Forum geografic. Studii și cercetări de geografie și protecția mediului
Volume **XX**, Issue **1** (**June** 2021), pp. **34-42**
http://dx.doi.org/**10.5775/fg.2021.032.i**

Comparative analysis on the role of vegetation in controlling the potential effects of gas stations on residential areas

Lavinia Corina PÎNDARU[1], Beatrice Ileana POPESCU[2], Mihai Răzvan NIȚĂ[2,*]

[1] Faculty of Geography, University of Bucharest, Bd. N. Balcescu, No. 1, Sector 1, 010041 Bucharest, Romania
[2] Centre for Environmental Research and Impact Studies, University of Bucharest, Bd. N. Balcescu, No. 1, Sector 1, 010041 Bucharest, Romania
* *Corresponding author*: mihairazvan.nita@g.unibuc.ro

Received on 19-04-2021, reviewed on 19-05-2021, accepted on 20-05-2021

Abstract

When considering human activities with potential negative effects in urban environment, gas stations are a hot topic. For over one century their presence increased associated to the number of vehicles used in cities, and frequently they are associated with residential areas – where the highest number of users are present. Acknowledging their potential effects, gas stations are a response to a high demand in cities – that of mobility. This is especially relevant in Central and Eastern Europe cities (such as Bucharest), which continue to be dominated by cars and alternative models of transportation are present in lower proportions. In the present study we started from extracting with field observations the present characteristics of gas stations in Sector 4 of Bucharest. We applied 31 field observation sheets using Survey 123, containing information about their emplacement and accessibility, the presence and structure of vegetation, etc. We compared results to those of 120 questionnaires applied to the population. Our results revealed the important role the presence of vegetation has on reducing the negative effects of gas stations (both observed and perceived), the differences between populations living in the proximity of gas stations and other residents, and also the fulfilment of legal requirements. We consider our results to be extremely relevant and useful instruments for urban planners and decision-makers in their efforts of improving the quality of life and wellbeing in cities.

Keywords: *gas stations, residential areas, perception analysis, vegetation.*

Rezumat. Analiza comparativă a rolului vegetației în controlarea efectelor potențiale ale benzinăriilor din zonele rezidențiale

În contextul activităților antropice din orașe cu potențiale efecte negative asupra mediului, benzinările reprezintă un subiect de actualitate. De peste un secol prezența lor a crescut direct proporțional cu numărul de vehicule, fiind asociate frecvent cu spațiile rezidențiale ce conțin un număr mare de utilizatori. Recunoscând efectele lor potențiale, benzinăriile sunt un răspuns la cerința de mobilitate a mediilor urbane. Acest aspect este extrem de relevant în orașele din Europa Centrală și de Est (precum București), ce continuă să fie dominate de autovehicole iar transportul alternativ are ponderi mai reduse. În prezentul studiu am pornit de la aplicarea unor fișe de observații ale caracteristicilor principale pentru benzinăriile din Sectorul 4 al municipiului București. Folosind Survey 123 am aplicat 31 de fișe cu informații despre amplasament, accesibilitate, distribuția vegetației, etc. Rezultatele au fost comparate cu cele din 120 de chestionare aplicate populației, și au evidențiat importantul rol al prezenței vegetației în reducerea efectelor negative ale benzinăriilor (observate sau percepute), precum și diferențele de percepție dintre rezidenții din proximitatea acestora și alți locuitori, precum și gradul de respectare diferit al cerințelor legale. Rezultatele sunt extreme de revelante și pot reprezenta instrumente utile pentru urbaniști și factorii de decizie în eforturile lor de îmbunătățire a calității vieții și bunăstării în orașe.

Cuvinte-cheie: *benzinării, spații rezidențiale, analiza percepției, vegetație*

Introduction

Alongside the increased presence of vehicles in transportation activities, human society aimed at increasing the speed and efficiency of such activities, especially in cities which are environments moving at faster paces (Makarova et al., 2017). The presence of accessible gas stations become fundamental, and the firs information about them are given as early as the beginning of the 20th century, with a rapid development especially in the United States (Cramer, 2005). In Romania, oil has been exploited from the 19th century, the first use in cities being represented by the public illumination in Bucharest starting with 1857 (Museum of Romanian Oil Industry, 2018). Especially after World War 2, the presence of gas stations in Romanian cities (and especially in Bucharest) become a common occurrence.

A gas station is defined by Romanian legislation as the enclosure which contains different constructions and installations for the deposit, manipulation and delivery of fuels to vehicles (Government Decision No.195/2004), evidencing for the technical and

industrial character of gas stations (Ioja & Tudor, 2012). In the scientific literature, gas stations are defined as areas including equipment for fuel distribution, depositing reservoirs and additional buildings such as restaurants, markets or car-washes (Nieminen, 2005).

The idea that any industrial activity taking place in inhabited and residential areas must be in compliance with the provisions of existing legislation and regulations of local authorities is also clearly expressed in the literature (Thales Botelho, 2015). It expressed the concern over the threats and risks associated with gas stations and which can affect the population and the environment (Iojă & Tudor, 2012). It has been found that the presence of a high number of gas stations in urban residential areas can expose the population to a wide range of contaminants with direct and indirect effects on their health and wellbeing (Abdullahi & Dawha, 2015).

The high number of gas stations in an area can represent also a fire hazard (Ahmed et al., 2011). Gas stations are one of the major sources of volatile organic compounds in cities, and it is expected that their emissions will influence not only air quality but neighboring population also (Hicklin et al., 2018). The perception of the population on the risk associated with gas stations has been studied before, also with analysis of differences between specific groups of population (Cezar-Vaz et al., 2012).

Residential areas are a fundamental component of cities, and in the case of Bucharest they are characterized by a high spatial and temporal dynamic in past three decades (Niţă, 2012). Residential areas are urban tissues which express the interactions between social, economic, ecologic and historical factors, with a high capacity of transforming land uses and functions especially in the periphery of cities (Zotic et al., 2010). Residential areas are represented therefore by a mixture of housing, urban infrastructures, green spaces, administrative areas, commercial and small industrial activities (Iojă et al., 2012).

Residential areas are characterized by a high complexity from a social and economic perspective, determined by the diversity of relations they establish with both the physical features of the space and the social communities inhabiting the area (Ianoş, 2008). One of the significant social changes is represented by the shift of proportions, with nowadays more people living in cities than in rural areas (Lombard, 2015). The higher concentration of urban population leads to the emergence of environmental conflicts which can be also represented as incompatibilities between objectives or needs of the population (Lutz, 2008), or even between specific urban functions such as residential areas and gas stations. This phenomenon comes with profound implications on the urban planning process (Rincon et al., 2019), aiming to balance between such functions and objectives of urban stakeholders and reduced the emergence of locational conflicts.

Starting from the known influence of gas stations in cities, the present study aims to analyze their spatial distribution in Sector 4 of Bucharest, and the distance between gas stations and areas in proximity (especially residential areas) as foreseen in the legislation (Douti et al., 2019). In the present study we approach aspects related to the perception of the population regarding potential negative effects induced by the gas stations on residential areas. We selected the case study of Sector 4 – Bucharest, as it contains a wide range of urban functional areas and a diversity of residential areas associated or not with gas stations. The population of the area is continuously increasing, and the consumption pattern is still very much car-oriented, requiring the presence of gas stations at reasonable distances.

Methodology

Study area

Situated in the south-eastern part of Bucharest (Fig. 1), Sector 4 stretches from the city center to the outskirts of the city. It has a surface of 32 km2 (from the total 228 of Bucharest) and is home to 258,000 inhabitants (representing 15.58% of the total population of Bucharest) (Sector 4 City Hall, 2016). Sector 4 includes seven categories of urban functional areas (Mirea et al., 2012); the highest percent being occupied by continuous urban fabric (37%). Residential areas are concentrated in the central and north sections of the Sector, which also has a diversity of green spaces (e.g., urban parks - Tineretului and Carol, urban protected area – Vacaresti Natural Park), water bodies (Dambovita represents the northern limit of the area), but also industrial and commercial areas. Similar to other cities of Romania, it has challenges balancing between public transportation and private car transportation (Iordache, 2009).

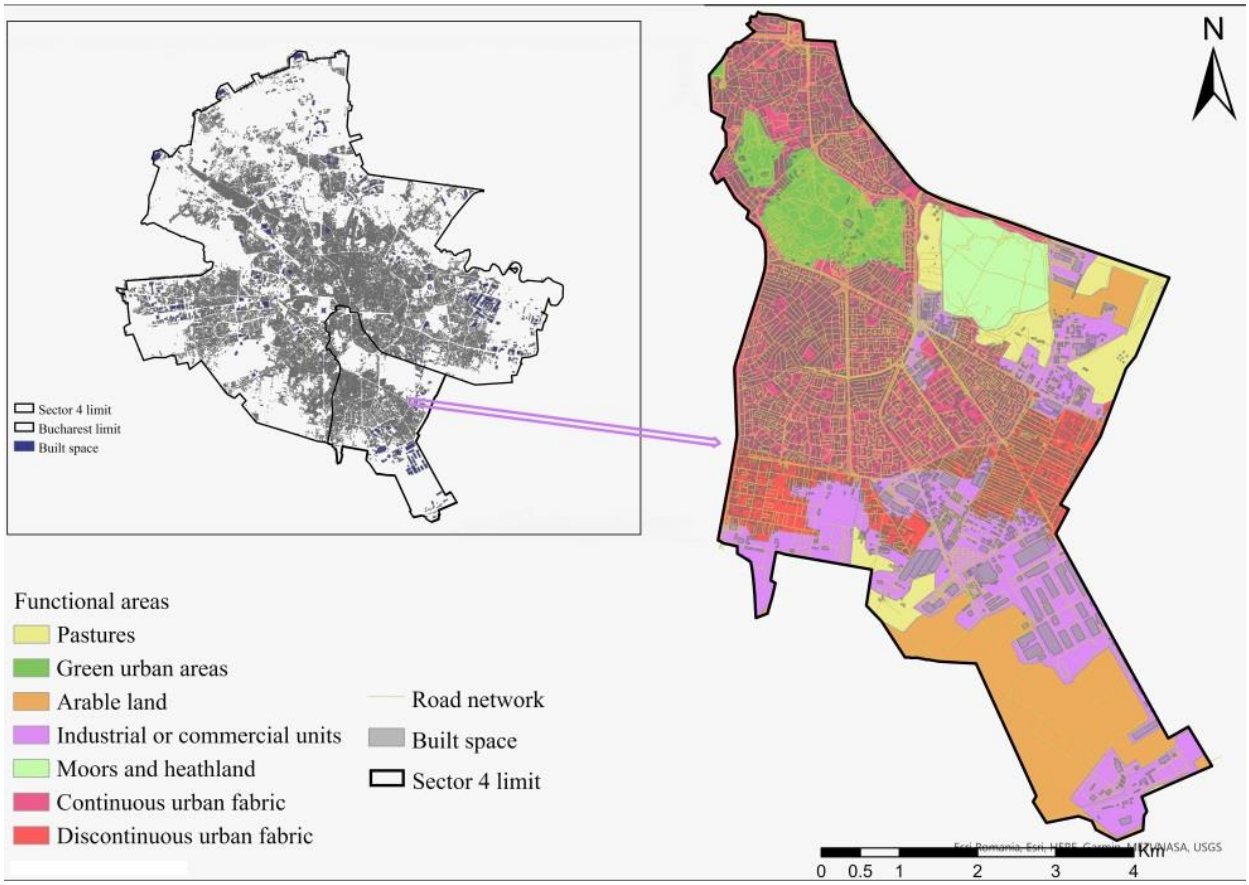

Fig. 1: **Functional areas of Sector 4 and its location in Bucharest**

Data collection and analysis

The database of the current study is resulted from two main sections (Fig. 2). The first one corresponds to information extracted from public access databases, such as Open Street Maps and shape files downloaded from geospatial.ro, and which represent the cartographic background for the analysis. The second section is represented by data produced in the study, which include: (i) 31 field observations applied for each gas station in February – April 2020, using a standardized observation sheet in Survey 123; (ii) 120 questionnaires applied online using Google forms between March and June 2020, of which 31 responses from people living in Sector 4 and 89 from other inhabitants of Bucharest.

For analyzing data, we used the following software: (i) ArcGIS Pro for realizing spatial singular and buffer analysis, as well as mapping information of the study (Pan & Zhou, 2018); (ii) Microsoft Office Excel for data centralization and graphical representation; (iii) R-Studio for the Canonical Correspondence Analysis (CCA). Singular spatial analysis made use of items resulted from the observation sheets. Buffer analysis was realized to verify the correspondence with the norms of Order 173/N from 5.10.1999 of M.L.P.A.T. and Government Decision No. 125/ 2004 (Ministry of Public Works and Spatial Planning).

The statistical multivariate method of canonical correspondence (Canonical Correspondence Analysis - CCA) uses binary qualitative data, and according to their role in the analysis, they are grouped into explanatory and response variables (Pătru-Stupariu et al., 2019). The data used for this analysis are derived from the questionnaire, which included 14 items with closed answers. We have grouped data according to two categories of actors: inhabitants from Sector 4 and those from the rest of Bucharest. Explanatory variables are represented by the distance between the residence of the respondent and a gas station: small distance (100-500 m), average distance (500-1000 m) and large distance (over 1000 m). The responses taken into analysis refer to the potential effects perceived from gas stations, but also their level of acceptance of gas station at various distances from their housing.

Forum geografic. Studii și cercetări de geografie și protecția mediului
Volume **XX**, Issue **1** (**June 2021**), pp.**34-42**
http://dx.doi.org/**10.5775/fg.2021.032.i**

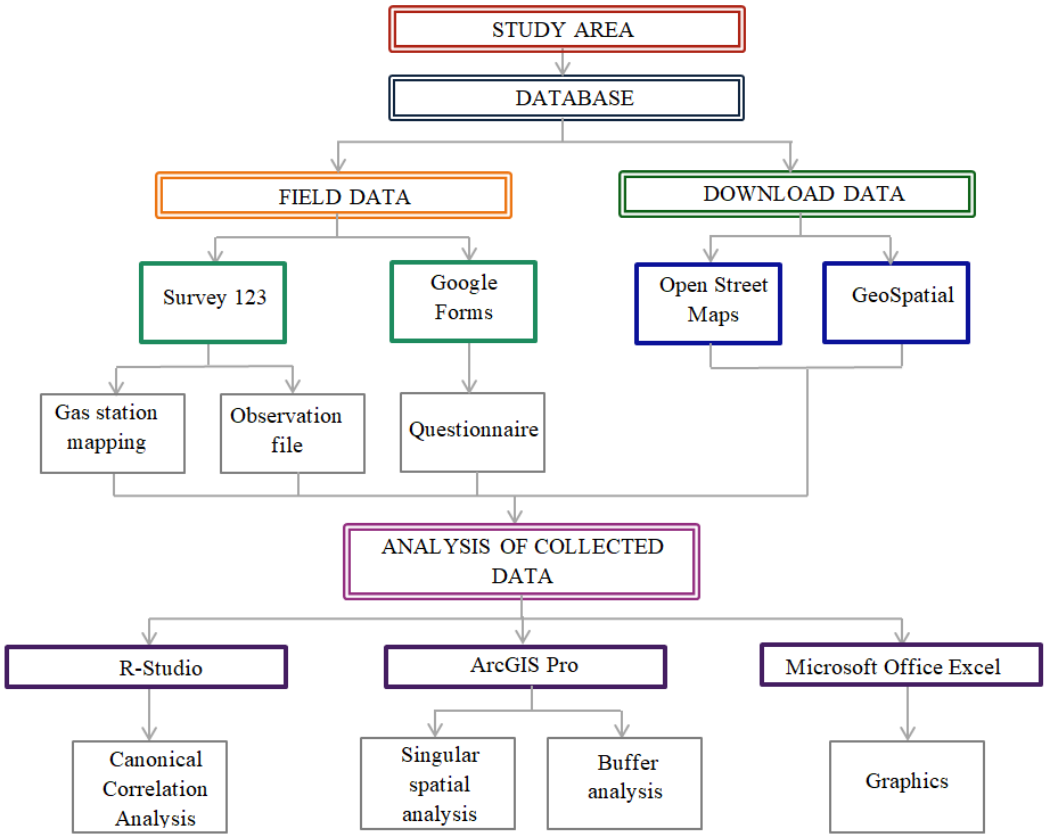

Fig. 2: Methodological flow of work for the current study

Results

Distribution and characteristics of gas stations

Gas stations from Sector 4 are not distributed uniform, most of them being position along the major roads of the area. From a total number of 31 gas stations only 7 are found in collective residential areas. The south of the Sector (which is the peripheral area) has a higher proportion of gas stations (Fig. 3).

For the analysis of the vegetation present in each gas station, we awarded scores from 1 to 5 in the observation sheets (where 1 - absence or precarious vegetation and 5 – vegetation in very good structure and quality). The average value for all the gas stations was of 2.9. In gas stations, the vegetation is represented by floral arrangements, trees, shrubs, grass and hedges. The most representative type of vegetation met within 21 gas stations are shrubs. In the majority of the cases, the vegetation is placed at the margins of the gas stations emplacement, there being said, there are situations in which hedges represent their very boundary.

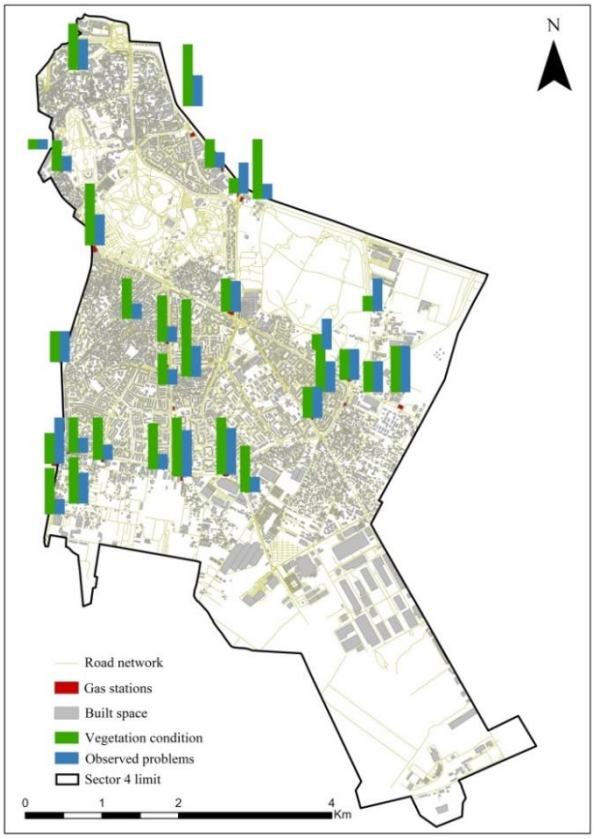

Fig. 3: Vegetation and problems observed in the analyzed gas stations

The most encountered problems in on-field observations are represented by unpleasant odors, presence of wastes, fuel leaks (with an average presence of 70%). We observed a strong correlation between the presence of higher quality vegetation and a reduced proportion of signaled problems. The values given to the problems encountered in the majority of the gas stations are assigned according to the direct situation observed from the field. Also, we can see that the problem is getting worse if the incidence is taken into account and applied to the number of gas stations in the studied area.

According to present legislation in Romania, gas stations should be emplaced according to the limits imposed by the legislation (Government Decision 125/2004). We found frequent differences from the regulations in the case of the distance to the intersection, residential areas and public transportation (Table 1), demonstrating a deficient emplacement of gas stations.

Examining the minimum safety distance between gas stations and intersections of the main roads, 13 gas stations are situated at a smaller distance (the lowest value being of only 5 meters) (Fig. 4). The field observations on the distances between gas stations and residential areas showed that almost half of them are situated closer than the minimum distance of 25 m in the legislation. Some of the gas stations are situated at fewer than 10 m from residential areas, with significant higher risks in their case. The position of gas stations in relation to public transportation presents a similar situation. From the total number of 31 gas stations, 19 are found closer than the limits set out by the legislation. For all of the three above aspects we also found gas stations which fulfill all of the legal requirements.

Table 1 Differences between minimum distances in the legislation and field observations

Emplacement	Legislation	Field observations distances		
		Min.	Max.	Median
Intersection	> 100 m	5 m	230 m	100 m
Residential space	> 25 m	10 m	50 m	30 m
Public transportation	> 10 m	1 m	50 m	10 m

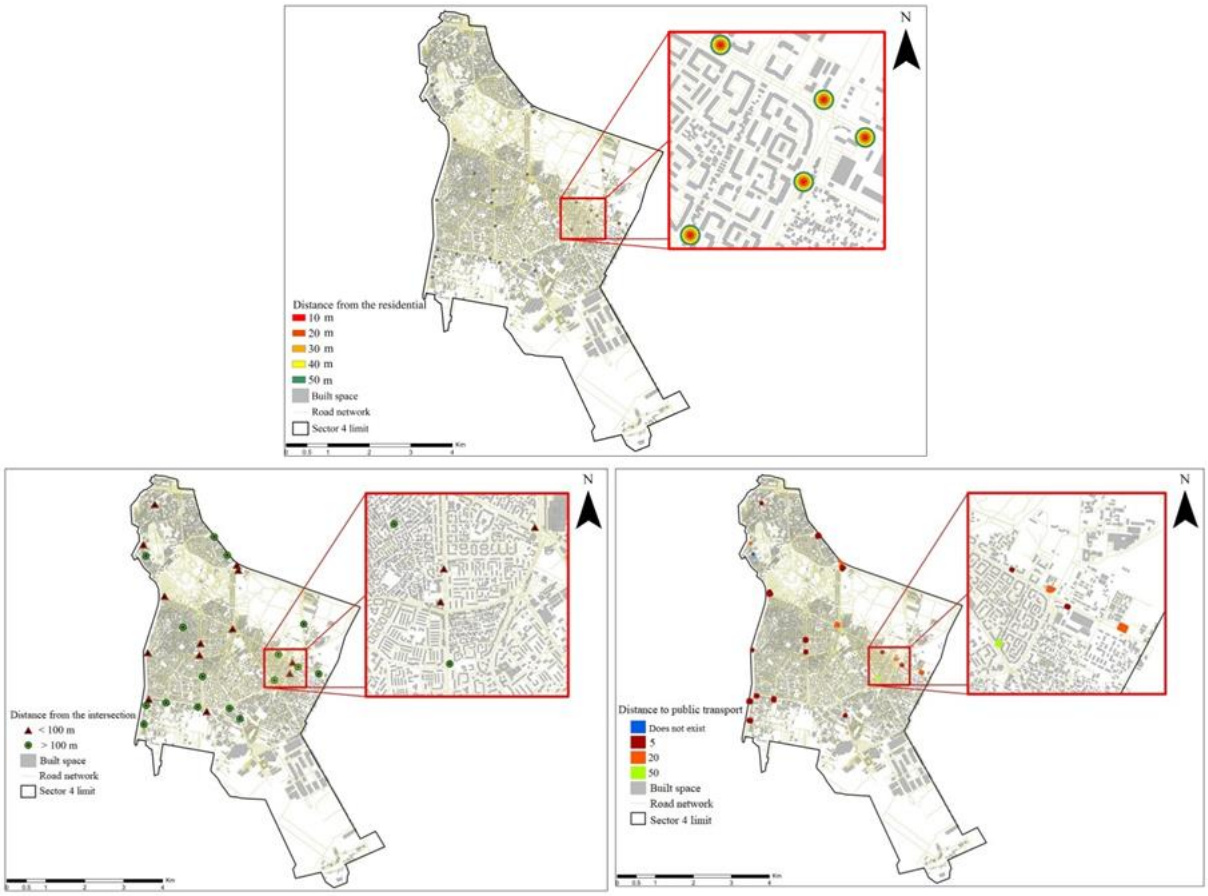

Fig. 4: Distances between gas stations and: a) intersection, b) residential areas, c) public transportation

Forum geografic. Studii și cercetări de geografie și protecția mediului
Volume **XX**, Issue **1** (**June 2021**), pp.**34-42**
http://dx.doi.org/**10.5775/fg.2021.032.i**

Perception analysis

An important role is played by the variable address of the respondent, after which we were able to spatialize their distribution in the study area. We found their residence to be distributed randomly in Bucharest, but with a higher concentration in Sector 4 (Fig. 5). In Bucharest, most of the respondents own a personal car, therefore gas stations are indispensable for their transportation. A smaller proportion of people prefer public transportation or alternatives such as bicycles or skateboards, which is consistent with other studies (Niţă et al., 2018).

Considering the necessity of gas stations in such a car-oriented city, we found their acceptance among the population to be divided into three main categories: those who approve to their presence, those who oppose them and those without a clear opinion. 48% of the respondents are against the presence of gas stations in residential areas and expressed their concerns about the associated negative effects and potential risks.

In addition, perceptions can be different according to the distance from the residence to gas stations. We used three intervals to test (100-500m, 500-1000m and over 1000m) to test if the distance really is an influence factor in the perception of the public from Bucharest and from Sector 4 (Fig. 6).

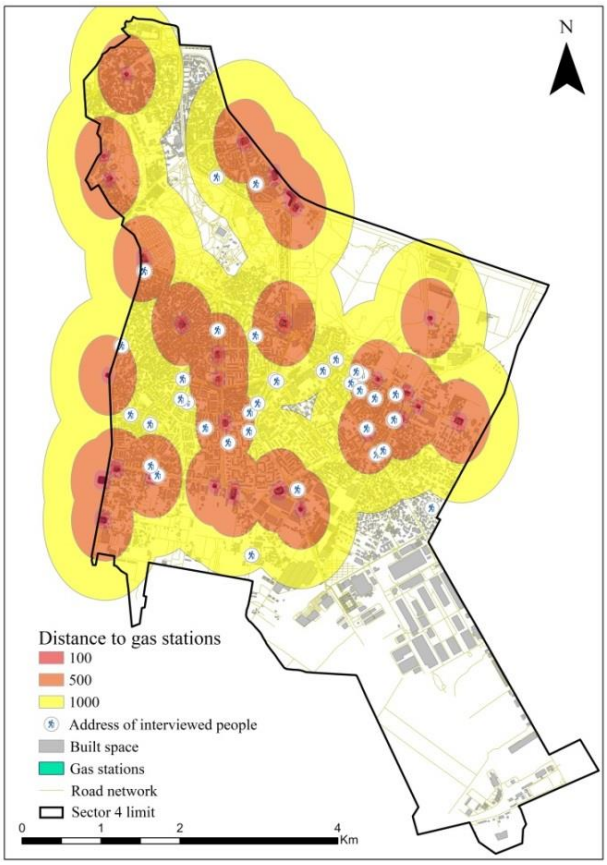

Fig. 5: Buffer analysis between the residence of respondents and gas stations

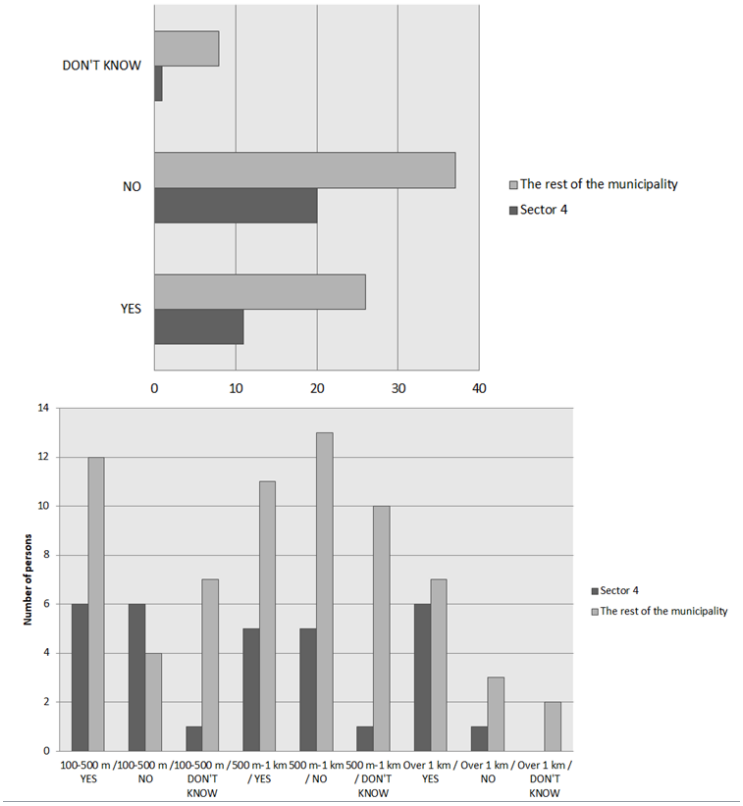

Fig. 6: Acceptance of gas stations in residential areas (above) and potential risks in the perspective of residents according to the distance to gas stations (below)

In the closest intervals (100-500m and 500-1000), there is a higher proportion of those perceiving associated risks with gas stations (64%) and those who are not, with differences between population in Sector 4 and overall Bucharest (more sensitive). It is a strange result that the highest proportions of perceived risks associated with gas station come from residents at over 1000m, a possible explanation being the theoretical perception of negative effects rather than daily experiences.

The multivariate statistical method of canonic correspondence reveals the perception of population regarding the main problems associated with gas stations in residential areas, according to the distance between the two functions (Fig. 7). The green dots in the graph represent residents of Sector 4 and the red ones those from the rest of Bucharest. The variables V8, V2, V4 positioned centrally are the most representative according to the distance from gas stations.

Most people do not agree with the presence of gas stations in residential areas or other public spaces, perceiving a potential risk associated with them, and considering gas stations should be farther away from their residences. V3 and V9 are the outside variables, possible due to the fact that respondents are unaware of the risks associated with gas stations, and therefore select the "I do not know" answer.

DFN1 represents the closest distance to the previously presented variables (V8, V2, V4), thus respondents are living between 100 – 500 meters from a gas station. This underlines that the distance is in concordance with an awareness of the potential effects of gas stations on residential areas, and aspect underlined by results of the CCA. The highest proportion of risk awareness is specific to the variable V4, situated at a distance of 100 – 500 m.

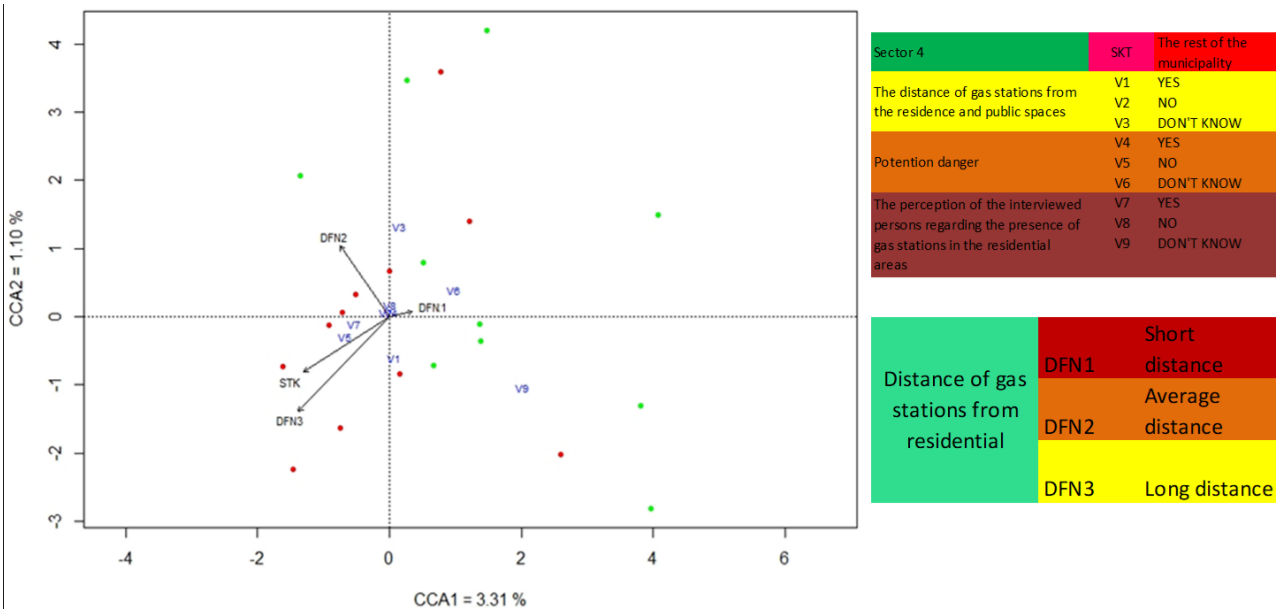

Fig. 7: Results of the Canonical Correspondence Analysis

Discussion and conclusion

In the other studies (Peprah et al., 2018), the main subject is about the indispensability of gas stations in the current society, thus being realized a spatial analysis between filling stations and public facilities with the help of GIS software.

The results of this paper show that the majority of gas stations are positioned along the main highways, not always complying with the law. Starting from this analysis, we did another analysis of 3 separate situations, all regarding the distance of gas stations from certain places.

Likewise, we considered the study entitled "Effect of leaking natural gas on soil and vegetation in urban areas", in which they analyzed problems regarding leaking of natural gases from the distribution system that can affect the chemical, physical and biological processes of the soil. As results, they implemented special measures to accelerate the regeneration of the soil, inclusive the present vegetation, so they decided to plant new trees and also to install ventilation channels in the soil. We concluded that the vegetation has an important role in reducing the problems associated with gas stations by pointing out the connection between them (Hoeks, 1972).

The field observation sheet is one of the simplest and easiest ways of data collection, based on our

direct approach of the gas stations, and providing us with reliable data with a spatial dimension. The precision of data is rather high and they provided information not influenced by perception (as in the case of the questionnaire). We have not encountered issues with access to locations in which to apply our field observations, as all of the gas stations are with public access.

As for the questionnaire, we found the method easy to use (especially as we applied it online), but in the same time we had little to no control in selecting a targeted audience for responses. The online approach allowed us to reach a higher community of people in a shorter time, but in the same time we had similar age and educational profiles of respondents.

In assessing the characteristics of fuel stations, we observed a strong relation between the presence of healthy vegetation and reduced environmental problems perceived by the population. In addition, by assessing the potential effects received by the population, they acknowledged distance as a main criterion associated with the presence of threats. Although we encountered a significant number of gas stations in Sector 4 of Bucharest which are not in total conformation with the existing regulations, they are perceived as a necessity by the population.

Our study reveals that 85% of gas stations in Sector 4 are found in the close proximity of residential areas. A high proportion of the inhabitants are aware of the potential risks associated with gas stations, the rest being undecided. Even though most of the gas stations are not abiding the minimum safety distances from the legislation, their functioning is continuing and deemed as important for the mobility in Bucharest.

In the future, we will continue our study by measuring Volatile Organic Compounds (VOCs) from gas stations areas, and improving the knowledge on direct possible effects. Concentrations of substances will allow us to asses the risks to which employers, clients and local residents are exposed. We will also increase the sample size of our questionnaire and make field observations to gas stations in the rest of Sectors in Bucharest. We consider such results to be of high importance to urban planners and decision-makers in their efforts of improving the quality of life and wellbeing in cities.

Acknowledgements

This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS/CCCDI – UEFISCDI, project number PN-III-P1-1.1-TE-2019-0316, within PNCDI III - Evaluating the role of nature-based innovations for healthy cities.

References

Abdullahi, M., & Dawha, E. (2015). Environmental Effects of Petrol Stations at Close Proximities to Residential Buildings in Maiduguri and Jere, Borno State, Nigeria. *Journal Of Humanities And Social Science*, 20(4), 1-8.

Ahmed, M., Hutty, M., Shariff, A., & Khamidi, M. (2011). Petrol Fuel Station Safety and Risk Assessment Framework. doi:10.1109/NatPC.2011.6136346

Cezar-Vaz, M., Rocha, L., Bonow, C., Santos da Silva, M., Cezar-Vaz, J., & Cardoso, L. (2012). Risk Perception and Occupational Accidents: A Study of Gas Station Workers in Southern Brazil. *International Journal of Environmental Research and Public Health*, 2363-2377. doi: 10.3390/ijerph9072362

Cramer, C. (2005). *Fill 'er up: the rehabilitation of early twentieth century gas stations*. Athens: The University of Georgia. Retrieved from https://getd.libs.uga.edu/pdfs/cramer_evan_c_200512_mhp.pdf

Douti, N., Abanyie, S., Ampofo, S., & Amuah, E. (2019). Spatial distribution and operations of petrol stations in the Kassena-Nankana district (Ghana) and associated health and safety hazards. *Journal of Toxicology and Environmental Health Sciences*, 50-61. doi:10.5897/JTEHS2018.0420

Government Decision No.195/2004. The location regime of the fuel distribution station for refueling vehicles in Bucharest. *Government Decision No. 195/2004 regarding "The location regime of the fuel distribution station for refueling vehicles in Bucharest"*. Local Council of the Municipality of Bucharest, Bucharest.

Hicklin, W., Farrugia, P., & Sinagra, E. (2018). Investigations of VOCs in and around buildings close to service stations. *Atmospheric environment*, 172, 93-101. doi:https://doi.org/10.1016/j.atmosenv.2017.10.012

Hoeks, J. (1972). *Effect of leaking natural gas on soil and vegetation in urban area*. Wageningen: Centre for Agricultural Publishing and Documentation.

Ianoş, I. (2008). A Major Challenge for Romanian Towns: The large habitats. In G. M. Pomeroy, *Global perspectives on organization* (pp. 106-135). Pennsylvania: University Press of America.

Iojă, C. I., & Tudor, C. A. (2012). Temporal Analysis of Incompatible Land-Use and Land-Cover: The Proximity between Residential Areas and Gas Stations in Bucharest Suburban Area. *Procedia enviromental Sciences*, 14, 49-58. doi:https://doi.org/10.1016/j.proenv.2012.03.006

Iojă, C., & Tudor, A. C. (2012). Temporal Analysis of Incompatible Land-Use and Land-Cover: The

Proximity between Residential Areas and Gas Stations in Bucharest Suburban Area. *Procedia Enviromental Sciences*, 14, 49-58. doi:https://doi.org/10.1016/j.proenv.2012.03.006

Iojă, C., Niţă, M., Rozylowicz, L., Pătroescu, M., Iojă, A., & Pătroescu-Klotz, I. (2012). Evaluarea integrata a starii mediului in spatii rezidentiale. Bucuresti: Editura Academia Română. doi:10.13140/2.1.3408.0327

Iordache, C. (2009). The Evolution of the Urban Public Transport During the 1950-2006 Period in Romania. *Forum Geografic*, VIII, 108-115. Retrieved from http://forumgeografic.ro/2009/258/

Lombard, M. (2015). Land conflict in peri-urban areas:Exploring the effects of land reformon informal settlement in Mexico. *Special issue article: Urban land and conflict in the Global South*, 2701-2719. doi:10.1177/0042098015603569

Lutz, S. (2008). *Conflict management in urban areas*. Eschborn: Crisis prevention and conflict management. Retrieved from https://www.ip-consult.de/fileadmin/Media/Publications/IPDigest/ip-digest-04-2008.pdf

Makarova, I., Shubenkova, K., & Gabsalikhova, L. (2017). Analysis of the city transport system's development strategy design principles with account of risks and specific features of spatial development. *Transport problems*, 12(1), 125-138. doi:10.20858/tp.2017.12.1.12

Ministry of Public Works and Spatial Planning. *Norm for the design, execution and operation of liquefied petroleum gas supply systems (G.P.L.) for motor vehicles, indicative NP-037/99, of 05.10.1999*. Institute of design, research and computer technique in constructions IPCT - S.A. Bucharest, Bucharest.

Mirea, D. A., Vânău, G., Niculae, M. I., & Dincă, C. (2012). Industrial landscape expansion and evolution in Bucharest's District 4. *Forum Geografic*, XI, 26-35. doi:10.5775/fg.2067-4635.2012.022.i

Museum of Romanian Oil Industry. (2018, 12 1). *Romanian oil industry*: History. Retrieved 4 5, 2021, from Hororary Consultate of Romania: http://www.roconsulboston.com/Pages/InfoPages/Commentary/OilRoHistory.html

Nieminen, P. (2005). *Environmental protection standards at petrol stations: A comparative study between Finland and selected European countries.* Tampere: University of tehnology.

Niţă, M. R. (2012). Mapping Favorability for Residential Development. Case Study: Bucharest Metropolitan Area. *Procedia enviromental sciences*, 14, 59-70. doi:https://doi.org/10.1016/j.proenv.2012.03.007

Niţă, M. R., Badiu, D. L., Onose, D. A., Gavrilidis, A. A., Grădinaru, S. R., Năstase, I. I., & Lafortezza, R. (2018). Using local knowledge and sustainable transport to promote a greener city: The case of Bucharest, Romania. *Enviromental Research*, 160, 331-338. doi:https://doi.org/10.1016/j.envres.2017.10.007

Pan, Q., & Zhou, G. (2018). A buffer analysis based on co-location algorithm. *Remote Sensing and Spatial Information Sciences*, 2487-2490. doi:10.5194/isprs-archives-XLII-3-2487-2018

Pătru-Stupariu, I., Pascu, M., & Burgi, M. (2019). Exploring Tangible and Intangible Heritage and its Resilience as a Basis to Understand the Cultural Landscapes of Saxon Communities in Southern Transylvania (Romania). *Sustainability*, 2-18. doi:10.3390/su11113102

Peprah, M., Boye, C., Larbi, E., & Appau, P. (2018). Suitability analysis for siting oil and gas filling stations using multi-criteria decision analysis and GIS approach – A case study in Tarkwa and its environs. *Journal of Geomatics*, 158-166.

Rincon, V., Alier, J., & Mingorria, S. (2019). Environmental Conflicts Related to Urban Expansion Involving Agrarian Communities in Central Mexico. *Sustainability*, 2-19. doi: https://doi.org/10.3390/su11236545

Sector 4 City Hall. (2016). *The general urban plan of the municipality of Bucharest*. Bucharest: Sector 4 local council. Retrieved from https://www.ps4.ro/

Thales Botelho, D. (2015). Environmental Impacts Management of a Brazilian Gas Station: A Case Study. *Global Journal of Researches in Engineering: Industrial Engineering*, 15(3), 22-32.

Thomas Kweku, T., Chanda, S., & Blessings, C. (2016). Public Perceptions on Location of Filling Stations in the City of Kitwe in Zambia. *Developing Country Studies*, 133-151.

Zotic, V., Alexandru, E., & Puiu, V. (2010). Functional Zoning of the City/Village Area and Its Contribution to the Sustainable Development of Settlements. *Journal of Settlements and Spatial Planning*, 1, 181-189. Retrieved from https://geografie.ubbcluj.ro/ccau/articoleCCAU/A_07_CCAU.pdf