



Evaluation of Odours Perception by Residents of the Municipality of Toledo/Paraná State/Brazil

**Jéssica Manfrin^{1*}, Arthur Felipe Feuchard Linhares Ceraso²
and Affonso Celso Gonçalves Jr.¹**

¹Post Graduate Program in Agronomy, State University of Western Paraná (Unioeste), Marechal Cândido Rondon, State of Paraná, Pernambuco Street, n° 1777, Brazil.

²Post Graduate Program in Bioenergy, Federal University of Paraná (UFPR), Palotina, State of Paraná, Pioneiro Street, n° 2153, Brazil.

Authors' contributions

This work was carried out in collaboration between all authors. Author JM designed the study, performed the analysis of the data, wrote the methodology and wrote the first draft of the manuscript. Authors AFFLC and ACGJ managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Air pollution is responsible for numerous discomforts and health problems in humans, and it can be observed in large urban centres and small towns. The present study aimed to evaluate the perception of odours by residents of the municipality of Toledo, located in Paraná State, South region of Brazil.

Study Design: The study was based on a questionnaire and a perception of the residents.

Place and Duration of Study: The study was conducted in the city of Toledo/PR/Brazil and all the procedures were realised in two months.

Methodology: To achieve the objectives, the municipality of Toledo was divided into four quadrants that housed 20 potential sources of odour emission. In each of the quadrants, 25 residents were randomly interviewed using pre-established questionnaires.

Results: From the answers given by the residents and after the tabulation of the results, it was

*Corresponding author: E-mail: jessicamanfrinn@gmail.com, jessicamanfrinn@hotmail.com;

verified that the presence of odours in the municipality was verified by 87% of the interviewees. Among whom they stated that the odours are responsible for some type of physical discomfort (43% of appetite due to odours) and even psychological (44% stated that odours present in the municipality cause stress). Through the interviews it was possible to confirm some sources of possible odour emission, however, there is a need for further studies and monitoring of the air quality in the municipality so that the emitting sources will be identified.

Conclusion: The residents of all quadrants studied in Toledo city observed odours in the city; also, they evidence the problems that are caused by them, what needs some concern of the municipal government. During the research, it was identified the need for further studies on this topic considering that it is a poorly studied area and that there is a need for regulations and methodologies to assist in the identification of pollutant sources.

Keywords: Air pollution; pollution sources; monitoring of the air; urban aspects; participatory monitoring.

1. INTRODUCTION

Air pollution can be originate from a wide range of natural and sources from human activities. It is responsible for discomfort and health problems that can be observed in large urban centres and in small towns. Among the main anthropic sources of odours are industries and agroindustries, such as food processing, beverages, feed, waste treatment plants, landfills, and dumps, among others [1].

In the face of air pollutants and their perception, odours are among the most noticeable atmospheric pollution manifestations, being them sources of frequent complaints in regulatory agencies and public departments. In spite of the numerous problems caused by the emission of odours, there is a great difficulty on the part of environmental agencies to regulate standards of emissions and to identify the generating sources, since odours are considered subjective [2].

The impacts that can be caused by odours vary from the discomfort of the population that receive it as well as being responsible for physical problems, such as nausea, vomiting, headaches, cough, sleep and appetite disorders, irritation of the eyes, nose and throat, restlessness, sadness and depression, among others [2]. Odours may also be responsible for the depreciation of property values, decline in tax collection and sales [3].

Odour pollution is little studied and it still insufficiently known in Brazil and even in the world. Only a few countries have discussed this form of pollution in their legislation, seeking to elaborate regulations and methodologies that relate air pollution to the level of discomfort caused in the population. Among these

countries, it is possible to cite Germany, the United States of America, Canada, France, Denmark, Netherlands and the United Kingdom [2,4].

The municipality of Toledo, located in the west of the State of Paraná is known nationally due to the high agricultural and industrial production. In terms of agricultural activity, the municipality has achieved the first place in agricultural gross domestic product (GDP) into Paraná State and the southern region. The city has 6,200 rural properties throughout its territory, is considerate the first place in swineherd, second place in chicken production and fifth largest milk producer in Paraná. In addition, the largest slaughterhouse of pigs and poultry in Latin America is installed in the municipality. Regarding industrial activity, the municipality provides the largest industrial park in Paraná State and counts with the presence of 731 industries in its territory [5].

However, despite having a well-structured economy, the municipality faces daily odours problems. The region's communication media often disclose the nuisance suffered by the Toledo population [6,7].

In view of the above, the present study aimed to evaluate the perception of odours by residents of the urban area of the city of Toledo – Paraná State, Brazil through interviews and questionnaires in order to verify the impact that odours exert on the municipality.

2. MATERIALS AND METHODS

The city of Toledo is located under the geographical coordinates 24.7254° S and 53.7420° W, with a total area of 1,197.016 km², and 133,824 residents in urban and rural area. In

order to systematise the information collection, the urban area of the municipality of Toledo was divided into four quadrants (Quadrant A, Quadrant B, Quadrant C and Quadrant D). The quadrants were idealised just to facilitate the application of the questionnaires and the discussion of the results. In each of the quadrants were identified possible points of emission of odours, totalling 20 sample points, as shown in Fig. 1. It is important to mention that during the interviews the potential sources of odours identified in the Fig. 1 in which quadrant was not presented to residents so as not to influence possible responses.

In order to collect data about the perception of the population in relation to odours in the city of Toledo, a questionnaire was drawn up containing questions with multiple choices of answers; the questionnaire is presented in Appendix 1. The interviews for completing the questionnaire were done at different times and weekdays, in order to serve all adult audiences (over 16 years old) [8].

Five questionnaires were applied per potential odour generation point identified, totalling 100 questionnaires.

3. RESULTS AND DISCUSSION

The 20 potential points identified by the authors were identified considering the possible activity that they are inserted. The literature presents that the major problems of atmospheric pollution in cities are caused by agroindustrial activities [9], the presence of industries [10], wastewater treatment plants [11], dumps and landfills [12], and others

From the application of the questionnaires it was found that the overall average of the dwelling time in the same place by the residents was 8.3 years, ranging from 6.7 years in the A quadrant to 10.3 years in the B quadrant. The dwelling time by the residents in the same address is critical to ensure that the answers given are actually related to the current residence and not

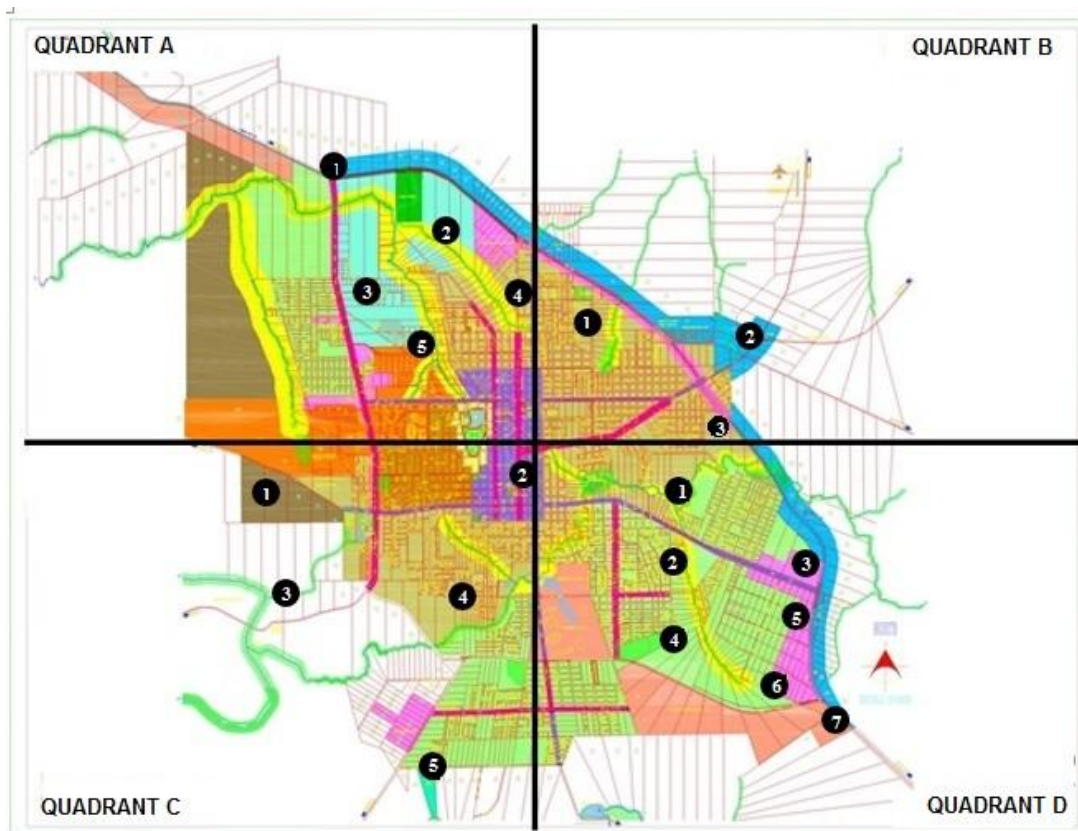


Fig. 1. Map of the municipality of Toledo with the systematised division for the collection of information about odours

to another location, and in function of this the individual have been witnessed a lot of situations with or without odours. In addition, during the application of the interviews, respondents were instructed to answer questions based on experiences found at their place of residence since, at mentioned before, this factor is very important in the evaluation of the perception [13].

In this sense, also mentioned above, the average of 8.3 years of residence time by Toledo residents is very important factor and considered interesting, since the residents have already witnessed different seasons and weather

conditions, which probably influences in the odour conditions.

When questioned about if they were smokers or not, only 2.75% of the interviewed said they smoked, and only 3% of the participants reported having olfactory disease (allergic rhinitis), and in this case the results obtained by residents with this healthy conditions were not considered in the study, since they can have a different perception of the odours. In addition, the olfactory disease reported by the residents was not related to the presence of odours, since this healthy problem can be originated from other factors.

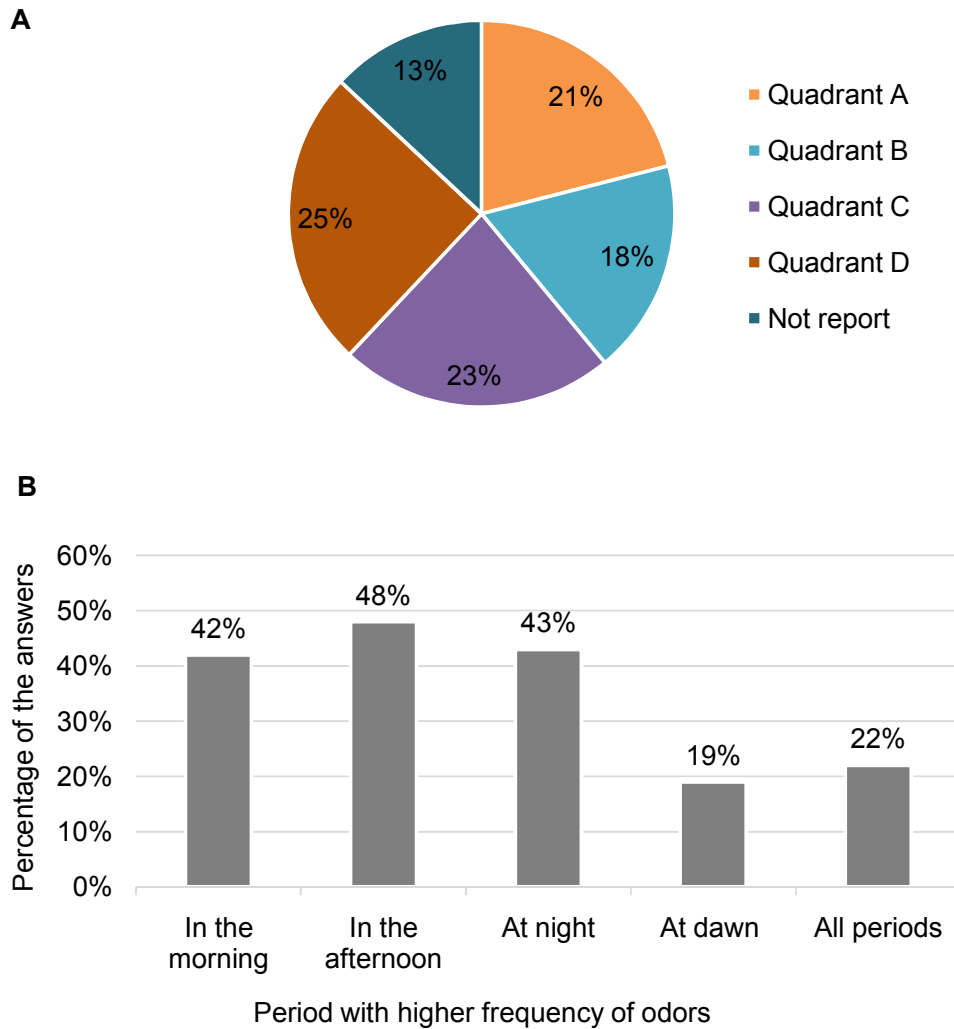


Fig. 2. Image A: Perception of the interviewees in relation to the odours in the city of Toledo/PR/Brazil. Image B: Perception of the interviewees in relation oh which periods they fell the odours

Regarding the interviewees' perception of odours, when questioned about having already felt some uncomfortable odour in their home, respondents were instructed to respond if they observed any perception of odours in the last years, regardless of origin. Among 100 interviewees, 87% reported feeling some kind of annoying odour, and 13% did not report, as presented in Fig. 2, Image A. In terms of which periods of unpleasant odours are more frequent, it can be observed in Fig. 2, Image B, that the period most evidenced by the interviewees was the afternoon period (48%), followed by the night period (43%), and last at dawn (19%).

Fig. 3 presents the odours perceived by the interviewed. Considering the systematisation of the work and ascertainment of the possible sources of odour emission in the municipality, interviewees belonging to Quadrant A more frequently associated the perceived odour to the odours of manure/ fertiliser (33%) and smoke (30%). The points identified as potential odour emission points in Quadrant A include a large agroindustrial cooperative - with large vehicles moving and the exit of the urban area for several districts and rural area of the municipality. In this sense, the observed results corroborate with the possible emission sources.

Respondents belonging to Quadrant B more frequently associated the perceived odour to manure/ fertiliser odours (32%), the same interviewees also related to the higher incidence of odours in periods with the intense wind. The points identified as potential points of odour emission in Quadrant B include a pharmaceutical industry, the proximity to the agricultural area, and proximity to another large agroindustrial industry. The perception of odours related to manure/ fertiliser and the relationship with strong winds can make it easier for wind currents to dissipate odours of that type in that region, in addition, none of those interviewed in that region complained of odours that could be associated with the pharmaceutical industry.

The points of potential odour emission in Quadrant C include a poultry and pork slaughterhouse, dairy industry, breeding and fish slaughterhouse. The interviewees in this region showed and associated high odours indexes with putrefaction characteristics (64%) and sewage (64%). Since this information, the respondents' reports are consistent with the potential sources of odour emission.

In a review of the problems generated by the treatment of slaughterhouse sewage, [14]

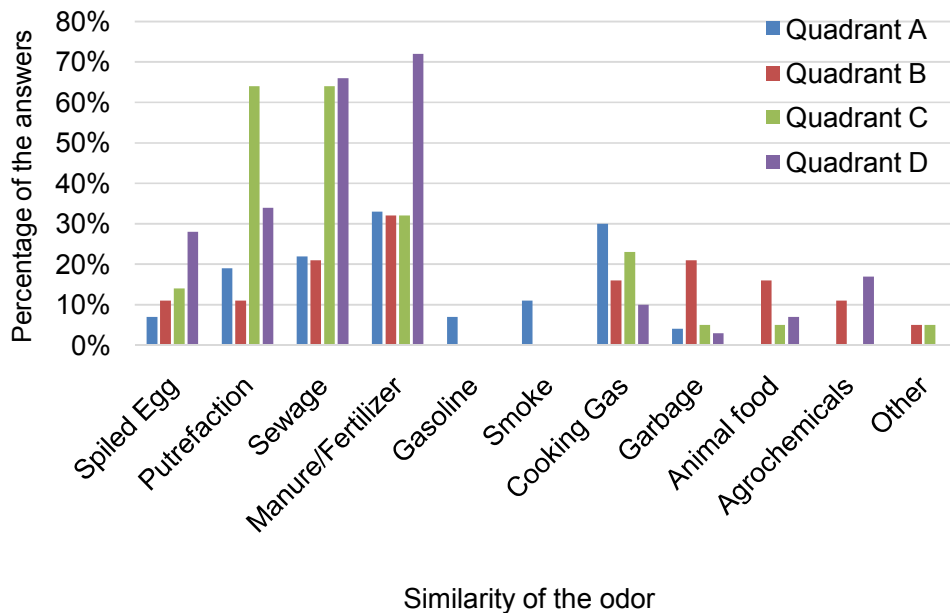


Fig. 3. Similarity of the odour felt by the interviewees in relation to the odours present in the municipality of Toledo / PR

present that there are many problems related of these systems, among them can be cited the proximity of the residences, because the odour generated can cause annoying in the people who live near of the industry. However, these authors also mentioned that there are some easy actions that can minimise the odours (constituted by sulfuric gas and produced by anaerobic bacteria), in the region. Among the techniques that can solve or reduce the problem is the natural coverage of the lagoon of sewage treatment, and in this way to improve the quality of the air in the region.

In Quadrant D the greatest similarities were observed to manure/ fertiliser (72%) and sewage (66%). It should be noted that in this region two-wastewater treatment plants, a brewing industry and a large cereal agro-industry are located. In relation to the similarities found in this quadrant, according to Archela et al. [15], usually the treatment system of urban sewage is characterised by bad odours. It happens because of the components of the sewage present high quantity of organic compounds that generate a great quantity of sulfites and sulfuric gas in their decomposition. Also, authors mentioned that industrial sewage present characteristics according to the industrial process, in this way the sewage generated by brewing industry presented characteristics of organic matter, which, as urban sewage, is composed by organic compounds and consequently, odours with sulfites and sulfuric gas.

Considering that this work approached the perception of the Toledo residents as a whole, the systematisation of the city in quadrants was idealised to help in the identification of the potential odours source. However, it is observed that the odours emitted by a determined pollution source may interfere in other quadrant. In this sense, may be some possibly odours felt by the residents in a determined quadrant can be originated in another.

Regarding the annoyances caused by odours, 78% of the respondents stated that they presented some discomfort attributed to odours in the municipality. Among the possibilities described, the most frequent complaints about the odours reported by the interviewees are stress (44%) and loss of appetite (43%) as shown in Fig. 4.

Regarding hedonics; that is the measure of pleasure or dislike of a sample of an odour, and

is independent of the character of an odour, 83% of respondents rated odours as unpleasant, 10% did not want to respond and 7% said they were indifferent. It is believed that daily exposure to odour made perception no longer considered a very unpleasant thing, a fact also observed and considered by Brandeburgo [13].

Regarding how often odours are perceived in the municipality, 78% of the respondents say they perceive the odours with a certain frequency, of which 48% affirm that periodically (3 to 5 days a week) they suffer some type of annoyance in function of the emissions. Alves et al. [16] comment on the presence of odours in urban centres and for the authors, it is a major problem in the cities nowadays. Since the cities concentrate many different activities, which can cause the generation of odours from various sources and different characteristics, but all of them can cause annoying in the population of the region.

When questioned about the sources of possible contamination, 58% of respondents stated that they did not know the source of the odour, the other 42% suggested private and public wastewater treatment industries and plants within the municipal urban area. The respondents also emphasised the fact that the agricultural production in the city was elevated and it is close to the urban area.

Due to the constancy of odours present in the municipality in November 2015, the first Workshop on Odour of Toledo city was held. The objective of the event was to bring together specialists in the subject, including other nationalities, in order to discuss and promote possible solutions to the odours arising from agroindustrial activities present in the municipality. Moreover, the objective of the event was to elaborate academic environment regulations and standards that could be applied in the municipality and in the entire state of Paraná [17].

The research on the perception of the population regarding the odour in the municipality, carried out in October 2016, and the reports and denunciations verified in the communication media of the region, show that despite efforts in the municipal government and other agencies have not yet been found solutions to the problems faced in the municipality, and that the difficulty of identifying the sources issuing is a reality. In addition, according Gouveia [18], the studies about the environment, such as odours,

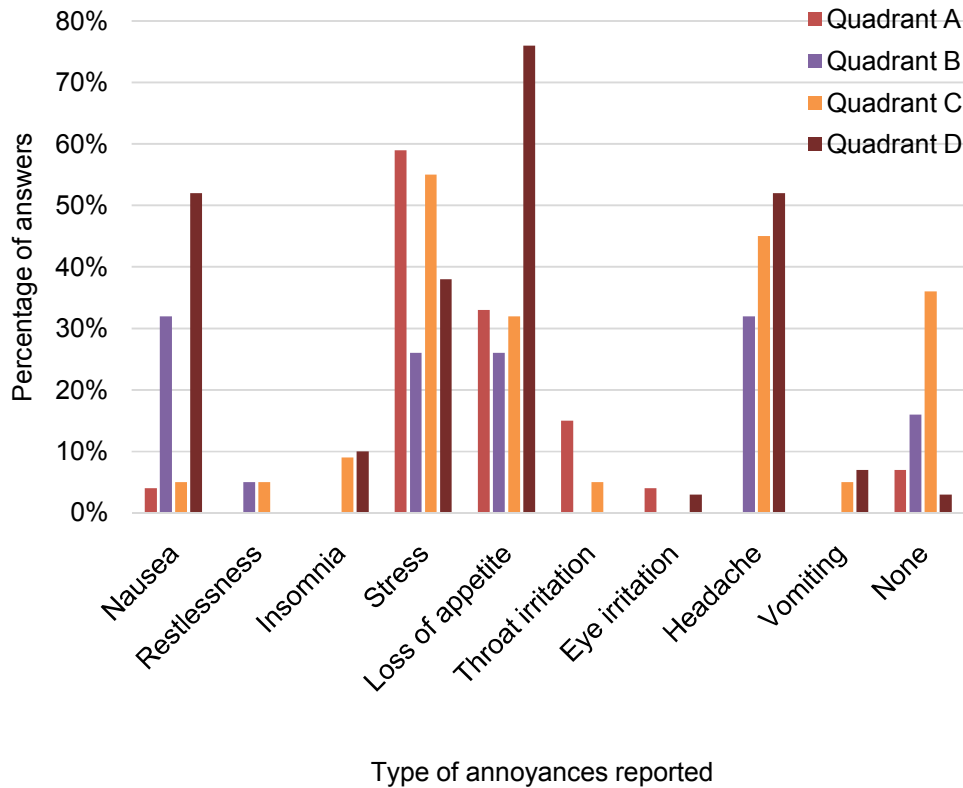


Fig. 4. Types of annoyances reported by the interviewees in relation to odours present in the municipality of Toledo / PR

represent a problem to the local government since it presents aspects hard to measure, and consequently, hard to provide some standards for the evaluation of it.

4. CONCLUSION

In view of the results observed in the application of the questionnaires, it is confirmed the intense presence of odours in the municipality of Toledo and the displeasure of the population in relation to this problem. However, it is suggested that new studies be conducted in the municipality, with the performance of the monitoring of air quality through continuous indicators that relate to meteorological conditions.

It was observed that scientific research on this subject is rare, which may make it difficult to elaborate public policies related to this and the development of methodologies and standards that assist in the process of regulating sources of odours.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Appendix 1. Survey questionnaire on the odours perception by residents of the city of Toledo/PR/Brazil

Date of the interview: ___/___/___
Quadrant: () A () B () C () D
Point with potential odour generation: () 1 () 2 () 3 () 4 () 5 () 6 () 7
CHARACTERISTICS OF THE INTERVIEWED
1 – How long time have you lived in this address?
2 – Are you a smoker? () no () yes
3 – Do you have some olfactory disease? () no () yes. Which disease?
PERCEPTION
4 – Have you ever felt any uncomfortable odour in your home? () no () yes
5 - If yes, in what periods of the day are unpleasant odours more frequent? () in the morning () in the afternoon () at night () at dawn () all the periods of the day
6 – What kind of nuisance do the odours cause in you? () nausea () restlessness () insomnia () stress () loss of appetite () throat irritation () eye irritation () headache () vomiting () none
7 – The odour you usually feel looks like () spoiled egg () putrefaction () sewage () manure/fertiliser () gasoline () smoke () cooking gas () garbage () animal food () agrochemicals () other
8 – Hedonics: The odour you usually feel is: () very pleasant () pleasant () indifferent () unpleasant () slightly unpleasant () very unpleasant
9 - How often do you feel the odour? () every day () periodically - 3 to 5 days in the week () rarely – 1 or 2 days in the week () weekly – 1 time a week () I do not know
10 – In which period does the odour bother you? () in the morning – 6 to 11:59 a.m. () in the afternoon – 1 to 5:59 p.m. () at night – 6:00 to 12:00 p.m. () at dawn – 1:00 to 5:59 a.m. () I do not know
11 – Do you feel with more intensity the odour when the weather is: Você sente com mais intensidade o odour desagradável quando o tempo está: () sunny () cloudy () rainy () before the rain () without wind () with strong wind () independent of the weather () I do not know
12 – Can you tell where the odour comes from? () no () yes. Where?

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