in relation to the general composition and are furnished with park

furniture, the assortment and number of which is:

- Benches - 69 pcs.;
- Bins – 21 pcs.;
- Bike racks – 2 pcs.

Of all tree species, *Tilia*, should become predominant in order to comply with the prescriptions of the National Institute of Natural Resources and Environment, which emphasizes the linear structure with a focus on the Russian monument. Members of the genus *Tilia* are spectacular avenue trees, with a well-formed habit and fragrant flowering in the early summer. In addition to the *Tilia cordata* species, the composition of the decorative vegetation includes basic shrub species such as *Ligustrum ovalifolium* is mentioned for its vibrant foliage and *Rosa* ssp - for colorful accents in linear compositions. The remaining species are secondary and complementary to the main compositional line. The choice of tree and shrub species used in the project was influenced by their morphological and physiological characteristics and the specific microclimatic features of the site.

Table 3. Morphological and physiological characteristics of the plant species used

N	Name	Soil requirements		
		demanding	medium demanding	undemanding
1	<i>Tilia tomentosa</i>	●		
2	<i>Juniperus horizontalis</i>			●
3	<i>Berberis thunbergii</i> `Atropurpurea			●
4	<i>Ligustrum ovalifolium</i>			●
5	<i>Rosa</i> ssp.		●	
		Solar requirements		
		light-loving	shade-tolerant	
1	<i>Tilia tomentosa</i>		●	
2	<i>Juniperus horizontalis</i>		●	
3	<i>Berberis thunbergii</i> `Atropurpurea	●		
4	<i>Ligustrum ovalifolium</i>		●	
5	<i>Rosa</i> ssp.	●		
		Gas resistance		
		gas-tight	not gas-tight	
1	<i>Tilia tomentosa</i>	●		
2	<i>Juniperus horizontalis</i>	●		

3	<i>Berberis thunbergii`Atropurpurea</i>	•		
4	<i>Ligustrum ovalifolium</i>	•		
5	<i>Rosa ssp.</i>	•		
		Growth rate		
		fast growing	medium growth rate	slow growing
1	<i>Tilia tomentosa</i>			•
2	<i>Juniperus horizontalis</i>		•	
3	<i>Berberis thunbergii`Atropurpurea</i>		•	
4	<i>Ligustrum ovalifolium</i>	•		
5	<i>Rosa ssp.</i>	•		
		Foliage density		
		dense foliage	solid openwork	openwork foliage
1	<i>Tilia tomentosa</i>	•		
2	<i>Juniperus horizontalis</i>	•		
3	<i>Berberis thunbergii`Atropurpurea</i>	•		
4	<i>Ligustrum ovalifolium</i>	•		
5	<i>Rosa ssp.</i>			•
		Suitable for undercutting		
		suitable	unsuitable	
1	<i>Tilia tomentosa</i>	•		
2	<i>Juniperus horizontalis</i>		•	
3	<i>Berberis thunbergii`Atropurpurea</i>	•		
4	<i>Ligustrum ovalifolium</i>	•		
5	<i>Rosa ssp.</i>	•		
		Crown tracery		
		openwork	medium openwork	solid crown
1	<i>Tilia tomentosa</i>			•
2	<i>Juniperus horizontalis</i>			•
3	<i>Berberis thunbergii`Atropurpurea</i>		•	
4	<i>Ligustrum ovalifolium</i>			•
5	<i>Rosa ssp.</i>	•		
		Time of appearance and fall of leaves		
		early emergence and early fall	late emergence and late fall openwork	evergreen
1	<i>Tilia tomentosa</i>		•	
2	<i>Juniperus horizontalis</i>			•
3	<i>Berberis thunbergii`Atropurpurea</i>			•
4	<i>Ligustrum ovalifolium</i>			•
5	<i>Rosa ssp.</i>		•	

When choosing the main plant species in the project for a linear park on "Macedonia" boulevard, an important factor is their positive physiological potential for development with planned intensive maintenance: forming

cuttings of tree crowns /*Tilia*/, forming cuttings according to a template and with a characteristic hedge profile /*Ligustrum*/ and specialized prunings for wintering/overwintering and for flowering /*Rosa*/. The existing parking spaces

were removed in the dividing strips. The new areas, released from the "parking" function, became green areas with a total square footage of 2,321 sq.m., not including the area of the designated "Green Tram". The linear vision, in addition to the large-sized decorative vegetation, is also emphasized with bushy. /Appendix 6 - cross profile/. The hedge was located along the entire length on both sides of the tram route, as an ecological and aesthetic barrier to the two localities and the bike lane. The sound insulation function of the ligustrum plantation is enhanced thanks to the multi-layer arrangement of the leaf mass and the planting in a two-row strip. Together, the hedge deters accidental crossings across the tram route and has an undeniably positive aesthetic effect. The height of the hedge should be kept under

control, by pruning, with a maximum height of 1 m. The fixed height of 1 m is intended to provide visual coverage of the entire space and, at the same time, fulfill its ecological and aesthetic functions. Seasonal flowering is planned, which will provide dynamics in the color of the compositions of decorative bushes and will bring individuality to the spaces.

For all existing trees that are not subject to removal, according to the project development and remain in the pavement (total 12 pcs.), cast iron grids at the base of the stem and vertical cast iron grids-fences to protect the stem are provided. The scope of the development includes young tree saplings /26/, which would be moved to a more suitable place. The measures for replanting the trees were included in the bill of quantities for the project.

Dendrological list:

1. Deciduous trees

№	NAME	Planting scheme
1	<i>Tilia tomentosa</i> height 350+ cm, stem diameter 18/20 cm, container - min. 90 l	single

2. Decorative conifers

2	<i>Juniperus horizontalis</i> `Blue Chip` height 20-30 cm - container 1.5 l.	7 pcs./m
3	<i>Juniperus horizontalis</i> `Old Gold` height 20-30 cm. - bale or container 1.5 l.	7 pcs./m
4	<i>Juniperus horizontalis</i> `Prince Of Waves` height 20-30 cm - container 1.5 l.	7 pcs./m

3. Decorative deciduous shrubs

5	<i>Berberis thunbergii</i> `Atropurpurea Nana` height 20-30 cm - container 2 l.	7 pcs./m
6	<i>Ligustrum ovalifolium</i> height 40-60 cm - bale or container 1.5 l.	9 pcs./m
7	<i>Rosa</i> `Imagine` height 40-50 cm - container 3 l.	3 pcs./m ²
8	<i>Rosa</i> `Grand Gala` height 40-50 cm - container 3 l.	3 pcs./m ²
9	<i>Rosa</i> `Lili Marlene` height 40-50 cm - container 3 l.	5 pcs./ m ²
10	<i>Rosa</i> `Iceberg` height 40-50 cm - container 3 l.	5 pcs./ m ²
11	<i>Rosa</i> `Bonica` height 40-50 cm - container 3 l.	5 pcs./ m ²

4. Seasonal flowering – Autumn

12	<i>Viola wittrockiana</i> height 2-10 cm, container C 9.	45 pcs./m ²
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5. Bulbous plants

13	<i>Crocus</i> ‘Jeanne d’Arc’	35 pcs./m ²
14	<i>Crocus</i> ‘Pickwick’	35 pcs./m ²
15	<i>Muscari</i> ‘Touch Of Snow’	20 pcs./m ²
16	<i>Hyacinthoides</i> ‘Hispanica Blue’	35 pcs./m ²
17	<i>Iris hollandica</i> ‘Apollo’	15 pcs./m ²
18	<i>Iris hollandica</i> ‘Alida’	15 pcs./m ²
19	<i>Narcissus</i> ‘Ice Wings’	20 pcs./m ²

6. Seasonal flowering – Summer
20 For the sun

21	<i>Begonia semperflorens</i> ‘Super Olympia White’ height 5-10 cm, container C 9.	45 pcs./m ²
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22	<i>Begonia semperflorens</i> ‘Super Olympia Red’ height 5-10 cm, container C 9.	45 pcs./m ²
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23	<i>Senecio cineraria</i> height 10-15 cm, container C 9.	35 pcs./m ²
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24 For shade

25	<i>Impatiens walleriana</i> ‘Busy Lizzie White’ height 10-15 cm, container C 9.	45 pcs./m ²
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16	<i>Impatiens walleriana</i> ‘Victorian Rose’ height 10-15 cm, container C 9.	45 pcs./m ²
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27	<i>Impatiens walleriana</i> ‘Scarlet’ height 10-15 cm, container C 9.	45 pcs./m ²
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The "Green Tram" is a solution that leads to a significant reduction in the noise pollution from the rail transport. The selection of grass species is as follows:

- *Lolium perenne* - English ryegrass, which is characterized by quick and easy adaptation to most types of soil /even heavy/ and exceptional resistance to trampling;

- *Festuca arundinacea* – Reed fescue, finesse and density, slow growth, adaptation to light soils and different climatic conditions;

- *Cynodon Dactylon* – Decorative reed, highly drought-resistant, rhizome grass; extremely resistant to intense load and wear, with a unique regenerative ability. It can be cut rarely. It forms a dense and very fine grass carpet. Suitable for landscaping areas with reduced intensity of watering and mowing.

The selected species complement each

other during growth and life cycle. The fast-growing ones give the initial effect, and the slower-growing and durable species ensure the longevity of the grass chim. In this way, a wide and comprehensive utilization of the nutrients in the soil is achieved due to the different physiological needs of the individual species.

Chim has greater ecological plasticity, vitality and resilience in general due to its wider range of adaptation to habitat conditions. In addition, the selected grass mixture represents a combination of different life forms (types of root systems, above-ground shoots) that complement each other. For the purposes of weeding, a compacted humus layer - 15 cm and geotextile 400 g/m² is provided. /Appendix 9 – cross profile ,Green Tram/'. The total amount of lawns for the "Green Tram" is 1,628.25 m².

CONCLUSION

Based on the conducted research and project development, the following conclusions were drawn:

- Green plantings perform the functions of a sanitary barrier between the street lane and the survey area.

- The traditional methods for designing linear park sites should be studied in more detail. It is imperative to carry out in-depth analyzes of noise load for this kind of objects in the conditions of an urban environment, so that a unified strategy can be created in the investment design for optimal reduction of acoustic discomfort;

- Consideration of the complex influence of the sources of noise pollution;

- The differentiation of the territory according to the level of noise load, which is the basis for making decisions about the location of functional areas, organizing traffic or making decisions about the type of reconstruction, the type of vegetation and its location.

- The numerical analysis in the form of environmental safety criteria allows at the assessed level to establish cost indicators for ecological quality of the environment of individual urban areas for the compilation of a cadastre or investment level;

- Based on the obtained gradation and a set of noise protection measures, a strategic plan for the development of the territory and its reconstruction was formulated;

- Possibility of extended planning for active formation of the urban environment;

- In the case of reconstruction of already developed urban areas, as well as the management of the urban environment, the proposed design approach opens perspectives for operational regulation of the noise regime.

The prediction of the noise regime is particularly important when developing long-term plans for the development of the city. At the same time, it is possible to take action step from passive methods of protection to active

influence on the state of the acoustic environment by organizing functional areas of the city. Considering the city territory as a combination of noise centers and functional areas with different regulatory requirements, it is possible to assess the noise regime as a whole, the effectiveness of certain planning and development options and the organization of the transport network. It is at this level that the most vulnerable areas in terms of noise generation can be identified and a set of measures to minimize the noise load can be developed in a timely manner and thus eliminating huge future costs for special structures and protection.

REFERENCES

- Banerjee D. (2014) Association between transportation noise and cardiovascular disease: a meta-analysis of cross-sectional studies among adult populations from 1980 to 2010. *Indian J Public Health*, 58 (2), 84 -91. <https://doi.org/10.4103/0019-557X.132279>
- Broderson, A. B., Coakley, W. S., Edwards, R. G., Jackson, T., & Hauser, W. P. (1979). Environmental noise in Kentucky. *Acoust Soc Am*, 65, S 63. <https://doi.org/10.1121/1.2017364>
- Calixto, A., Diniz, F.B., Zannin, P.H.T. (2003) The statistical modeling of road traffic noise in an urban setting. *Cities*, 20 (1), 23 -29. [https://doi.org/10.1016/S0264-2751\(02\)00093-8](https://doi.org/10.1016/S0264-2751(02)00093-8)
- Canelli, G. B. (1980). Traffic Noise Pollution in Rome. *Applied Acoustics*. 1974 - 2. p. 103-115 6) Compatible land use with respect to noise. FNSI 53-23 1980. Acoustical soc. of America.
- Den Boer, L.C., Schroten, A. (2008) Traffic noise reduction in Europe. CE Delft.
- Harris, D.A. (1997) Noise Control Manual for Residential Buildings. McGraw Hill.
- Kephalopoulos, S., Paviotti, M., Anfosso-Ledee, F., Van Maercke, D., Shilton, S.,

Jones, N. (2014) Advances in the development of common noise assessment methods in Europe: The CNOSSOS-EU framework for strategic environmental noise mapping. *Sci Total Environ.* 482-483, 400 – 410. <https://doi.org/10.1016/j.scitotenv.2014.02.031>.

Mirzaei, R., Ansari-Mogaddam, A., Mohammadi, M., Rakhshani, F., Salmanpor, M. (2012) Noise Pollution in Zahedan and Residents' Knowledge About Noise Pollution. *Health Scope*, 1 (1), 3 -6. <https://doi.org/10.5812/jhs.4544>

Ordinance No. 6 to the Environmental Noise Protection Act Ordinance No. 7 on rules and regulations for the organization of individual types of territories and development zones, ZUT, ZOO and all currently effective regulatory documents related to the site's parameters.

Roosli, M. (2013) Health effects of environmental noise exposure. *Ther Umsch*, 70 (12), 720 -724. <https://doi.org/10.1024/0040-5930/a000470>