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Correlations between Traffic Noise and Accommodation Units Location in Craiova (Romania)

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Abstract

On the background of regional development, during the last decade, the number of the accommodation units, especially hotels, increased significantly. Thus, if in 2001 there were 8 accommodation units, in 2014, the number of registered units reached 35 out of which 18 were hotels, 9 guesthouses, 4 hostels and 2 motels and 2 tourist villas. Besides the business tourism, Craiova city has the possibility to increase the number of tourists, their trend, already increasing, is evidenced by the 63,144 tourists registered in 2014, as compared to 41,081 persons registered at the beginning of the above mentioned period. On this background, noise is an important degradation factor of the urban environment, a major problem that impacts the quality of life and one of the most important causes of the fundamental contradiction between urban tourism and environmental quality. This study analyses the present situation regarding the location of the accommodation units from the point of view of the noise comfort and accessibility. The study correlates the existing noise map of Craiova with the measurements (Sound Level Meter NL-31) performed for the main accommodation units existent, recordings on the basis of which the units will be granted a grade value according to the noise level, accessibility and related improvements. Emphasis is placed on conducting accurate measurements and computer simulations in order to evaluate the noise exposure levels for the accommodation units in Craiova. Furthermore the study attempts to understand the prioritization made by the urban tourists when considering environmental sound quality versus distance from the main city attractions. The study reveals that the average noise level surpassed 50 dB in the case of all accommodation units (and even 55 dB, with a single exception), irrespective of the measurement interval, transcending the limits stipulated by the present policy.

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1. Introduction

During the last decade, noise has been recognized as an important ambient pollutant that can affect human health [1]. Due to technological development, which increased the movement possibilities of people and goods, the environmental noise caused especially by traffic and other specific economic activities raised exponentially [2]. Nowadays, the negative impact of environmental noise and its stress on human health is widely recognized. The European Union acknowledged the stress that noise has on humans' daily activity and issued the Directive 2002/49/EC, which represented the starting point of many noise maps and studies conducted for major European cities [3]. In line with the directive, most of the UE member countries, the noise mapping studies were largely completed [4, 5, 6]. Romania transposed in its national legislation the provisions of the EU directive regarding the evaluation and management of the environmental noise (G.D. 321/2005 republished in the Decision 831/1461 from July 2008 regarding the evaluation and management of environmental noise and G.D. 1260/2013; Ministerial Ordinance 1830/2007 for the approval of the Guide regarding the issuance, analysis and evaluation of strategic noise maps).

In a typical urban environment, which is densely populated, with tall buildings and high usage of resources, noise pollution and the creation of comfortable sound environment is a vital issue, therefore several papers have been written on urban acoustic and they emphasize the idea of developing a sustainable acoustic environments, particularly in urban residential areas [7].

Noise pollution is widely prevalent in urban areas, where transportation systems are the main source, although other local or episodic noise sources like bulldozers, air compressors, loaders, dump trucks, jackhammers, pavement breakers, loudspeakers, plumbing, air-conditioners, fans or dogs barking also bear considerable blame for increasing the environmental noise and disturb and normal cognitive processes [8, 9] or sleep during the night [10, 11].

In the UK, Skinner and Grimwood [12] (quoted by Dahlan et al. [13]) undertook a survey of environmental noise levels, and they concluded that in the last years, there has been an increase in the number of people reporting being annoyed by noise from neighborhood and road traffic.

A sound level beyond 50 dB in the tourism areas can be regarded as noise [14]. Dahlan et al. [13] assessed the effects of acoustic comfort in high-rise hostel rooms at different levels by means of objective and subjective measurements in three sites in Klang Valley, Malaysia. Results showed that sound pressure levels increased on vertical due to wind and air temperature influences and were based on objective and subjective measurements. The desire to meet tourist needs induces a fundamental contradiction between urban tourism and the quality of the acoustic environment [9].

Noise mapping is acknowledged as one of the best tools to indicate the problems related to environmental noise [15]. The role of GIS in tourism management is mainly in the following areas: conducting tourism information management and being able to produce a comprehensive thematic map [16, 17, 18].

A few important noise mapping assessment works were conducted by Doygun and Gurun [19]; noise levels were mapped in terms of spatial-temporal variability in the city of Kahramanmaraş (Egypt). Similar works, conducted by Seto et al. [20] for American cities, made use of GIS techniques and particularly assessed the health impacts of noise on local communities; the generated noise maps were employed in urban planning. Yilmazo and Hocanlı [21] conducted the noise assessment and mapping in the city of St. Anliurfa (Turkey).

The main objectives of the research consists in establishing the measuring points, depending of the location of accommodation units in respected to the main streets in Craiova, selecting the measurements parameters (time, frequency, distance, height), processing, interpretation and mapping of the data. The meeting of the proposed objectives resulted in a classification of the accommodation units in respect to the surrounding noise levels registered and accessibility. These details represent the main objective of the paper which can be further used by in analyses of touristic activities in Craiova.

Study area

The city is connected to the national and international transportation network by European and national roads (E-70, E79 and DN 67), railway and an international airport. The development of urban transport network makes the mobility inside the city easy, almost all points of interest being accessible by means of public transportation. Regarding the air access, Craiova airport started an intense activity in 2008 and the future policies target the introduction of more low-cost airlines in order to facilitate the contact with other European states. On the background of regional development, during the last decade, the number of the accommodation units, especially

hotels, increased significantly. Thus, if in 2001 there were 8 accommodation units (3 of which were hotels), in 2014, the number increased to 35 (18 hotels, 9 guesthouses, 4 hostels, 2 motels and 2 tourist villas). Besides the business tourism, Craiova city has the possibility to increase the number of tourists. The increasing trend is evidenced by the 63,144 tourists registered in 2014, as compared to 41,081 persons registered at the beginning of the above mentioned period.

In the regional context, Craiova is considered a growth pole. Thus, the tourism potential, which is an image generator, is based on a tourism supply that includes a transit tourism, due to the city location at the intersection of access roads in south-western Romania, a business tourism that relies on the automotive industry (Ford company), a scientific tourism through the presence of the University of Craiova, as a regional higher education institution and a cultural and recreational tourism due to the numerous objectives included in the national cultural heritage [22].

Craiova's touristic model shows a concentration in the city's centre that has advantages as: an effectiveness of visitor management, a low cost alternative for development, a better control over tourism development, but also some weaknesses as: low quality of touristic services, growing the tourism pressure in the city centre, under-utilization of the outskirts resources [22].

As all large urban areas, for Craiova city were issued noise maps that take into consideration all important sources for the sound level generated by road and train traffic and the sound generated by industrial activity. The present study focuses on the level of noise measured in the proximity of accommodation units, trying to identify (based on a scale classification) which are the best locations from the viewpoint of quiet surroundings and accessibility for 41 accommodation units existent in the city.

3. Database and methodology

The present study correlates the existing noise map of Craiova with measurements (Sound Level Meter NL-31) performed for the main accommodation units, recordings on the basis of which the units will be granted a grade value according to the noise level (which allows us to include the respective units in three category of noise comfort: low, medium and high), accessibility and related improvements. In particular, the research details the spatial-temporal distribution of noise, generated by urban traffic, by means of monitoring and mapping as a tool for evaluation of impact.

A digital sound level NL-31 meter with frequency weighting network as per A/C/FLAT specifications, frequency range of 31.5Hz to 8,000Hz and measuring range between 0–120 dB, was used for the study. Sound data were recorded for a continuous sampling period of 15 minutes during working days and week-end. The data collected from field were recorded in MS excel worksheet and later transferred to GIS geodatabase. All noise values were expressed in dB.

The measurements were performed at all accommodation units located in Craiova and nearby during the following time intervals: two hours in the morning (7.30-9.30), three hours in the evening (20.00-23.00) and three hours in week-end (11.00-14.00). We considered that these time intervals are important for the presence of tourists inside the rooms of the hotels. For the proper assessment and analysis of the results, the following noise indices were computed: L-m and L-e (sound level for morning and evening period); L-w (sound level for week-end).

The measurements were conducted on a period of three months (nine times for each accommodation unit under study, i.e. three times for each considered moment of the day/week); the measurement span was 15 minutes each time. The measurements were performed outside the accommodation units at a height of 2 meters above the ground for all sides of the building which face the streets. Also, the maximum distance to the walls was 1 meter. In cases where windows were facing other sources of noise there was calculated an average taking into account all values registered. The study uses a comprehensive database created in GIS environment. The noise maps were achieved by interpolating the measured values (IDW method, 10-m spatial resolution in raster data) based on the noise values: L-m, L-e (morning-evening) and L-w (week-end).

The use of basic GIS techniques enabled the transition from the individual analysis of the tourist accommodation units to the comprehensive vision required in the achievement of useful hypotheses for the tourism development in Craiova; thus, the existent tourist accommodation infrastructure can be improved and raised to the national and European standards. In order to better understand the real possibilities for tourism development, as well as the advantages triggered by this type of activity upon the local stakeholders, the study took into consideration the present transportation characteristics and socio-economic context of the area (information selected from available

cartographic materials, i.e. topographical maps, satellite imagery and databases, but subsequently completed through field observations and documentation, in order to limit the inconsistencies between sources).

4. Results and discussions

The main elements correlated in the present study are represented by the location and accessibility of the accommodation units, on the one hand, and the corresponding noise levels, on the other.

Given the tourist potential of the urban area under study, it can be noted that the main forms of tourism are strongly connected to the presence of representative institutions with heterogeneous profile (administrative, scientific, economic etc.), as well as to the organization of various attractive events (fairs, concerts, exhibitions etc.). Generally following the distribution of the functional areas of the city of Craiova, the spatial organization model of the tourist attractions is a concentric one, with an obvious concentration in the central part, within the local Central Business District (which is important for business tourism, scientific tourism, event tourism, cultural and religious tourism, leisure tourism) and with an isolated, insular presence towards the periphery, particularly southwards and eastwards.

In order to analyze the distribution and the accessibility of the accommodation units in relation to the main attractions that trigger tourist mobility in the urban area, we considered Craiova City Hall as a spatial reference point (this institution being located in the historic city center, as well as in the central area delineated by the General Urban Plan) and the main roads as further axial references. Thus, there is to be noticed an overall similarity between the spatial distribution model of the accommodation units and that of the city tourist attractions, with a massive presence in the central area and with ramified development along the major transportation lines, eastwards (Bucharest exit), westwards (Timișoara exit) and southwards (Caracal exit). About 39 percent of the total number of accommodation units under study (i.e. 16 out of 41) is located in the central area, within a distance of 1,000 meters at the most from the Craiova City Hall. An even more significant share (about 41 percent of the total) is held by the accommodation units located farther from the center (between 1,000 and 5,000 respectively), but nonetheless placed closer than 150 meters from an important road (Fig.1).

The time spent in traffic can be relevant in certain circumstances, as the main access roads may provide a more rapid mobility rather than central streets which are sometimes too narrow, too sinuous or one way streets. A small number of accommodation units (representing 14.6 percent of the total) are located at more than 5,000 meters from the city center; in 5 of the 6 such cases, the units are also situated at more than 150 meters distance from an important access road.

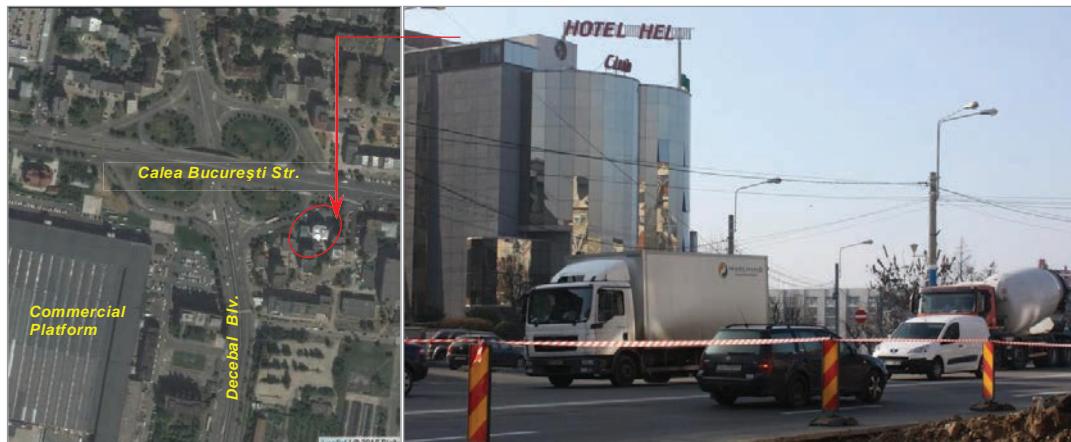


Fig. 1. *Helin* Hotel, located within 50 m of a main road and 100 m of an important internal transportation ring (Location: 2015 Microsoft Corp., Bing, 50 m)

The analysis suggests that most of the accommodation units hold a favorable position in relation with the access time towards Craiova city center. In normal traffic conditions, the urban core can be reached in approximately 15 minutes by car when departing from the periphery of the city, or by foot when moving within the central 1,000 meters compass. The real traffic experience shows, however, that there are enough issues connected to the general

urban transportation characteristics, road quality, parking spaces etc. and these aspects can induce supplementary and unplanned delays.

The correlated analysis of the noise level within the precincts of the accommodation units in relation to their location on the main roads led to several interesting conclusions.

Thus, 13 of the 41 units under study (i.e. 31.7 percent) are located at less than 50 meters from an important transportation line. The average values registered during all three measuring intervals (morning, evening, week-end) point out to a medium, relatively constant noise level and they are comprised between 62 and 79.7 dB; within this spectrum of values, there is to be noticed a slight decrease towards the evening, following the general limitation of all economic activities and of the road traffic.

About 24 percent of the accommodation units under study (i.e. 10 of the total number considered) are located within a distance comprised between 50 and 100 meters from a major road line and they are characterized by average noise levels of 73 up to 82 dB during the morning, while the corresponding value span is 68 – 77 dB in the case of the evening and 70 – 77 dB for the week-end. Along the slight decrease of the noise level towards the evening, this class of accommodation units is characterized by sensibly higher values than the precedent hotels.

Approximately 22 percent of the total units are located within a distance comprised between 100 and 200 meters from an important access road. Although less important as number of elements, the present category is quite heterogeneous in values, the noise level being influenced by the functional characteristics of the conterminous area. The highest values characterize the morning interval (60 – 76 dB, frequently over 70 dB), while during the evening they decrease to 55 dB and they only surpass 70 dB in three instances (reaching the most important average value of 74.6 dB). There are to be noticed the constantly lower values in the area of the isolated hotels/motels/villas (as, for example, *Hanul Doctorului*: 60 dB during the morning, 59.2 dB during the evening and 58.7 dB during the week-end) or in that of the units surrounded by residential areas (for example, *Vila Flormang*: 64 dB, 54.9 dB, and 61.1 dB respectively), while the higher values are characteristic to the easily accessible units located in the CBD (for example, *Helin Central*: 75 dB, 74.6 dB, and 73.5 dB respectively), or to those located near the commercial areas (for example, *Casa Flamingo*: 76 dB, 73 dB, and 77 dB respectively).

The same type of features is displayed by 9 accommodation units located at a distance comprised between 200 and 1,000 meters from an important access road. The average values are comprised between 65 and 79 dB during the morning, 58.5 and 72.3 dB (exceptionally 79.3 dB – *Andres*, with a particular location not far from the Municipal Hospital) during the evening, and 55.9 – 77 dB at the week's end. The lower values are characteristic to the remoter units, with diminished accessibility that is predominantly realized on unpaved secondary roads (for example, *Bruxelles Guesthouse*: 65 dB during the morning, 59.5 dB during the evening and 55.9 dB during the week-end) (Fig.2), while the most important average values were registered within the central area of the city (for example, *Hotel Rexton*: 79 dB, 72.3 dB, and 77 dB respectively).

The raw measured data was processed and used for the generation of three noise maps; their analysis highlights the sound levels that can be expected in any accommodation unit from Craiova during the morning, evening and week-end and it points out the main contributing factors to all the noise. The morning time interval was selected on criteria that involved the types of tourism (cultural, business) or tourist activities (visits, meetings). Regardless of their activity, tourists are likely to be inside the accommodation units between 7.30 and 9.30 in the morning.

Morning measurements, performed during the working days of the week, evidenced high noise values especially for the accommodation units located along the main traffic routes like Calea București, Caracal and Severinului Boulevards or along the north ring. The highest values were registered for *Casablanca*, *Sidney*, *Plus Hotel* and *Andrița's Inn* (average values range between 78.3 and 82 dB, while maximum sound levels between 89.5 and 104.3 dB). The main source of noise is related to intense road traffic (Fig.3). High values were also registered at *Casa Flamingo* and *Casa cu Tei* (75.9 dB, 78.6 dB) respectively located on connections roads. Accommodation units like *Helin* and *Hotel Royal*, located within a distance of 10-15 meters from the main road, have high levels for the noise outside due to heavy traffic or intense road traffic, as the streets they are located on make the connection between two major arteries (Calea București – east exit and Decebal Boulevard for heavy traffic).



Fig. 2. Bruxelles Guesthouse, on a more isolated location: lower noise levels, more difficult accessibility (Location: 2015 Microsoft Corp., Bing, 50 m)

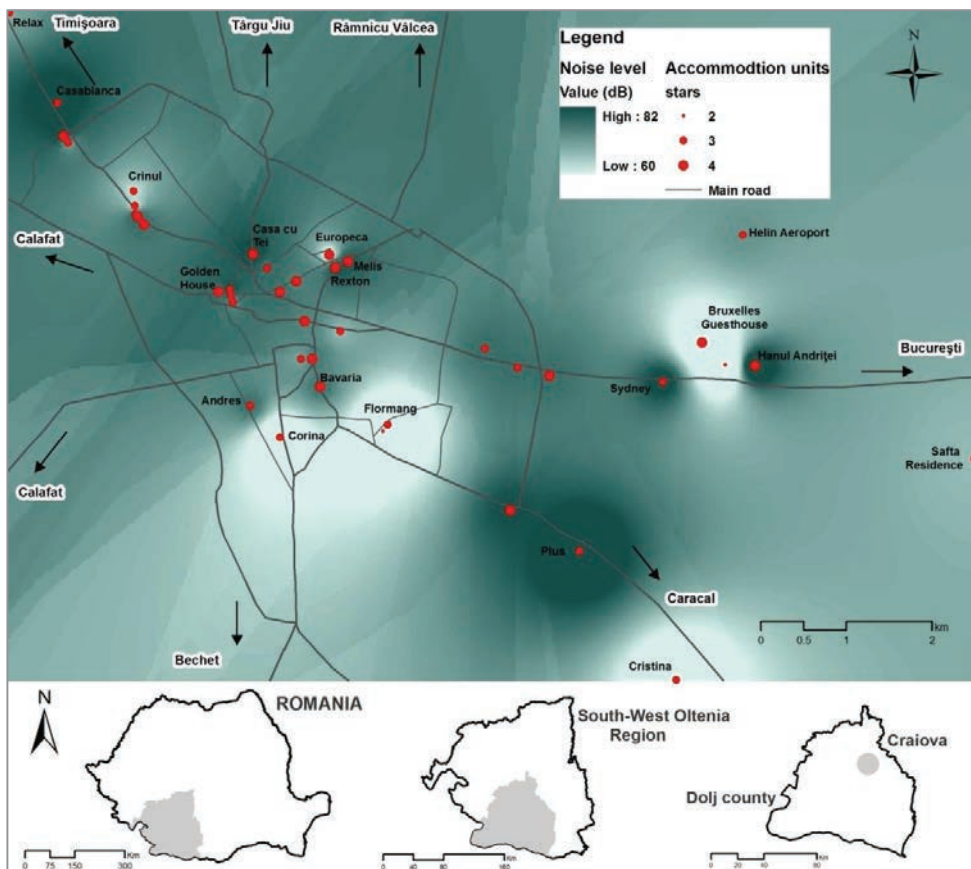


Fig. 3. Distribution of noise levels during morning measurements in Craiova

The selected time intervals for the *measurements performed during the evening* showed the same high values for the hotels located alongside the main roads. Although we tend to believe that the noise values should be lower, as the road traffic is less intense and the general noise generated by various activities is eliminated or significantly reduced, this is not a general case. Relatively high values were also registered at accommodation units located in residential areas (*Cărămida Verde Guesthouse* 73.7 dB average value and 92.2 dB maximum value – Fig. 4). The

average values registered exceed the threshold of 50-60 dB for general background noise level in residential areas during daytime and even the levels of normal conversation (60-70 dB).

Except the hotels located on important streets (*Sydney, Flamingo House, Casa cu Tei* and *Oltenia*), the values registered during the **week-end measurements** were lower than those registered during the week. The maximum sound levels registered were generated by the road traffic and other human activities (loud speaking generally, children playing): 92.8 dB (*Oltenia Hotel*) and 89.5 (Sydney), while the averages ranged between 79.7 (*Casa cu Tei*, located on a street that makes the connection between major roads which link the people to the city exits and supermarkets) and 55.9 (*Bruxelles Guesthouse*, located on an isolated area) (Fig.5).

A five-point linear scale was generally used for the noise level extreme values (maximum and minimum) from very comfortable to very uncomfortable.

The statistical analysis of the maximum noise values (Tab.1) showed that two distribution classes (i.e. 82.1-90 dB and 90.1-94 dB) comprise most of the accommodation units (34 in the case of morning measurements, 31 for week-end measurements, respectively 30 for evening measurements). The highest values correspond to the 94.1-104.3 dB span, with the variation of the units from 2 (evening), to 4 (morning) and, finally, to 5 (week-end).

In the case of the minimum values (Tab.2), no distribution class corresponds to the majority of the accommodation units, as the amplitude of the noise level is much more heterogeneous. The evening and week-end measurements reveal the fact that minimum values comprised between 44.9 and 63 dB are characteristic to most of the registrations (35 units during the evening, respectively 33 during the week-end). The morning measurements pointed out that the registered minimum values are also consistent with high noise levels, corresponding to the 58-73.2 dB span in the case of 22 accommodation units.

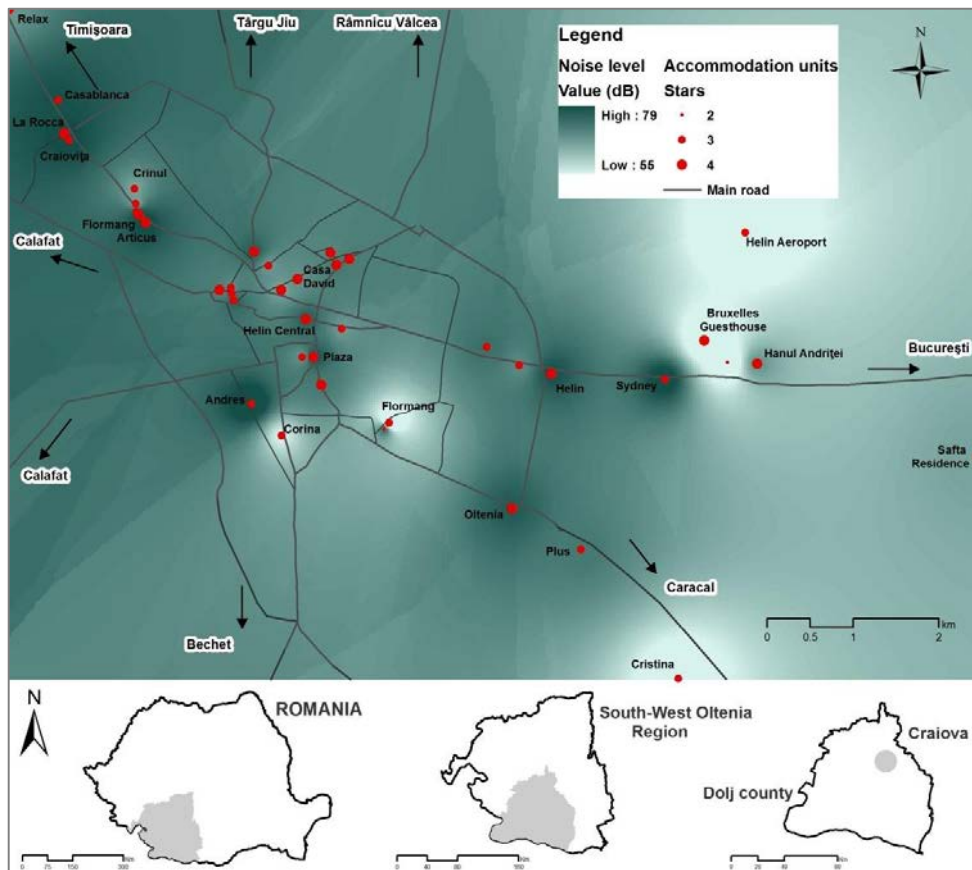


Fig. 4. Distribution of noise levels during evening measurements in Craiova

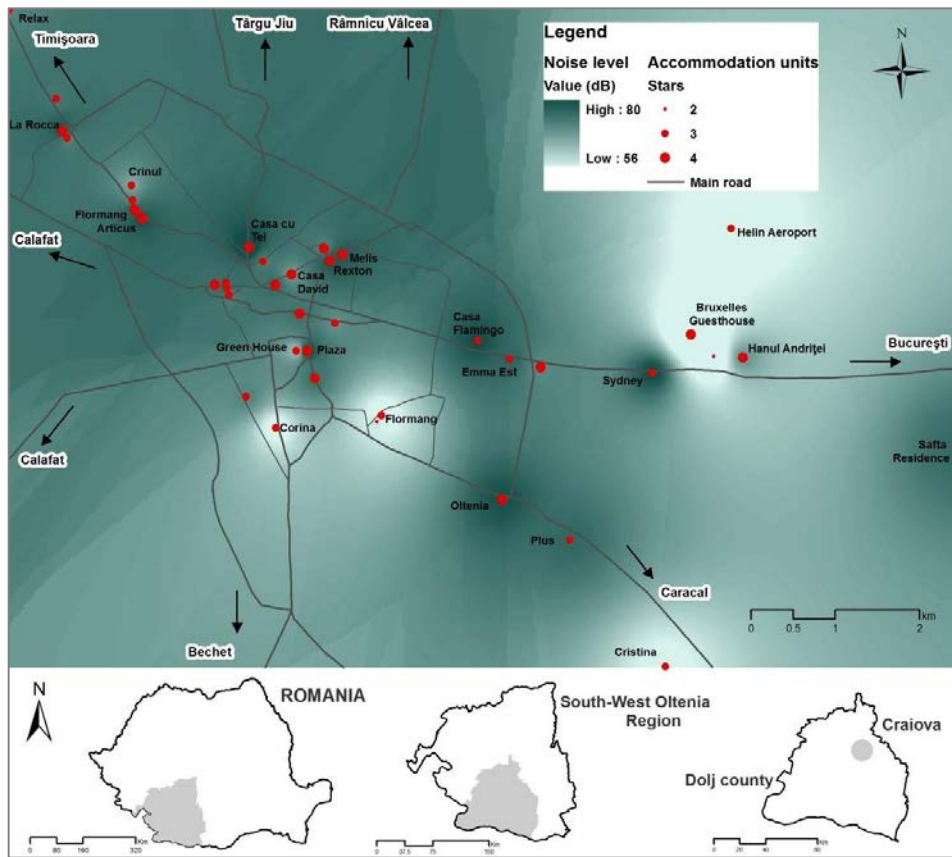


Fig. 5. Distribution of noise levels during week-end measurements in Craiova

The average noise recorded surpassed 50 dB in the case of all accommodation units (and even 55 dB, with a single exception), irrespective of the measurement interval (Tab.3). About 78 percent of the accommodation units account for outdoors average noise levels above 70 dB during morning, the same values being registered in 66 percent of the cases during night and 76 percent of the total instances during week-ends. Thus, the limits stipulated by the present policy (Order of the Ministry of Health No. 119/2014, STAS 10009/88 etc.) are transcended to a level that underlines the impact of noise pollution in tourist activities and requires adequate mitigation measures from the part of the involved public and private stakeholders.

Nevertheless, the spatial distribution of hotels and the present prevalence of business/event tourism support the fact that accessibility prevails over ambient quality in tourists’ options for now. This is expected to change with the diversification of tourist activities in Craiova and with the implementation of Community/national measures regarding health, environmental protection and integrated urban development [4, 7].

Table 1. Noise Level – Maximum values

Value classes dB	No. of units (morning)	No. of units (night)	No. of units (week-end)
55.7-77	2	3	4
77.1-82	1	6	1
82.1-90	19	21	24
90.1-94	15	9	7
94.1-104.3	4	2	5

Table 2. Noise Level – Minimum values

Value classes dB	No. of units (morning)	No. of units (night)	No. of units (week-end)
44.9-53	1	12	12
53.1-58	8	16	9
58.1-63	12	7	12
63.1-67	16	3	7
67.1-73.2	4	3	1

Table 3. Noise Level – Average values

Value classes dB	No. of units (morning)	No. of units (night)	No. of units (week-end)
54.9-60.0	1	4	3
60.1-65.0	3	2	4
65.1-70.0	5	8	3
70.1-75.0	9	16	19
75.1-82.0	23	11	12

The augmentation of noise generating sources, which was not followed by comparable antiphonic measures, explains these levels of noise pollution in the precincts of accommodation facilities and may affect tourist activities. In this respect, the measures to be implemented must address the reduction of noise level at the sources and the consolidation of antiphonic protection. Noise annoyance management is possible through the establishment of tree protection belts (where possible), traditional traffic management measures aiming to improve the acoustic environment: road/tram lines rehabilitation, the deviation of heavy/special traffic, accompanied by adequate technical conditions of the roads (lining, dimensions, signs), traffic restraint schemes etc. [2, 17]. In perspective, a better correlation between traffic management and future tourist facilities represents an important issue. If planned properly, these measures can limit noise and enhance the environmental (and tourist) quality of the accommodation facilities, as already proved by previous studies in tourist areas [9].

There can be stated that the noise level is clearly dependent on the distance from the main axes of transportation, but the values thus induced tend to be somewhat constant, more important during the morning. Furthermore, the analysis underlines the fact that a strong influence upon noise level is exerted by the presence of commercial platforms, construction sites or various institutions related to intense circulation (normal and special traffic), even if they are not located on the main roads.

5. Conclusions

The study reveals that vulnerable accommodations situated along the great boulevards are subject to significantly high noise levels throughout the day and immediate mitigatory measures are required to alleviate the problem.

The values that indicate a high noise level to some accommodation units, during all three moments selected and registered at all measurements repeated are explained by the continuous road traffic and permanent sources of noise. Except the main source for the environmental noise (road traffic), the values of the noise levels may also be influenced by proximity to construction projects nearby (e.g. *Helin Airport Hotel* and *Hanul Doctorului*), hospitals (*Andres*) or fire department location (*Plus Hotel*) and how close a location is to railroads (*Sydney Hotel*), airports or public transportation (tram which was is not currently in use due to modernization works).

The measurements need to be continued and repeated for the accommodation units located on *Calea București* and *Severinului* Boulevards, once the tram is in operation, after the modernization of the line. During the three months period, when the measurements were performed, the tram was not in operation.

The accommodation units that registered maximum, average and minimum values indicating a low sound level were: *Bruxelles Guesthouse*, *Corina*, *Flormang Guesthouse*, *Cristina* and *Crinul Pensions*. These values are explained by the isolation of these units, as they are located in residential areas, far from important traffic roads. The only sources of noise, which explain the high values, are given by episodic sound pollution (like dogs barking).

The quantified data shows that the accommodation units within Craiova are exposed to noise levels ranging mostly from the moderate to extremely high levels in comparison to the national standards. Following objectives and results this study:

- Improve noise management practices in the study area;
- Assist in planning for upcoming developments in the city;
- Increase awareness among the managers of accommodations units to recognize their existing noise environment.

By using noise model analysis method, it timely offers a variety of spatial and dynamic information to set up the computer technology system in order to serve Geography research and decision-making.

Other environmental comfort parameters such as the association between sleep disturbances induced by noise pollution and other pathological effects caused by prolonged exposure to high noise levels which are generally underestimated. Also, a particular attention must be paid to nightly environmental noise exposure.

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