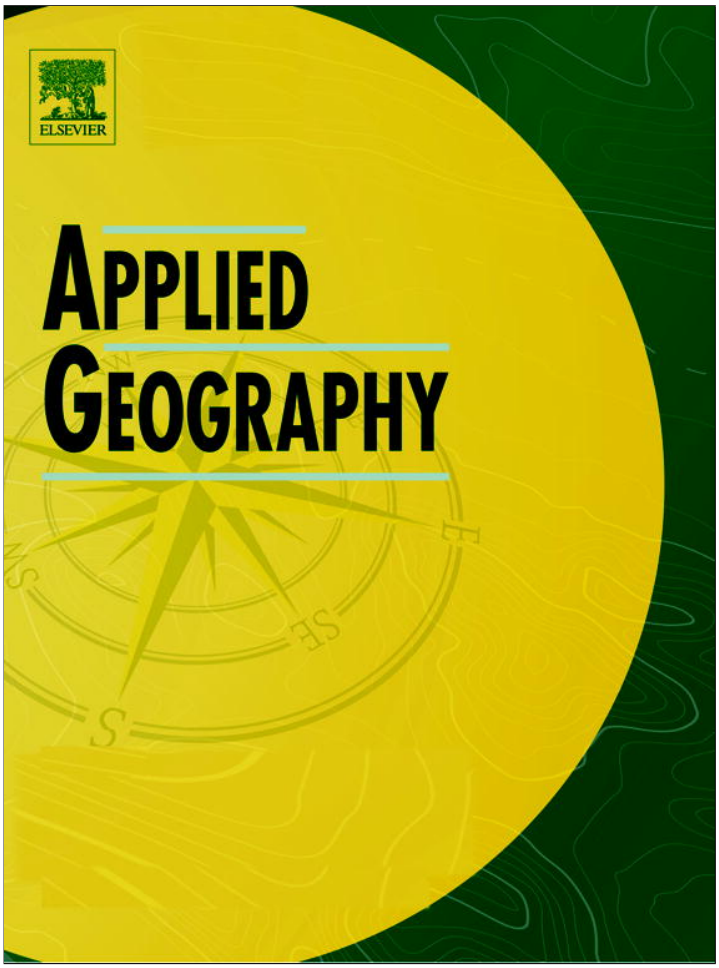

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Environmental nuisances from industrial activities in residential areas of Arab municipalities in Israel

Michael Sofer [a,*], Oded Potchter [b,c], Noaman Gnaim [a], Jallal M. Gnaim [d]

[a] Department of Geography and Environment, Bar-Ilan University, Keren Hayesod, Ramat-Gan, Israel
[b] Department of Geography and Human Environment, Tel Aviv University, Israel
[c] Department of Geography, Bet Berl Academic College, Israel
[d] Department of Chemistry, The Triangle Regional R&D Center, Israel

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A B S T R A C T

The random development of small-scale industrial and workshop activities in residential areas of Arab municipalities in Israel is causing environmental nuisances such as noise, air, water and soil pollution, and heat emissions. These nuisances are both harmful to the environment and local populations. The aim of this research is to investigate this issue by environmental monitoring and a residential survey in one such municipality, Baqa el Garbiah. Data collection was carried out based on mapping of industrial activities and workshops in residential and industrial areas of Baqa el Garbiah. Air and noise pollution were monitored using settled dust and noise samples collected from various sites in the municipality during periods of plant and workshop operation. The experience of residents in relation to these activities was explored using questionnaires and interviews with workshop owners and residents living within the vicinity of these workshops. We found significant levels of environmental nuisances in residential areas and the residential survey indicated that the activities negatively affect the quality of life of the local population. In light of our findings, solutions and ways to reduce the environmental nuisances arising from industrial activities located in residential areas should be sought after.

Introduction

Israel is a highly urbanized country and its city dwellers, influenced directly by the urban environment, tend to have increased awareness of the environmental impacts of urban development. Accordingly, they work to find high-quality and environmentally friendly ways to ensure the sustainable development of urban environments for current residents and future generations (Gabbay, 2002). One such way is zoning whereby industrial activities, being a major producer of environmental nuisances, are agglomerated in specific zones, preferably well monitored. Nevertheless, there are a significant number of cases where residential land uses are mixed with industrial activities, resulting in unnecessary environmental nuisances. This is relevant for many Arab municipalities in Israel that are going through a process of latent urbanisation characterised, among others, by the activities of cottage industries, and a shortage of recognised industrial areas. Moreover, even if industrial areas are available, the costs associated with relocating such activities into these areas are not always affordable, and the will to shift is not evident.

The aim of this paper is to describe and analyse the environmental outcome of the phenomenon of industrial activities and workshops that operate in residential areas in the Arab town of Baqa el Garbiah located in the "Triangle area", on the north-east of the central region of Israel (Fig. 1). Baqa el Garbiah is a good representative town in the Triangle area in terms of average size, central location, urban density and variety of economic activities typical of Israeli Arab municipality of that size. The paper begins by providing a background on Arab industry in Israel, the characteristics of towns with industrial activities in residential areas, and their derived environmental implications. It is followed by the research methodology. The third part presents the mapping of the phenomenon, monitoring results, the residents' experiences and plant and workshop owners' perceptions of environmental nuisances and their impacts. The discussion and conclusions are followed by a number of practical proposals for how to improve the current environmental conditions and quality of life of the Baqa el Garbiah residents.

* Corresponding author.
E-mail addresses: Soferm1@biu.ac.il (M. Sofer), potchter@post.tau.ac.il (O. Potchter), noaman@nana.co.il (N. Gnaim), Jallalg@gmail.com (J.M. Gnaim).

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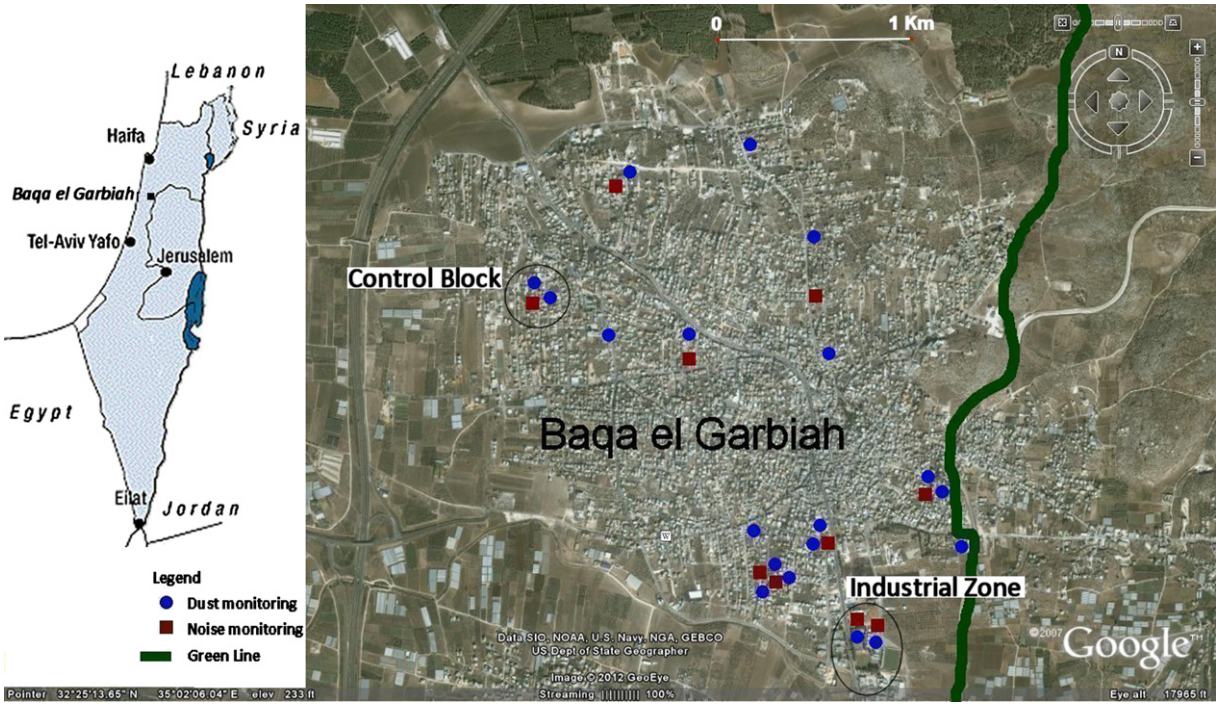

Fig. 1. Location map of Baqa el Garbiah and the distribution of monitoring devices.

Arab industry and industrial activities in residential areas

Arab industry in Israel

Since the 1970s, the Arab economy has become increasingly integrated into the larger Israeli economy due to a number of major factors. First, the shift out of the labour force from agriculture towards alternative sources of income. Second, this shift resulted in a transformation of the Arab labour force into a proletariat that was conveyed into the urban labour market in the relatively lower employment bracket. Third, a market was created in the Arab sector for commodities produced in other sectors of the growing Israeli economy. And fourth, there was an institutionalization of bureaucratic mechanisms as local authorities mediated between state institutions and residents. The overall result of these processes has been a relatively lower level of development in Arab communities, reflected, among others, in terms of industrial activities (Sofer & Schnell, 2007). By the 1970s, Arab communities sought to adapt to changing conditions and acquired different strategies to integrate into the mainstream of national development (Swaid, 2004). Under a process of latent urbanisation characterised by a gap between the population size and the number and type of economic functions (Meyer-Brodnitz, 2009), various industrial and workshop activities developed in Arab communities. The majority of these activities are located in residential areas, near or within residential buildings, and reflects the development of a mixed urban space.

Industry in the Arab sector in Israel is largely characterised by household production and informal subcontracting activities. The size of the average activity is small – less than five employees – and its growth possibilities are limited (Atrash, 1992). There are a very small number of larger factories employing more than 50 employees per factory, but their impact is minimal (Schnell, Sofer, & Drori, 1995). Most of these activities are privately or family owned, where several brothers typically own and manage a plant. The formal training of the labour force is limited, with a limited share of that labour force having full formal academic or technical education, and most professional workers are trained on the shop floor. With respect to entrepreneurs, personal savings are the most common source of initial capital investment with additional recruitment of further resources mainly from other family members (Schnell, Sofer, & Drori, 1995; Sofer & Schnell, 2005).

During the 1980s and 90s there was a high concentration of employees in four main branches of industrial activities: textile, construction materials, wood works, and food and beverage production. The textile and clothing industry expanded during the 70s and became the major form of employment in the Arab sector by the 80s, using a primarily female labour force. However, the number of textile and clothing plants was reduced by 50 percent during the second half of the 1990s. Most output, except textile and clothing, was marketed within the enterprise's own community, as well as in both Arab and Jewish neighbouring towns and cities (Schnell, Benenson, & Sofer, 1999).

Allocation of land for industrial zones began in Arab settlements in the 1970s. Nevertheless, only a few enterprises took advantage of these areas due to the inferior quality of its infrastructure and size of available land. The major factors concerning land for industry are: limited reserves of land; absence of governmental support for the development of industrial infrastructure; the legislation for the encouragement of capital investments has not been applied in Arab settlements; limited internal land market; the structure and pattern of land ownership; entrepreneurial culture; and the absence of allocation of industrial zones in the settlements master plans; (Sofer & Schnell, 2002; Sofer, Schnell, & Drori, 1996). The first three factors are partly affected by discriminative government policy which does not support Arab industrial development, while all other factors are internal factors related to the specific features of the Arab economy. Together, these factors reduce the attractiveness of Israeli Arab communities for the influx of external industrial plants, or co-owned industrial activities with Jewish entrepreneurs, and have a negative impact on internally initiated industrial entrepreneurship. To wit, the phenomenon of locating

industrial and workshop activities in residential areas is common in Arab settlements and in Arab neighbourhoods in mixed Arab–Jewish towns, but a rare phenomenon in other towns which are characterised by a zoning pattern.

The outcome of this situation is that many production plants, depending on the municipality, are situated in residential areas, particularly on the ground floor of owned or rented residential buildings (Sofer et al., 1996). This approach makes the industry cheaper to establish and maintain as it is taxed according to residential taxes. By comparison, shifting to an industrial zone is costly in terms of renting a place or constructing an industrial building, as well as the additional cost of higher municipal taxes. In sum, the majority of these workshops and plants located in residential blocks are owned and operated by people with relatively low environmental awareness, and whose human and economic resources are limited (Mir & Feitelson, 2007).

Environmental nuisances resulting from industrial activities in residential areas

Environmental nuisances in residential areas arising from human activities have been largely documented. Studies of noise pollution from airports, transportation or industrial workshops and factories, and even leisure activities (Berglund and Lindvall, 1995; Garcia, Miralles, & Sempere, 1990; Haines, Stansfeld, Berglund, & Head, 2001; Ludlow & Flindell, 1997; Shaw, 1996), and of air pollution (Kaur, Nieuwenhuijsen, & Colvile, 2007; Kumar, Chu, & Foster, 2007), have focused on the influence of these phenomena on human health, life expectancy, and quality of life of urban dwellers. However, the features, characteristics, and implications of environmental pollution (noise, air, water, and soil) produced as a result of industrial and workshop activities located in residential areas, have not yet been studied in depth (Mahesh, 1993) and the majority of documented cases are from developing countries.

The negative effects of noise on people are disturbances to communication, rest and sleep, and general annoyance. Over long periods of time these effects have a detrimental influence on well being and perceived quality of life (Berglund and Lindvall, 1995; Fyhri & Aasvang, 2010). There are unacceptable levels of noise as shown by the four tiered classification of the US Department of Housing and Urban Development (Tsai, Lin, & Chen, 2009):

(1) Clearly acceptable: $L_{eq} \leq 49$ dB(A)
(2) Normally acceptable: $49 < L_{eq} \leq 62$ dB(A).
(3) Normally unacceptable: $62 < L_{eq} \leq 76$ dB(A).
(4) Clearly unacceptable: $L_{eq} > 76$ dB(A).

There are a number of comparatives studies of noise pollution levels in commercial, industrial, and residential areas in developing countries. Studies were carried out in Varanasi, India (Gupta & Aggarwal, 2005), and Karachi, Pakistan (Mehdi, Kim, Seong, & Arsalan, 2011), where noise levels were measured from commercial traffic related to business, industry and trade activities occurring in residential neighbourhoods. The noise levels recorded exceeded recommended threshold levels, and the implications for residents living nearby were alarming. Mbuligwe (2004) studied the factors affecting the level of noise pollution resulting from workshop activities in residential areas of Dar es Salaam, Tanzania. The findings suggest that the noise levels are largely influenced by the nature of workshop activity, the type and life-expectancy of the machinery, and the location of the workshops. Moreover, a study by Schnell et al. (2012) demonstrated that noise is the major source of stress among all other stressors (air pollution and thermal stress) in the urban environment.

In the case of Ho Chi Minh City, Vietnam, more than 27,000 industrial and workshop activities were operating in residential areas in the late 1990s (Frijns, 2001). Under increasing pollution and environmental nuisances, the local authorities encouraged owners of these activities to relocate to the industrial zones at the urban fringe, yet most refused to move. The major reason for this refusal was concern about losing customers, since over time local reputation and networking had developed by each workshop and small plant. Another disadvantage was the relatively high costs of relocation. The alternative solution offered was to control the pollution through the introduction of more environmentally friendly means and methods of production; a solution that was easier to accept. Similar solutions were offered in other places such as Kenya, Ghana and Tanzania (Van Dijk & Rabellotti, 1997; Frijns, Kirai, Malombe, & van Vliet, 1997; Frijns & Vliet, 1999; McCormick & Pedersen, 1996).

The majority of the above mentioned activities are small-scale operations, yet it is estimated that small and medium-scale industrial enterprises contribute a large share of global pollution and their local impact may be even more significant. The problem is magnified by low levels of awareness by industry owners and operators (Mir & Feitelson, 2007). Environmental authorities, in cooperation with industry, work to prevent and reduce environmental hazards produced by industrial activities (Mahesh, 1993) with varying rates of success.

In the case of Israeli Arab towns the population has increased with urbanization, but the number and variety of urban functions has not increased at the same rate, as well as the necessary infrastructure for industrial development (Meyer-Brodnitz, 2009; Schnell, Sofer & Drori, 1995). Lack of designated commercial and industrial areas has caused much of the business development to occur randomly within residential neighbourhoods (such as shown in Fig. 2). The majority of these enterprises are small family based activities, characterized by prioritization which sometimes is in conflict between the aims of the family and the enterprise development. The nature of this development, the difficulties and determination of enforcement of environmental bylaws, some degree of neglect by the municipal and national authorities, and limited awareness of environmental issues are producing the background to the sources of environmental nuisances (noise, air, water and soil pollution, and heat emissions) which harm local populations and reduce their quality of life (Mir & Feitelson, 2007). Relocation of these activities outside the residential areas "could significantly improve the quality of the residential environment, eliminating the noise and dust that accompany the industrial functions" (Shmueli & Kipnis, 1998).

Fig. 2. Canning factory located within residential neighbourhood.

Research methods

This research has focused on three interlinked research issues:

1) Number and character of industrial and workshop activities in the town of Baqa el Garbiah. This issue has been dealt with by mapping the phenomena in all parts of the municipality.
2) The intensity of environmental nuisances resulting from industrial and workshop activities in the town. This issue has been achieved by monitoring procedures.
3) The perception and awareness of the population regarding industrial and workshop activities in the town. This issue has been investigated by surveys conducted among residents and enterprise owners.

Mapping workshops and industrial activities in the town of Baqa el Garbiah

Mapping was based on extensive land surveys in combination with aerial photographs of the municipality of Baqa el Garbiah. The mapping was based on the layout of the municipality in August 2007 and divided the town into grid squares (each square represents an actual area of 62,500 m^2). From a total of 30 formally declared blocks in the municipality, most of which are residential blocks, eight residential blocks were selected which contain a relatively large number and variety of activities spread throughout, including one as a "control block" (Fig. 1). The control block, characterised as a low exposure area, comprises 11 activities (five of which are warehouses located on the fringe and to the east of the block). Hence, most of this specific block is free of industrial and workshop activities, and the monitoring devices were located in the zone without any industrial or workshop activity. The industrial zone was studied as well (Fig. 1).

Monitoring environmental nuisances resulting from industrial activities

There is great value in monitoring various environmental nuisances, such as noise and settling dust that result from industrial activity in residential neighbourhoods, and which are disturbing and hazardous to local populations. Monitoring helps enable us to derive conclusions concerning the characteristics and intensity of environmental nuisances associated with both the distribution of these workshops (by quantity and type) and the perception of local residents. Dust and noise monitoring, were conducted during the summer period to reduce the risk of disruption due to weather conditions, such as rain, thunderstorms, etc.

Monitoring settling atmospheric dust

The purpose of this experiment was to monitor the amount of settled dust (of particle size greater than 45 microns) in different areas of Baqa el Garbiah. The monitoring was carried out in the eight selected residential blocks as well as the industrial zone. Dust particles were weighed using analytical scales (with an accuracy of 0.0001 g), glass slides (each 2.5 cm $\times$ 7.5 cm, i.e. 18.75 cm^2) and Petri dishes (14 cm diameter $\times$ 2 cm depth). This method, used in recent studies (Chudnovsky & Ben-Dor, 2008; Chudnovsky, Ben-Dor, & Paz, 2007), is handy for habitat monitoring since it is compact and can be placed on the windowsill. Each Petri dish contained three slides, and three Petri dishes were placed at each location. Two residential locations were sampled per residential block and two different factory locations were sampled in the industrial zone. In each location, the Petri dishes were placed next to the noise monitoring devices on the top floor of a building on the windowsill facing adjacent workshop activities. Thus, a total of 162 trials were conducted (nine slides in each location in a total of 18 buildings). The experimental period lasted 30 days during summer, from 31/07/2008 to 30/08/2008.

Noise monitoring

The purpose of the experiment was to monitor the noise intensities in different places in the residential areas. The device selected to measure noise pollution was the "Noise-Pro" manufactured by Quest Technologies. This device is portable, easy to use, has appropriate sensitivity levels, stores data in a range of desired measurements, has a battery life of 60 h, and a large data storing capacity. 10 Noise-Pro devices were used.

Devices were placed in the eight selected blocks, including the control block and the industrial zone, in homes closest to workshop activities. To insure the actual noise exposure of local inhabitants, devices were placed at second floor bedrooms' windows facing workshops, five to seven metres away. Noise data-collection was done continuously (24 h a day) for seven days, from Friday 11.07.2008 to Thursday 17.07.2008 – a total of 168 h non-stop monitoring. Noise levels in different locations were recorded every minute and saved in monitoring devices (a total of 10,080 measurements were saved in each device). Battery replacement for the devices took place at appropriate intervals to ensure continuous data collection for the study period.

Survey of the population's awareness of environmental nuisances

The first survey examined the awareness of residents living within the vicinity of industrial activities to the environmental nuisances, including noise and dust, caused by those activities. Furthermore, it aimed to examine residents' tolerance and identify their objections to these nuisances.

The questionnaire was carried out with a random sample of the town population which was divided into two groups of interviewees. Each group received a customized questionnaire: 1) Residents who live near to the workshops in seven residential blocks; and 2) Residents who live in the control block largely free of industrial activity. The survey included 30 randomly chosen interviewees comprising men and women over 18 years of age in each residential block. The survey questions included open and close-ended questions regarding the environmental nuisances. Some of the questions provided the opportunity to give subjective, qualitative data about the residents' personal experience of the environmental nuisances. The answers were based on a Likert-scale from 1 to 5. To investigate the relationship between variables, we used the Pearson's Chi-Square Test.

A second survey was conducted among 30 workshop owners from the selected seven blocks where industrial activities were located. These questionnaires included details about interviewees' enterprises, their views regarding the effects of workshop activities on the environment and quality of life of neighbouring residents, the intensity of nuisances caused by their workshops, and their awareness of health effects resulting from these nuisances. The answers were based on a Likert-scale from 1 to 5. The surveyed population consisted of men all aged over 27 years and living in Baqa el Garbiah.

Results

Spatial distribution of the types of industrial activities in residential areas

The distribution of industrial and workshop activities is shown in Fig. 3. The total number of such activities in the residential areas of Baqa el Garbiah is about 281 (83% of total activities in the settlement), compared to 57 activities located in the industrial area,

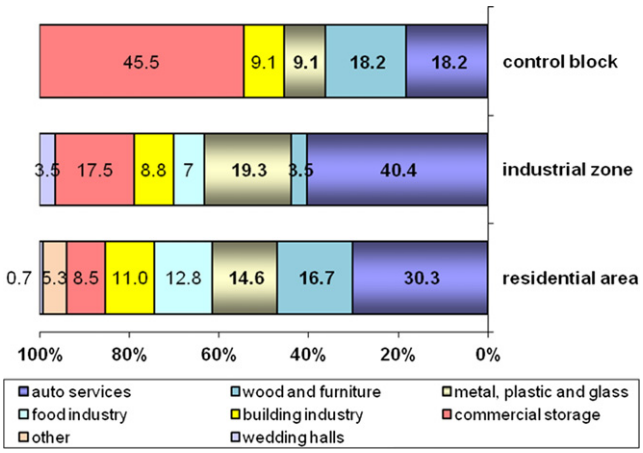

Fig. 3. Distribution of types of industrial and workshops activities by area: 281 activities in the residential blocks, including 11 in the control block, and 57 in the industrial zone.

a ratio of about 5 to 1. Industry and workshop activities most common in the residential area are auto services (30%), wood and furniture and metal factories. By comparison, the most common activities in the industrial zone are auto services (40%), metal, plastic and glass factories, and commercial storage. The industrial and workshop activities are spread throughout the town within old and new neighbourhoods. There is a clear concentration along and in the vicinity of the main road that crosses the town from north to south, and particularly on its eastern side.

Monitoring dust and noise pollution

The intensities of the environmental nuisances (noise and settled dust) caused by industrial plants and workshops located in residential areas were compared to those characterising residential neighbourhoods without workshops (the control block), and the industrial zone.

Monitoring settled dust

There are significant differences among the various blocks in relation to settled dust in residential areas compared to the industrial zone. The recorded range of 1.451 tons/km^2 (welding workshop) to 10.674 tons/km^2 (food canning plant), presents the gap between the lowest and highest recordings in the residential areas. The highest recorded value for the industrial zone was 17.067 tons/km^2 (cement plant) followed by a value of 10.827 tons/km^2 (metal workshop for greenhouse construction). The result for settled dust recorded in the control block was 3.037 tons/km^2 of which only four recorded measurements were lower in other residential areas. A comparison of the average amount of settled dust per block where the variance between them is significant [$f(7,136) = 0.8666$, $p < 0.05$], shows a high level of variance. Only one block had an average level lower than the control block.

Average dust levels at all monitored locations, including the industrial zone, was 5.423 tons/km^2 while average dust levels in all residential areas, excluding the industrial zone, was 4.206 tons/km^2. These values are higher than the amount recorded for the control block (3.037 tons/km^2) where minimal industrial activity takes place, but lower than limits set by both European and Israeli standards, both set at about 20 tons/km^2.

Monitoring noise intensity

Noise levels as a function of time were measured for seven days (168 h) in dwellings next to industrial activities in the residential areas. Activities included a canning factory (2 monitoring devices), a furniture factory, a garage, an auto body workshop, a petrol station, and an aluminium factory. These measures were compared to the control block and two industrial activities located in the industrial zone including a cement plant and a metal workshop for greenhouse construction some of which are shown in Fig. 4. A period of relative inactivity occurred in the industrial zone during the fourth day of the monitoring period due to Palestinian workers from the West Bank being unable to reach work on this particular national holiday – Jewish Day of Atonement. Generally, a diurnal pattern of noise level was observed in the industrial zone, canning factory and control block. The furniture factory did not match this pattern. It should also be noted that only the industrial zone was affected by the Day of Atonement, while all other workshops located on household premises in the residential areas operated continuously. These are far less affected by hired non-family labour. Additionally, it should be emphasised that the separation between factory noise and the usual street level noise is expressed by the

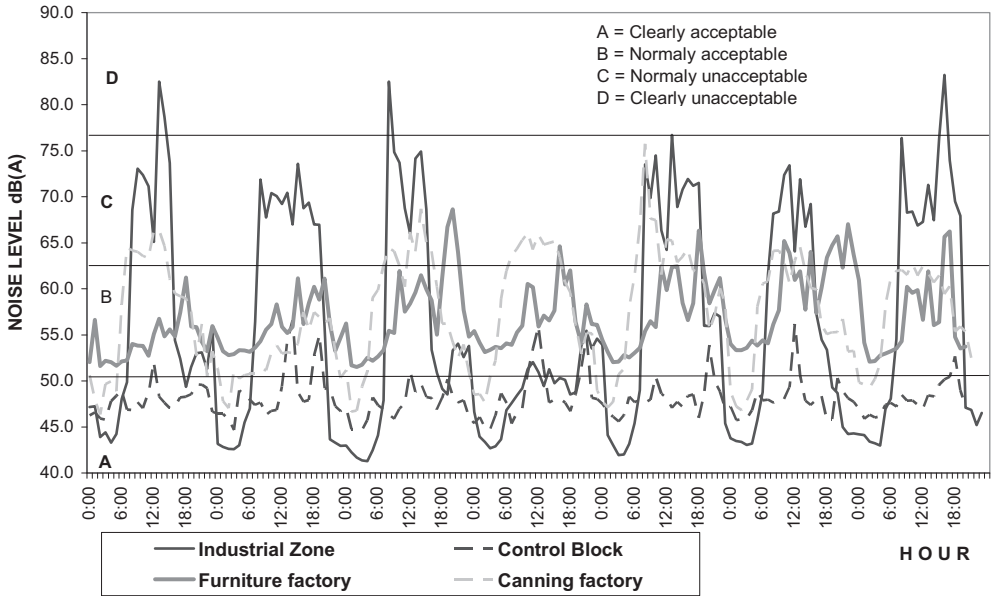

Fig. 4. Average (1 hourly) noise intensity levels measured for 7 continuous days in selected locations and in the control block.

comparison between the control block and the other blocks. Street level noise is the common noise in the control block while noise levels in the other blocks are obviously affected by the noise derived from industrial and workshop activities, some of which located in secondary streets where street level noise is very low.

Classification of noise level according to the US Department of Housing and Urban Development showed the following results. The highest noise level was measured between 08:00 and 20:00, and reduced to a minimum in early morning. The highest level of noise (category 4 – clearly unacceptable: $L_{eq} > 76$ dB(A)) was measured in the industrial zone at a maximum hourly average of 85 dB(A), except on the Day of Atonement. The noise level at the canning factory and the furniture factory was normally unacceptable ($62 < L_{eq} \leq 76$ dB(A)) exceeding values of up to 75 dB(A) at the canning factory and 69 dB(A) at the furniture factory. The lowest noise levels, clearly acceptable ($L_{eq} < 49$ dB(A)) and normally acceptable ($49 < L_{eq} \leq 62$ dB(A)) were measured at the control block.

Average minimum–maximum noise levels measured hourly at nearby workshop activity is shown in Table 1 in descending order of maximum values. The highest recorded value was for the greenhouse construction metal workshop in the industrial zone – 101 dB(A). The smaller gap was recorded for the petrol station – 58–83 dB(A), and the control block – 44–69 dB(A).

According to the results of noise monitoring it is possible to depict a cycle of noise levels during weekdays, when there are high-levels of activity during the day (08.00–16.00) and much less and even inactivity during the evening and night (16.00–08.00). Based on the figures recorded by various devices we were able to identify rest days as compared to work days. Most workshops ceased activities over Friday, a rest day for the Muslims, and/or Saturday. A more detailed depiction of the noise levels for a 24 h period is displayed in Fig. 4, which clearly shows an increase in the level of noise resulting from industrial activity around 08.00 and 15.00, and a gradual decrease in noise levels afterwards. This phenomenon has been observed in all blocks and on all days of monitoring.

Fig. 5 presents the frequency of noise distribution at four sites in Baqa el Garbiah at different daily periods: day time – 07:00–16:00, evening – 17:00–21:00 and night time – 22:00–06:00. Noise levels were acceptable in the control block for 99% of the day time, evening and night times. In the industrial zone noise level exceeded unacceptable levels for 64% of day time and 30% of the evening hours, while during the night time noise levels were acceptable. In the canning factory only 37% of the time noise level was acceptable during day time, while for the furniture factory 86% of the day time noise level was acceptable. Furthermore, during night times unacceptable noise level was measured during 5% of the time for the canning factory and 8% of the time for the furniture factory. These findings emphasize the problematic location of workshops in residential neighbourhood.

Table 1
Average minimum–maximum noise levels (measured hourly) at nearby factories and workshop activities.

Types of activities	Average hourly noise level (dB(A))	
	Minimum value	Maximum value
Metal workshop for greenhouse construction (industrial zone)	42	101
Auto body workshop	42	90
Cement plant (industrial zone)	48	87
Petrol station	58	83
Furniture factory	52	83
Canning factory (1)	44	79
Car garage	48	74
Aluminium plant	43	74
Canning factory (2)	44	71
Control block	44	69

It should be emphasised that Israeli law prohibits exposing employees to noise intensities of 80 dB(A) for more than 24 h, 100 dB(A) for 15 min, and completely prohibits exposure to levels above 115 dB(A). By general world standards, noise levels permitted during the day in residential areas are 45–55 dB(A), in workshop activities with heavy vehicle movement, 50–60 dB(A), commercial activity areas, 55–65 dB(A), and industrial zones, 60–70 dB(A) (The Ministry for Environment Protection, 1992).

Having said that, Table 2 shows that all the blocks experience noise levels over 70 dB(A) which is not allowed according to the Israeli ordinance in residential areas and even in industrial zones. For example, measurements recorded next to the auto body workshop showed a level of noise above 70 dB(A) for almost 80 h during one week. By comparison, in the control block it occurred for only 0.3 h. In the Industrial zone, levels of noise above 70 dB(A) were measured 41.3 h near the cement factory and 31.1 h near the metal workshop. There are some individual industrial activities which produced noise above the level of 80 dB(A) (Table 2).

The population's perspective regarding the environmental nuisances

The questionnaires used to survey residents included a number of questions that were designed to gain a clear indication of the population's perspective about environmental nuisances. To analyse the data two measures were built:

1. An index of the population's perceptions about plants and workshops in residential areas being environmental nuisances (based on a hierarchy of values 1–5: 1 = not at all; 5 = very much).
2. An index of the population's perspectives regarding the varying intensities of environmental nuisances produced by plants and workshops located in residential areas (based on a hierarchy of values 1–5: 1 = not at all; 5 = very much).

Table 3 shows the perception of residents regarding the two indices. No significant differences were found in the mean indices of residents' perceptions of the industrial and workshop activities in the selected residential blocks (3.6) and the control block (3.5) (with a significance level of $p > 0.05$). Indices of perspective of nuisance intensities have shown significant differences (with a significance level of $p < 0.05$) between the means for the blocks with industrial activities (3.9) and the control block (3.1). The degree of intensity is 'medium to high' in both data, but is closer to 'high' in blocks with industrial activities and closer to 'moderate' in the control block.

Residents were asked to rank the relative degree of disturbance caused by the different industrial environmental nuisances: harmful or unpleasant odours were ranked highest in terms of the disturbance level (4.15), noise was second (3.99) and air pollution third (3.97). Burning of waste was ranked lowest in terms of the relative disturbance level (3.70).

The differences in average noise intensity levels between residential blocks with industrial activity and the control block were determined to a statistically significant degree $p < 0.05$. The canning factory was perceived as producing the most disturbing noise level of "very disturbing" on average among all blocks (3.60). In the control block, wedding halls, which operate late into the night, received the highest average (3.17) with the extent and intensity of the noise being "disturbing" to "very disturbing". In all blocks the furniture factories were perceived as the least disturbing – in the control block "a little disturbing" to "disturbing", while in other

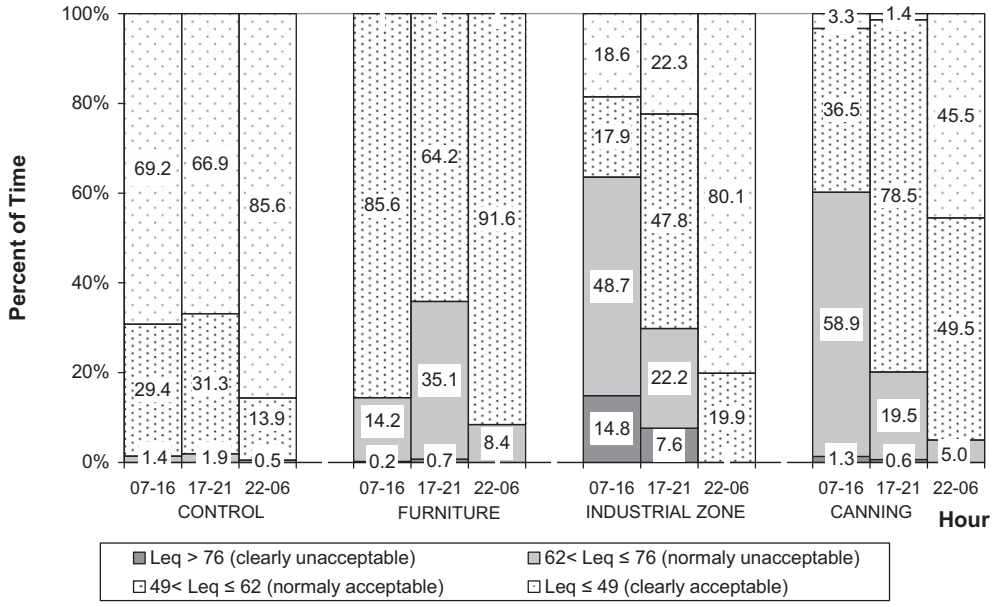

Fig. 5. Percentage distribution of noise level categories for four selected stations.

blocks, "disturbing" to "very disturbing." The difference in average disturbance levels due to noise pollution in all blocks is not significant for $p > 0.05$, except in the morning and afternoon, in which significant differences of $p < 0.05$ were perceived. The highest noise levels were determined to be produced at night, including the control block.

When comparing the awareness of different subgroups of the society to the effects of noise levels on health, we found that a higher percentage of women were more aware than men, the 50+ age group was relatively more aware than the other age groups, and residents in the control block were more aware in general than in other blocks. It should be specified that women spend more time during the day in the community as opposed to men who may work outside and being less exposed to noise and other environmental impacts during day time. In terms of complainants about the noise levels by demographic characteristics: men complained more than women; residents whose highest level of education was high school were more likely to complain; people whose income was above average had a tendency to complain more than other income groups; the percentage of complainants 50+ was highest relative to the other age groups, most likely as they are at home for longer periods of time, in the vicinity of the noise-disturbances for longer periods, and are therefore more exposed to and disturbed by the pollution.

The average intensity of disturbance caused by air pollution, and the various sources of pollution, was higher for all residential blocks compared to the control block. For all blocks, the furniture factories were the least disturbing sources of air pollution at an average of 2.89 which indicates "little disturbance" to "disturbing" and for the control block the average was 1.83, indicating "not at all" to "very little disturbance". The source with the highest average (indicating the greatest level of air pollution relative to other sources) is the canning factory at "somewhat disturbing" to "very disturbing". In terms of air pollution by time of the day, the differences between all blocks and the control block were significant to $p < 0.05$, except on Saturday where the differences were not significant $p > 0.05$. The lowest average disturbance level at "little disturbance" was recorded in the morning in the control block (2.70). For all blocks, the highest level of disturbance was in the evening, and the intensity of disturbance (3.46) was lowest "disturbing" to "very disturbing" in all blocks on Friday, the Muslim rest day, as workshops might cease their activities.

The level of awareness of air pollution on health by demographic characteristics indicates that the percentage of women with awareness of the effects of air pollution on health was lower than that of men, respondents with high school level education were more aware of the effects of air pollution than those with a university education, the salaried employees were more aware

Table 2
Number of hours of noise intensity level by source of noise during one week.

Source of noise	Number of hours by noise intensity levels (dB(A)) over 1 week					
	40–49	50–59	60–69	70–79	80–89	90–101
Aluminium plant	60.9	87.7	14.1	1.1	0.1	0.0
Metal workshop for greenhouses (industrial zone)	75.6	33.6	27.6	22.7	6.7	1.7
Canning factory (1)	65.6	89.6	9.2	0.3	0.1	0.0
Canning factory (2)	37.9	56.8	63.5	5.4	0.5	0.1
Cement factory (industrial zone)	34.8	73.0	18.9	16.4	24.1	0.8
Auto body workshop	27.4	57.2	52.9	24.5	2.7	0.5
Garage	27.1	127.2	9.6	0.6	0.0	0.0
Furniture factory	0.0	128.3	31.2	6.7	0.1	0.0
Control block	134.3	27.6	2.2	0.7	0.1	0.0

Table 3
Residents' perceptions of environmental nuisances compared with the perceived intensity of these nuisances.

Indices	Residential blocks ($N = 210$)		Control block ($N = 30$)		T test	Sig. $p < 0.05$
	Mean	S.D.	Mean	S.D.		
Residents' perception of plants and workshops as environmental nuisances	3.6	0.68	3.5	0.58	0.76	0.40
Residents' perception of the intensities of the environmental nuisances	3.9	0.85	3.1	1.1	3.60	0.00

Table 4
The distribution of workshop owners answers to the questions (%).

Question	Not at all	A little	To some extent	A lot	Very much
To what extent does your workshop activity harm the environment?	36.7	40.0	20.0	0.0	3.3
To what extent does your workshop create environmental nuisances?	33.3	43.3	23.3	0.0	0.0
To what extent does your family suffer due to these environmental nuisances?	56.7	26.7	13.3	0.0	3.3
To what extent are you concerned about factories nearby your residence?	76.7	10.0	10.0	0.0	3.3
To what extent do workshops in the residential area harm the quality of life?	10.0	23.3	23.3	23.3	20.0
To what extent are the existence of workshop activities in residential areas due to the neglect of authorities in regulating industrial zones?	3.3	3.3	10.0	1.0	73.3

than independently employed and the unemployed, residents with an average income level were more aware than residents with above average income, and the 31–49 age group had a heightened awareness compared with all other age groups. Residents of the control block were very aware of the effects of air pollution on health – 100% of those surveyed.

The perceptions of the surveyed population were as expected: the residents of the control block clearly expressed a preference to be separated from the environmental nuisances by moving into a workshop-free area. Residents who continue to live in blocks with industrial activities are apparently 'used to' these nuisances, or alternatively, they are related to or socially connected with workshop owners. More thorough examination of residents' perceptions about environmental nuisances suggests that the canning factory, wedding venues, and metal workshops are the most significant sources of noise disturbing residents, especially in the evening and night. Residents' awareness of the effect of noise on health is very high (from 73% to 97%), while the percentage of complainants about noise pollution is not significant (from 20% to 49%) in all demographic groups.

We examined the willingness of residents to change their place of residence and found that a significant percentage (from 13% to 42%) of the population according to their demographic, economic, and social characteristics is prepared to relocate. The relatively older (>50 years) residents and the more well-off residents were keener to shift to other parts of the town. The exception was the case of the control block, in which 100% of residents were satisfied with their current location.

The position of workshop owners in relation to environmental nuisances

Three-quarters (76.7% = not at all + a little) of the 30 workshop and factory owners claim that the work carried out by their workshops does not affect environmental quality (Table 4). A similar percentage felt that no environmental nuisances were caused by their workshop activities. Higher rates (83.4%) expressed the opinion that their workshop activities are not harmful to their families and are similarly unconcerned with workshop activities being conducted close to their place of residence (86.7%). On the other hand, 73.3% of the surveyed workshop owners believe that the existence of workshops in residential areas is the result of the negligence of the municipality regarding the regulation of industrial zones. These data indicate that workshop owners are unaware (or alternatively, ignore) of the environmental effects of industrial and workshop activities, on the health and quality of life of residents in residential areas (Table 4).

Workshop owners were asked about their attitudes towards different types of environmental nuisances in relation to their workshop activities. Most owners (53.3%) claim that their activity creates no air pollution, 63.3% believe their workshops do not create dust, 43.3% say their workshops do not create hazardous odours, and 23.3% think their workshops do not create waste. However, workshop owners reported that they have made efforts to minimize the level of environmental nuisances caused by their activities by investing in new technology (55.2%), changing hours of operation (10.3%), and ceasing some of the polluting operations (13.8%).

Discussion and conclusions

Arab small entrepreneurs, in Israel have developed industrial and workshop activities in residential neighbourhoods in a spontaneous and random manner, of which a relatively large number of these activities are small-scale household based operations. The main reasons for this pattern, among others, are limited reserves of land for industry by government authorities, the structure and pattern of land ownership, the absence of allocation of industrial zones in the municipality's master plans, and absence of public and governmental support for the development of industrial infrastructure. In the case of Baqa el Garbiah the ratio of industrial activities in the residential areas to those in the industrial zone is 5:1, and these activities do not differ materially from those located in the industrial zone. Spatially, there is a certain degree of specialization which appears to occur in different residential areas, and the major concentration of such activities exists in close proximity to the main road which runs through the city from north to south.

The industrial and workshop activities in the residential areas of Baqa el Garbiah are major sources of environmental nuisances, particularly noise. Differences between all the blocks in terms of noise intensity levels, in comparison to the control block, allow us to distinguish various noise sources to a statistically significant degree. The canning factory produced the highest intensity of noise

pollution, and this was also reported by residents in all residential blocks including the control block. However, the wedding venue was considered by residents to produce a greater level of noise nuisances. This is because their noise is very loud into the night when people want to sleep, and on summer when windows may be kept open.

Comparison of average noise levels during weekdays produced throughout the day (during working hours and hours of inactivity) indicate that the highest values were recorded in the industrial zone and canning factory. The lower values were recorded near a garage, a furniture factory, and an aluminium factory. The lowest overall recorded value of noise intensity was in the control block, even though a number of warehouses exist in that block. Comparison of noise levels with those measured in commercial zones of Tel-Aviv metropolitan area shows that the range of noise in Tel-Aviv is wider where the minimum is lower than in Baqa el Garbiah while the maximum is higher up to 10 dB(A) (Schnell et al., 2012). In this context residents' expectation can play an important role, since people in small settlements such as Baqa el Garbiah anticipate a lower noise level compared with the big cities. Altogether, noise level recorded reached in some particular cases unacceptable levels and residents perceived noise as a major environmental nuisance.

There are significant differences between the amounts of settled dust recorded in the different areas. Results depended on the type of industrial activity next to the monitoring equipment. The highest values recorded in the residential areas occurred near a canning factory and a tyre-repair workshop. However, these are significantly less than results obtained near the cement plant and the metal workshop in the industrial zone. Altogether, dust was not recorded as a major nuisance though residents complained about dust as a major environmental nuisance.

Workshop activities in residential areas are perceived by inhabitants as environmental hazards and sources of noise and air pollution. Noise is one of the factors that create major nuisances at inconvenient hours and its levels are above the EPA and IEPM standards. Metal workshops and the canning factories have a local impact, while wedding halls have a wider influence on the residential areas. In regards to air pollution, traffic was seen as the greatest source of disturbance in the control block, while the canning factories were most disturbing for all other blocks. Residents who live relatively close to the activities are generally more accustomed to the nuisances or have a social obligation to enterprise owners producing such nuisances. Residents who want to improve the quality of the environment prefer not to confront workshop owners due to the fact that they are neighbours or relatives. These residents prefer to leave areas with workshop activity in favour of areas without such activities as is evidenced in the perceptions of residents in the control block who had a greater awareness of the disturbances caused by workshop activities, and had therefore chosen to move to the industry-free area of the town.

Local authorities need to become more involved in monitoring environmental quality and the sources of pollution and disturbance, and should insist on becoming part of the national monitoring network of the Ministry of Environmental Protection. They also need to be involved in establishing strategies to help to control or stop these activities from producing pollution or creating health hazards for local populations. There are clear economic and environmental advantages derived from such monitoring policies that minimize the negative effects of environmental nuisances, through creating spillover effects that extend them to all economic activities in the municipality (as shown by Lozano & Vallés, 2007). Furthermore, policies need to be adopted to encourage and assist industrial facilities in transferring their premises to the industrial zone.

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