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# Community noise in Kuwait—Social and environmental aspects

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## ABSTRACT

Noise level in dBA was recorded for 24 hr in 29 localities in the State of Kuwait. Nine points were used to record noise generated by traffic and aircraft movements. Community noise was recorded at 20 points in various districts representing three types of housing patterns: villa-type districts (10), apartment-building districts (6) and mixed (i.e. villa-type and apartment-building) districts (4). The prevailing noise was higher in the apartment-building districts than in the other two. The background level ($L_{90}$) was 44·2, 48·7, and 42·1 dBA in these areas respectively. This was persistent in the four periods into which the day was divided. The morning period (06.00–14.00 hr) was the most noisy. The night period (24.00–06.00 hr) was appreciably more quiet. The level of noise was significantly correlated with the density of the population living therein. The mean hourly number of peaks was highest in the apartment-building districts compared to the other two. This was common to both the peaks estimated from the base line or within 10 dB from the highest noise event recorded within the hour.

Noise was the principal cause of annoyance (56·7%), and this was common to all types of residential areas. It was more marked in the areas near the airport. The sources of the prevailing noise complained of were mainly traffic (83·5%), aircraft (42%), neighbours (17·3%), and air conditioning (14·1%). The types of disturbance recorded were mostly related to sleep (47·5%), interference with relaxation (48·1%), and disturbance of TV watching (32·5%). Interference with speech was less frequently reported. The degree of annoyance was: 16·7% were moderately annoyed, 14·7% severely annoyed, and 6·9% very severely annoyed. Those reporting to be severely and very severely annoyed were more frequent in the areas around the airport.

Reaction towards noise was related to nationality, economic status, and distance of the house from the street.

The correlation between the prevalence of the complaints and their severity and the various parameters of noise showed that the L values (except $L_{90}$ and $L_{95}$) were significantly correlated with the prevalence of complaints. The severity, as averaged over the total population or over those giving positive response, gave a significant correlation only with $L_1$. The community noise equivalent level (CNEL) was significantly correlated with both the prevalence of the complaints and their severity. The formula that gave the highest correlation was the one giving a weighting to the afternoon period (14.00–17.00 hr) almost equal to that given to the night. It seems that people are as sensitive to noise in the afternoon period as they are at night. This is probably due to the fact that most people take an afternoon nap. The peaks of noise did not give a significant correlation with either the prevalence of the complaints or their severity.

## INTRODUCTION

A person's acoustical environment consists of the sound that he hears at any instant of time. A sound which adversely affects people is called noise and is considered to pollute the acoustical environment. A person indoors may experience noise from sources located indoors such as a vacuum cleaner, an air conditioner or the radio of someone else. Also he may experience noise pollution which enters the house through a closed or partially opened window from sources located outdoors such as motor-cars, motor-cycles, or aircraft.

Noise generated by transportation is among the principal sources of community noise, particularly the diesel engined lorry (Priede 1967). The introduction of the jet engine in aircraft has probably added significantly to the community noise problem, particularly around airports (ICAO 1974). Moreover, many types of recreation such as the modern types of music, rifle shooting and fireworks entail exposure to high levels of noise.

Noise is one of the stress factors in all segments of the environment, namely work, community and home. All add together in an attack upon the auditory system. The hazardous effect of noise on the hearing of the population exposed to it in the course of their work or due to military service is well documented. However, for a full appraisal of the variety of exposure effects, it is important to deal with the complete situation and not make a division between occupational exposure and exposure to noise in the community (WHO 1971).

The effects of exposure to high community noise go beyond its effect on hearing. Noise has been reported to cause vaso-constriction of the blood vessels at the precapillary arteriolar level, mainly in the skin and mucous membranes (Jansen 1969). Changes in blood pressure (Anticaglia & Cohen 1970) and some effects on cardiac muscles are reported to occur (Rusco *et al.* 1965). Signs of endocrinal stress were reported in experimental animals. Sleep interference is perhaps the most serious. Noise may make falling asleep difficult or awaken the sleeper. It may disrupt the normal sleeping pattern without awakening the subject (RRL 1970). Speech interference is probably among the important effects of noise. The interference caused by noise is basically a masking process. The effect varies according to the level of noise, its frequency content, continuity and the means by which it is conveyed.

Description of the outdoor noise should account for the frequency distribution, the overall sound pressure level (SPL) and the variation of both with time (EPA 1971). The most simple method for the integration of the first two parameters is the use of the A-weighting which attenuates the low frequencies. A third character of noise is usually expressed in a statistical manner by stating the value of noise exceeded for a certain percentage of time (the L values).

A striking feature of outdoor noise is its fluctuation between several levels. Moreover, it appears to be characterised by a fairly steady lower or background level upon which is superimposed the intrusion of discrete single levels (EPA 1971). The statistical measure used generally to reflect this background is the $L_{90}$ (ISO R 1996, 1971) or the level exceeded for 90% of the time. The residual noise is generally established by motor vehicles and depends on the traffic flow, vehicle speed, distance from the road and the ratio of trucks to automobiles (Richards 1975).

People are reported to be more disturbed by noise when they are at home (Shaw 1975). Several factors may influence the response (Stevens 1969). These include the attitude towards the source, the magnitude of the intruding noise, its duration, the state of the weather, whether windows are closed or open, the time of day, background noise level in the community at the time of the intruding noise, and history of previous exposure to noise. Various formulae integrating all the above-mentioned factors have been devised. These include the composite noise rating (CNR, Galloway and Pietrasanta 1964), the noise exposure forecast (NEF, Galloway & Bishop 1970), and the community noise equivalent level (CNEL, Noise Standards 1970). The CNEL is based on the A-weighting to avoid the complexity of calculating the effective perceived noise level (EPNL). It also includes an evening period (19.00–22.00 hr) weighting in addition to the day and night time used in both the CNR and NEF.

The normalised CNEL was used extensively to assess the observed community reaction to situations of community noise. It was reported in the USA that no reaction would occur if the normalised CNEL was between 50 and 61 with an average of 55 dB. Widespread complaints may be expected when the normalised CNEL is 55–70 with a mean of 65, while vigorous community reaction would be expected between 76 and 85 with a mean of 81.

Dissatisfaction of the population was sometimes measured by traffic noise index (TNI, Griffiths & Langdon 1968), based on integrating the values of $L_{10}$, $L_{50}$, and $L_{90}$. $L_{eq}$ was also used in some equations. The $L_{10}$ averaged over 18 hr (06.00–24.00 hr) gave a significant correlation with the community reaction.

The most satisfactory place to deal with noise problems is at the source, particularly by better design of the machines or reduction of the number of sources. Modifying the transmission path by re-routing traffic or setting aside large areas of land around airports for non-residential use are practised. The receiver can be screened from the source by building noise barriers. Sound-proofing of the building is a measure that proves effective particularly with aircraft noise control.

Legislative control is being enforced by various countries recognising noise as an undesirable by-product of modern technology (Shaw 1975). Setting standards for the community noise level is endorsed in various legislations. Nevertheless, in many situations there are not enough persons properly qualified, or sufficient equipment at hand to handle the necessary noise checks for enforcement purposes (Cohen 1969). In addition, there may not be enough competent acoustic engineers or noise control experts available in every country to solve the innumerable problems that exist or can be anticipated in reducing noise to recommended levels. Moreover, the major sources of community noise, namely the aircraft and motor vehicles, are beyond the control of the normal citizen. He has little to do except to move away from the airport or road with heavy traffic.

## MATERIALS AND METHODS

Twenty-nine sampling points were selected to determine the level of noise prevailing in various residential areas in the State of Kuwait. They represent three patterns of housing: villa-type districts (10), apartment-building districts (6) and mixed (i.e. villa-type and apartment-building) districts (4). Nine sampling points were selected to record the noise associated with outstanding, existing, or potential noise sources: 3 points in the vicinity of the International Airport, 5 on the side of one of the main streets, and a single point inside the Shuwaikh Industrial Area (Map, Fig. 1).

Inside each locality, the site of measurement was determined by the availability of

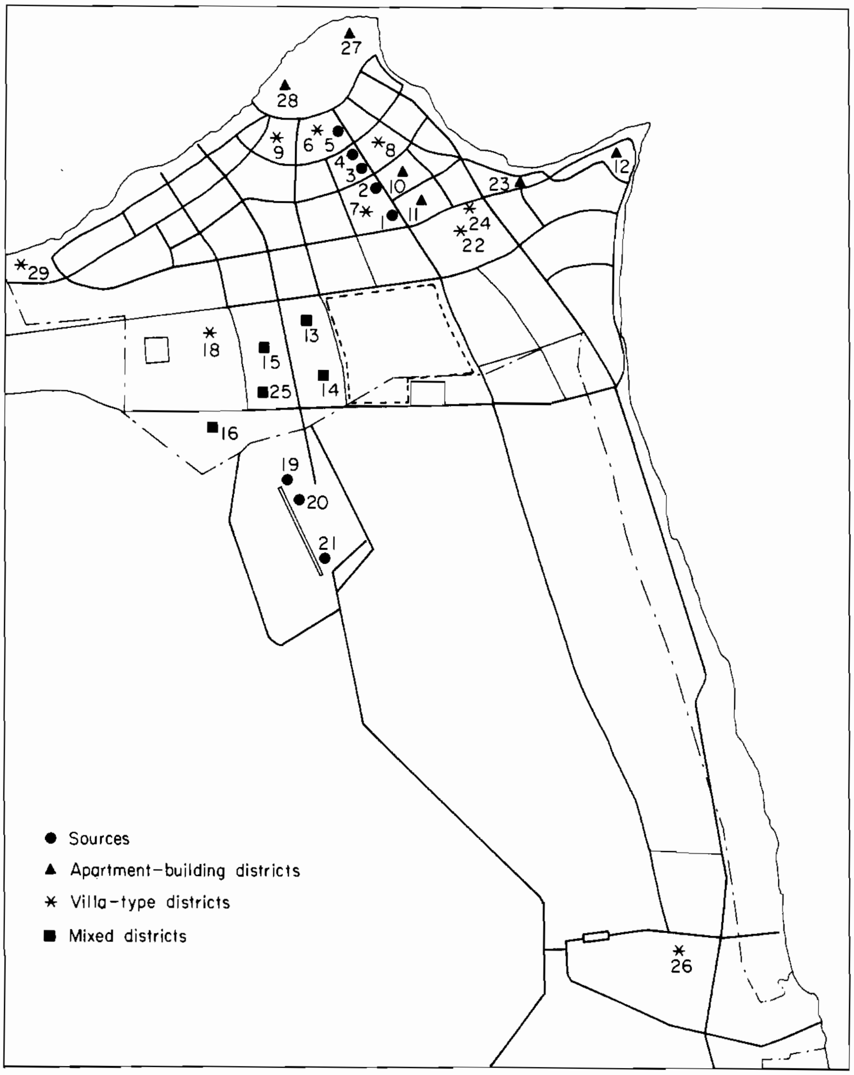


**Fig. 1.** Location of the sampling points for noise measurements.

electric current. The measuring point was chosen 15 m from any reflecting surface and 15 m from the centre of the nearest traffic lane or nearest street.

The investigation started on 9 January 1977. The equipment used in the investigation included a B & K outdoor microphone, type 4921, a B & K measuring amplifier, type 2607, and a B & K level recorder, type 2305. The level recorder was used to operate a B & K statistical analyser type 4420. The level recorder was adjusted to actuate the analyser's 12 channels in 5 dB steps and to record a count every second. The dynamic range of the system was thus 55 dB. The lowest level of noise measured was set at 33 or 43 dBA according to the site. Strip chart recording was done all the time. The charts were run at a speed of 0·1 mm/sec at all the measuring sites, except the first five points where the charts were run much faster. The mobile laboratory was parked at the measuring site and the measurement continued for 24 hr. To guard against any malfunction of the equipment resulting from the heat, an electric fan was operated in the hot hours of the day.

Recording of the counts of the statistical analyser was done at 06.00, 14.00, 17.00 and 24.00 hr dividing the day into four periods. This method is different from the conventional methods reported in the literature for division of the time. It was decided upon owing to the national habit of having an afternoon nap by most of the population, and it was thought that the period 14.00–17.00 hr deserved separate weighting. The habit of having a nap in the afternoon is believed to be very common in the Middle East area, to avoid the heat in this time of the day.

Noise data were manipulated to determine the ambient level together with the various other parameters. The parameters were the CNEL, the level exceeded for a certain percentage of the time in the various periods, and for the whole day at each location. In estimation of the CNEL, the mathematical formula used was that suggested by the Wyle Laboratory as reported by Gay (1972) in the U.S.A. Provisionally an arbitrary value of 6 was used in weighting the afternoon period.

The hourly tracing of the prevailing noise taken by the level recorder was inspected visually. The number of peaks exceeding the background level at the moment of the noise event by either 10, 15 or 20 dB in each locality was estimated.

A social survey was made to determine the reaction of the population living in the vicinity of the measuring point towards the prevailing noise. A preplanned questionnaire was used (an English translation is given in the Appendix). Four hundred and fifty households were selected from those living in the immediate vicinity of each measuring point. The questions included personal and social data, car ownership, and the use of aircraft for work or vacation, the housing condition together with the time of residence in the house, and the distance from the street were also recorded. Sources of noise inside the house, such as air conditioning and TV and radio sets were inquired into. The type of air conditioning and the number of window units installed in the house together with the number of TV and radio sets were recorded. The sources of annoyance in the area, namely transport, schools, water and electricity supply, sewage disposal, the neighbours, recreation facilities, over-crowding, and the prevailing noise were inquired into. This was done mainly to show how noise would be looked upon by the residents in such areas in view of the probable other factors of annoyance. The sources of the noise as considered by the interviewed persons were also recorded.

The percentage of people annoyed by the noise and the score of annoyance in each area was estimated. The results of the social survey were correlated with the various parameters of noise for the purpose of detecting the most significant parameters. Furthermore, they were used to adjust the weighting of various factors used in the estimation of the CNEL to describe the level of noise compatible with the satisfaction of the population living in Kuwait.

## RESULTS AND DISCUSSION

### *1. Environmental aspects*

*Noise level.* The noise level prevailing along Maghreb Street, which mostly originates from traffic, and that prevailing at both ends of one of the runways within the airport, are shown in Table 1. The level exceeded for a certain percentage of the time during the 24 hr (L values) starting from $L_{95}$–$L_{10}$ on the day of the measurement, is shown in the table. The level measured at the side of the street is not community level in the proper sense. It will only represent the noise exposure of the people living in houses directly on the side of major streets having traffic loads similar to the present one. A few amendments are, however, to be introduced to the data to account for the absence of any reflecting surface at the point of measurement and the distance from the houses, which were, on the average, about 30–50 m from the carriageway.

The level exceeded for 99% of the time, which is considered the average minimum noise level (not shown in the table), ranged between 43·6 and 49·5 dBA. Both the $L_{95}$ and $L_{90}$, considered as the ambient noise levels, are shown in the table. The $L_{90}$ considered by the ISO 1996 (1971) as the background noise was between 49 and 56·7 dBA, whereas the $L_{95}$ considered by AS 1055 (1973) as the background noise was between 44 and 54 dBA. The $L_{10}$ used to assess the traffic noise was on the mean 76·8 dBA. This level is markedly higher than the accepted $L_{10}$ of 70 dBA recommended by Dickinson (1972) as the limit for residential development in areas along streets with free-flowing traffic. It was also much higher than the $L_{10}$ of 66 dBA reported by Langdon (1976a) as the level above which dissatisfaction from traffic noise resulting from free-flowing traffic is expected in U.K., and that this dissatisfaction is expected whether the $L_{10}$ is averaged over 12, 18 or 24 hr.

The 18 hr traffic load along the street was 23, 636 cars (Traffic Department, Kuwait Municipality, January–February 1977). The expected $L_{10}$ at 30 m from the side of the nearest lane would be 74 dBA (Dickinson 1972). The level recorded is higher than that expected, probably due to the relatively higher speed of the cars and the frequent use of horns. Based on these findings, and because of the absence of any barrier on either side of the street, the distance at which the noise level would be acceptable and consequently development could be allowed would be slightly less than 60 m, which is greater than the existing distance. Moreover, the street is being developed to motorway standards. This will naturally increase both the traffic load and speed. Furthermore, the carriageway will come nearer to the line of the villas on the side of the street, as the road will be widened, hence the noise will be higher.

The $L_{50}$ was, on average, 69·7 dBA. At this level a whispered voice would not be intelligible. A normal voice would be intelligible at 60 cm and a raised voice would be intelligible at less that 1·5 m. At a greater distance a very loud voice or shouting would be necessary. It could be concluded that outdoor conversation or the use of a garden or a balcony will be restricted along the street (Shaw 1975). The $L_{90}$ or the background noise for the integrated 24 hr was on average 52·5 dBA. This level would cause the area to be included among the noisiest urban category (EPA 1971). The day-time level is naturally higher than the level shown here, which includes the night-time, having a much lower noise level. The reported day-time level in very noisy urban areas in the USA was 58 dBA. Some control measures should be introduced to alleviate the noise problems. Setting standards for the insulation of houses may be practised for the new houses. This could not be advised for the existing houses since the cost will be prohibitive. Building a barrier on the side of the street may be of value (Scholes & Sargent 1971). The height of the barrier could be determined once the distance of the line of the residential development from the nearest lane of the planned motorway is determined.

The noise resulting from the other major source, namely aircraft movements, is shown in Table 1. The ambient noise level $L_{95}$ and $L_{90}$ was definitely lower than that recorded at the side of the major street. The maximum difference was, however, in the middle portion of the frequency spectrum presented by the $L_{75}$, $L_{50}$, and $L_{25}$. The difference at $L_{50}$ was 16·3 dBA. This is to be compared with the difference at the $L_1$ which was 4·7 dBA and the $L_{99}$ which was 2·4 dBA. The noise was recorded within the boundary of the airport at one end or another of the major runway. Nobody lives in this area and it was done to show the effect of aircraft movements on the acoustic environment in the vicinity, and their contribution to the noise pollution in the residential areas near the airport. There was no indication of the specific effect of the aircraft movements on the acoustic environment other than the relatively higher $L_1$ which is naturally influenced by the marked fluctuation of the noise resulting from the flyover of aircraft.

The third source of noise, namely industrial noise, was also measured. The level of noise at a point inside the Shuwaikh Industrial Area was recorded. The tracings were quite similar to those in the residential areas. Moreover, they are not likely to trigger any reactions from the people living in the surrounding areas since the industrial area is well separated by adequate distance from each of the nearby residential areas.

*Community noise*. The level of noise recorded at the 20 residential areas is shown in Table 2. The mean L values in each type are shown in the table. The level shown in the table is that for the whole 24 hr. It should be noted that the level was not affected by the use of air conditioning, which is popular in Kuwait. The time of measurement was between January and March and air conditioners are not operated at this time of the year. The effect of air conditioners will probably add significantly to this level though the change could not be assessed at that time. The ambient noise level $L_{90}$ in the villa-type districts was higher than the 40 dBA recommended in the ISO 1996 (1971) for similar residential areas. Moreover, the integrated 24-hr value was similar to the day-time level in normal suburban residential quarters in the U.S.A. The type of house is the detached single family villa and these areas are generally considered the quiet suburban type having a background level of 38. The $L_{95}$ reported here was only 2 dB lower than the upper level of the residential areas recommended in the ISO 1996 (1971). Marked fluctuation of the level was observed among the various villa-type residential areas. The median noise level ($L_{50}$) in the districts was on average 52·8 dBA. the $L_{50}$ recorded here is compatible with relaxed conversation at slightly less than 2 m and conversation with normal speech at a distance of 5 m or slightly less. The $L_{10}$ showed marked fluctuations within a range of 56·2–67·2 in the different areas. The minimum, mean and maximum CNELs are shown in the second portion of Table 2. As was previously mentioned, it was estimated in a way different from that used in the original Wyle Laboratory formula. Four periods were used, instead of the original day, evening and night periods used by that laboratory. The afternoon period (14·00–17·00 hr) was treated separately, giving it a weighting of 9 similar to the weighting given to the night period. Moreover, no normalisation was attempted. It was found that CNEL exceeded the day-time value of $L_{50}$ in all the residential areas. The $L_{50}$ was considered the basic value to which everybody would compare the level of the intruding noise. The mean difference between the CNEL and the $L_{90}$ was above 17 dB in 11 localities. This would be compatible with widespread complaints. The difference was not above 33 dB where vigorous community reaction was expected in any of the sites, though it exceeded 30 dB in two localities.

The noise level recorded in each of the areas in which the prevalent housing is the apartment-building type is shown in Table 2. The $L_{95}$ was 44·7 dBA. This was 2·5 dBA higher than the level reported in the villa-type residential areas. The difference was more marked at the $L_{90}$, amounting to 4·5 dBA. The difference persisted at this level of magnitude at $L_{50}$ and was slightly smaller at $L_{10}$. The highest CNEL was 72·5 dBA and the lowest 65·6 dBA. The day-time $L_{90}$ was 54·3 dBA. This will include these areas among the noisy urban areas by U.S.A. standards (EPA 1971). The CNEL was persistently higher than the median noise levels. Moreover, the CNEL was higher than $L_{90}$ by the specified 17 dBA in most of the areas, though the difference was not greater than 30 dBA in any area. The $L_{95}$ was higher than the 45 dBA which is considered the highest level in the ISO 1996 (1971) in four out of six locations in which the measurements were made. The CNEL was persistently above 65 dBA which is considered the level compatible with residential areas in the U.S.A.

The noise level recorded in the mixed areas where both the villa-type and the apartment-building dwellings are present is also shown in Table 2. The background level $L_{95}$ and $L_{90}$ was slightly lower than that prevailing in the villa-type districts. This picture was preserved up to and including the level exceeded for 10% of the time. The values were similar to those calculated for the villa-type districts. The CNEL was higher than the critical 65 dBA in three out of four areas.

The hourly mean number of peaks of noise 10, 15 or 20 dBA above the background level in the various localities according to the type of residential area is shown in the table. It should be noted that the number of peaks was estimated by visual inspection of the tracings of the level recorder for the prevailing noise at each locality. The level was estimated relative to the background at the time of the noise event. This method, we thought, was more indicative of the intruding noise than the conventional methods of counting the number within 10–15 dB from the highest noise event in the period (EPA 1971). Naturally, the level will be negatively correlated with the background level, since the lower this level is, the more conspicuous and distinct will be the peaks. The causes of the peaks that occurred at the time of taking the counts are recorded on the charts. The most common causes were traffic movements in the locality, aircraft flyover, barking of dogs, and voices of children playing nearby. The peaks caused by aircraft are characterised by a relatively longer duration than those caused by cars (Fig. 2). The intensity was also higher in the mixed districts near the airport.

In the villa-type districts the most frequently recorded peaks were those of 10 dB followed by 15. The least were those of 20 dB or above. With the apartment-building districts, the overall hourly mean number of peaks was lower than that recorded for the villa-type districts (64·3). The relative frequency of the 20 dB peaks was lower while that of the smaller peaks (10 and 15 dB) was higher. The relative frequency of the peaks according to their intensity in the various localities was not uniform in all the areas.

The hourly mean number of peaks occurring within 10 dB of the highest noise event recorded within the hour is shown in the last column of Table 2. It was highest in the apartment-building districts, followed by the villa-type districts, and was lowest in the mixed districts.

*Noise level at the various times of the day.* Owing to the differences in the sensitivity of people to the noise prevailing at the various times of the day, the level prevailing in the four parts of the day was estimated individually. The noise values recorded in the various groups of residential areas in the different parts of the day are shown in Table 3. The level prevailing in the morning period (06.00–14.00 hr) in the mixed districts was generally lower than that prevailing in the apartment-building districts, and it was

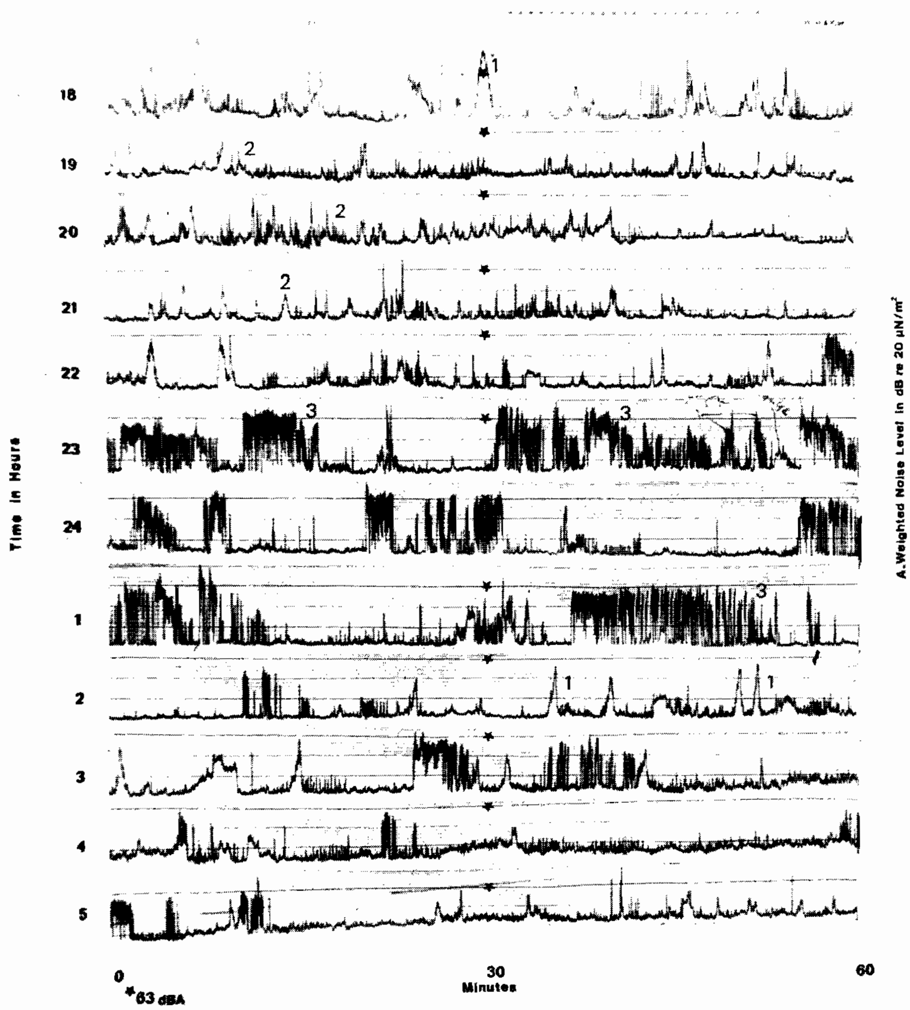


**Fig. 2.** Level recorder tracing of the community noise.

slightly higher than that in the villa-type districts at $L_{10}$ and $L_5$. The L values of the noise prevailing in the afternoon period (14.00–17.00 hr) in both the villa-type and the apartment-building residential areas were persistently lower in this period than those prevailing in the morning period. The level in the apartment-building districts was markedly higher than that prevailing in the other two types of districts and this was persistent at all the L values, though it was more marked in the integrated period exceeded for a higher percentage of time. The level in the mixed districts was generally higher than that prevailing in the villa-type districts though the difference was not marked.

The noise level recorded in the evening period (17.00–24.00 hr) was persistently higher in the apartment-building districts compared to either the villa-type or mixed districts. Also the level in the mixed districts was higher than that in the villa-type districts up to $L_{50}$. After that it was lower though the difference was not marked. The level recorded in this period was persistently lower than that recorded in the afternoon period and this was common to all types of residential districts.

The noise level recorded in the night period (24.00–06.00 hr) was naturally lower than that prevailing in all the other periods of the day. There was no marked difference between the various districts. However, the level up to that exceeded for 50% of the time or over, was higher in the apartment-building districts. The level exceeded for 10% and 5% of the time was higher in the villa-type districts. The level in the mixed districts was generally lower than that prevailing in the other two districts and this was persistent in all the percentiles.

The correlation between the level of noise exceeded for the various percentages of the time and the density of the population living in the area, the distance of the area from the airport, and the load of traffic movement in the main streets around the district was estimated. The results are shown in Table 4. It could be seen that the density of the population in the area gave a markedly higher correlation with the various L values. Moreover, the correlation coefficient was statistically significant starting from the level exceeded for 50% of the time up to the level exceeded for 5% of the time. Both the $L_{95}$ and $L_{90}$ were not significantly correlated. It seems that some factors other than the population density are responsible for the background level. The distance from the airport generally gave a lower correlation. This was also found even with the level exceeded for 1% of the time which is supposed to represent the higher portion of the noise. It was expected to find a different picture since aircraft movement is likely to contribute to the higher noise levels, though it has been reported by Eldred (1975) that a much smaller L value (0·10 or 0·01) is needed to indicate the peaks and that the $L_1$ underestimated the highest noise level. The correlation between the various L values of noise and the traffic load on the major streets at the boundaries of the area was quite poor. The correlation with the residual background level ($L_{95}$ and $L_{90}$) was slightly higher than the correlation with the other levels. However, it was still insignificant. It is probable that the estimation of the traffic loads based on the hourly mean number of cars in the streets at the boundary of the residential areas is not the proper indication of the traffic load causing the prevailing noise. It is probable that the noise is influenced by traffic movement inside the area rather than that at its boundaries. The relation of traffic movement with some parameters of noise is well documented in the literature. It is generally considered the source of the background or residual noise level in the community (Richards 1975). Moreover, the $L_{50}$ was reported by Shaw (1975) to follow clearly the fluctuation in traffic density. Shaw & Olson (1972) reported that $L_{50}$ can be calculated mathematically using the sound power produced by each vehicle and the number of vehicles moving/km$^2$/hr. The poor correlation requires further study. Though we tried to define the contribution of various sources to the prevailing noise, it should be noted that in the majority of cases, a mixture of sources combine to produce the noise environment with no source predominating (Anonymous 1973). The relation of traffic inside residential areas, which is non-freely flowing by its nature, was investigated by Langdon (1976b). He reported that the parameter that gave the highest significance with dissatisfaction of the population was the percentage of heavy vehicles and this was more important than the traffic count or the noise level. A similar study is being planned at the time being to clarify this in Kuwait.

*2. Social survey*

A modified form of the original disturbance scale (McKennel 1963) was used to assess the reaction of the people of Kuwait towards the prevailing noise. Social surveys were considered more representative of actual situations (Fuchs 1975). The use of disturbance to activities was found to be highly correlated with dissatisfaction. The interviewed people were selected from those living around the site of the measurement.

The people were interviewed about the various annoying factors to find out how prominently the complaints from noise would stand out relative to the others. Noise is generally one of many factors on which public opinion may concentrate. Satisfaction with the local neighbourhood, particularly visual and aesthetic factors, may influence annoyance from noise (Aubree & Bietry 1973). Moreover it may be masked by other factors (Walters 1975). Several annoying factors were inquired into. The results are shown in Table 5.

Three hundred and thirty people (73% of the sample) had one or another source of complaint. The percentage was lowest in the villa-type districts (70%) and was relatively higher in the mixed districts (80%) probably because of the recent development and lack of certain facilities in the latter districts. The vicinity of the airport is likely to cause a noise problem as a result of aircraft movements.

Noise was the major source of complaints (57%) followed by transport (46%) and lack of recreation facilities (25%). Sewage disposal was the factor least complained of (4%). Complaints about water supply and electricity were relatively much higher in the mixed districts. The high prevalence of the annoyance from noise was not expected since the population in Kuwait is well acclimatized to noise as a result of the extensive use of air conditioning (Hadi 1974).

The source most frequently reported in the whole sample was the traffic (84%). A similar conclusion was reached by Lamure (1975). Aircraft noise was complained of by 42%, whereas 17% complained of noise caused by their neighbours and 14% complained of noise caused by the air conditioning units. It should be noted that at the time of the survey no air conditioning was operated. It should be further noted that the total is not a mathematical summation of the individual items since most of those who complained reported more than one source. The importance of traffic was more marked in the apartment-building districts (94%), while aircraft noise was reported more frequently in the mixed districts (94%). Neighbours and air conditioning units were more frequently reported by apartment dwellers annoyed by noise. Those complaining of neighbours amounted to 23% whereas those complaining of air conditioning units reached 20%. A small fraction of the sample (18 people) felt the presence of noise and defined its source although it was not annoying them.

*Subjective reaction to the noise.* The type of disturbance most frequently reported was the waking up from sleep (48%) followed by interference with relaxation (45%) and interference with good watching of TV. The type least frequently reported was the vibration of home applicances (4%) and difficulty with carrying on face-to-face conversation (6%). However, marked fluctuations were observed. The startle reaction, keeping one from going to bed, interference with listening to the radio or TV, the flicker of the TV picture and vibration of the houses were more frequently reported in the mixed districts probably due to aircraft noise (Edwards 1975). People who complained of having to close the windows continuously constituted 19% of the sample. The types of disturbance were not very much related to speech intelligibility reported to result from both aircraft and traffic noise (Lamure 1975). The most important type of disturbance reported in our case was the interference with sleep, waking up and interference with relaxation. The intense annoyance resulting from interference with sleep due to aircraft noise is well established (Borsky 1973). The relation between disturbance of sleep and traffic noise which is the most common source in Kuwait is not so clear (Aubree 1973).

The severity of complaints was assessed by a method similar to that used by McKennel (1963). The scores are shown in the last portion of Table 5. Those who reported 1 or 2 positive answers (32%) were considered little annoyed. Those who gave 3 positive responses (29%) were considered moderately annoyed. 4–5 responses (26%) were considered severely annoyed, and 6 or more positive responses (12%) were rated very severely annoyed. The percentage of those severely and very severely annoyed (38%) was markedly higher in the mixed districts compared to the other two types of districts. Those slightly or moderately annoyed were markedly higher in the apartment-building districts. The findings presented in Table 5 are group values. Among the individuals, marked fluctuations in the responses were observed. Similar to the finding of Rylander *et al.* (1976), all grades from not annoyed to very severely annoyed were found in each group of population exposed to the same community noise level. The question of sensitivity to noise as self-rated was stressed by Langdon (1976a). He reported that differences in sensitivity accounted for a great part of the observed variance in response, though they would probably not influence the group reaction based on the average scores.

*Factors contributing to the complaints.* Certain personal factors may modify the response of people to noise (Langdon 1976c). The effect of various personal and demographic factors was investigated. The age and occupation, social status, presence of children in the family and family size did not influence the reaction to noise. Nationality, car ownership and travel by air were significantly correlated with the complaints. The percentage of Kuwaitis was higher in the group that complained ($\chi^2=6{\cdot}146$). Car ownership and travel by air were also significantly higher in the complaining group.

The effect of nationality may be attributed to socio-economic and cultural differences. It is generally believed that higher social classes are more particular about the quality of the environment and tend to concentrate on problems like air pollution and community noise which are usually not interesting to the less fortunate classes who are distracted by more serious problems. Walters (1975) reported that community noise control is a form of luxury. Langdon (1976c) reported that the lower-income classes were less dissatisfied by noise than those who were better off. Cultural differences have been reported by Jonsson *et al.* (1969) to influence the reaction of people towards community noise. Another point that may be relevant in this respect is the habit of staying late out of doors watching TV, listening to radio or simply chatting. This traditional habit is quite popular among the Kuwaiti sector of the population, and is frequently observed in summer. This is the situation that will be affected to a great extent by the prevailing outdoor noise.

The attitude of the person towards the transport medium is reported to influence his reaction towards the noise generated by that medium (Aubree 1973). The type of house did not affect the reaction towards noise. The statement of Lamure (1975) that owner-occupiers of houses are more likely to complain about noise was not supported by our findings. The presence of one or another of the auxiliary facilities to the house did not provide any significant effect. The period of residence in the locality was not significantly different between those who complained and those who did not. The idea that people tend to move away from areas with high noise levels is not supported by our findings, which agrees with the findings of Langdon (1976c) in his study of the distribution of the self-rated noise-sensitive people in the various localities.

*Level of the prevailing outdoor noise.* The community noise prevailing in the various residential districts has already been presented for each type of district in Table 2. The noise, according to the time of the day and residential district, was presented in Table 3. The correlation between the various parameters of the prevailing noise and the percentage of complaints of the population interviewed in each district was estimated. The correlations with the L values recorded in the various residential districts are shown in Table 6. Group correlation was estimated between the crude prevalence of complaints and the prevailing noise in 12 residential districts. It should be noted that group correlation rather than individual reaction was used all through this report. This was done to avoid the marked fluctuation in the sensitivity of the individuals towards noise. The use of the mean population reaction for public health purposes was recommended by Rylander *et al.* (1976). The complaints in some districts were not consistent with the expected reactions and were excluded. The regression equations for the complaints against the various L values are also shown in Table 6. The coefficient of correlation was positive with all the L values and it was significant with all the L values starting from $L_{50}$ to $L_5$. The regression equations shown in the table would provide the percentage of complaints expected on exposure to a certain level of noise. Correlation between the background level and the prevalence of complaints was insignificant. However, all the regression lines (Fig. 3) were almost parallel and any of them can be satisfactorily used in predicting the percentage of people dissatisfied by noise. The significant correlation between simple parameters as L values and the dissatisfaction due to noise is similar to that reported by Langdon (1976a). Correlation with $L_{10}$ was the highest. The importance of the $L_{10}$ was stressed by many workers (Dickinson 1972).

From Table 6 and Fig. 3 it could be deduced that the background noise $L_{95}$ or $L_{90}$ should be as low as 37 or 40 dBA respectively for no complaints to be expected. Allowing 10% of the people to be dissatisfied, the $L_{90}$ would be up to 41 dBA and $L_{95}$

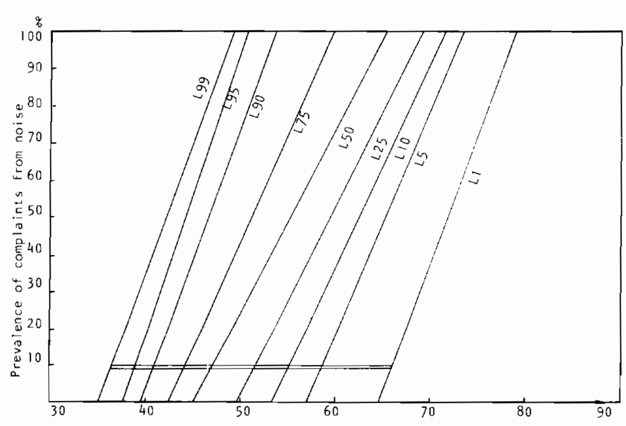


**Fig. 3.** Regression line between the prevalence of the complaints about noise in different residential districts and the various L values of noise prevailing in the particular district.

would be 39 dBA. This is the level recommended for the background of community noise in Kuwait. It should be recalled that the data presented in Table 6 are based on 24 hr records. The level at which 100% of the people would complain from the noise was a background level of 50·2 dBA and 52 dBA for $L_{95}$ and $L_{90}$ respectively.

Correlation between the various L values and the severity of the complaints in each locality was estimated. The severity of the complaints was averaged over both the total persons interviewed in the locality and those giving a positive response to the noise. The results are shown in the 4th and 5th columns of Table 6. Correlation between the various L values and the severity of the complaints averaged both ways was rather poor. The only significant correlation was recorded for the highest noise level $L_1$ not shown in the table. This is in line with reports by Rylander *et al.* (1976).

Correlation between the frequency of peaks and the prevalence of complaints and their severity was estimated. The mean hourly number of peaks in the morning, afternoon, evening, night, and the total 24 hr was used in the estimation of the correlation coefficient. The prevalence of the complaints gave a weak positive correlation with the mean hourly number of peaks averaged over the 24 hr. Correlation with the number of peaks in the morning period was higher than that with the overall mean or the number of peaks in any other period. Moreover, it was significant with the number of 15–20 dB peaks and the overall average in that period. Correlation with the peaks in either the afternoon or evening periods was quite low. With the night period it was negative. The results of the correlation between the average number of peaks and the mean severity of the complaints averaged over the number of population interviewed or the number of those who gave a positive annoyance reaction to the prevailing noise gave a similar picture, that is a higher value of correlation with the peaks in the morning period and a lower or negative correlation with the peaks in the night period. The poor correlation with the night peaks may be due to the fact that the peaks were determined relative to the background noise level at the moment of the noise event. Naturally, the lower the background level the more conspicuous will be the peaks. So the negative correlation is probably not influenced by the number of peaks but by the low background level of the prevailing noise.

The correlation between the mean number of peaks within 10 dB from the highest peak recorded within the hour in the morning, afternoon, evening, night and the total 24 hr gave a similar picture. Correlation with the percentage of the complaints was higher than that with the severity of the complaints whether averaged over those giving positive response to noise or over the total people interviewed in the locality. Moreover, the correlation coefficient was relatively higher with the morning peaks than with the other portions of the day. Correlation between the weighted average of the number of peaks multiplied by the average intensity in each locality, and the percentage and severity of complaints also was poor.

It could be concluded that the number of peaks was not of much value in predicting the prevalence of annoyance by noise or the severity of annoyance among the population in Kuwait. This is irrespective of whether we count all the peaks, or only those which lie within 10 dB of the highest peak within the hour. The poor correlation reported here is similar to the findings of Rylander *et al.* (1976).

*Community noise equivalent level.* To account for differences in sensitivity towards noise prevailing in the various portions of the day, CNEL was estimated. The use of CNEL is now generally accepted for assessment of the reaction of the people towards noise (EPA 1971). It has been reported that CNEL gave the best correlation with aircraft noise nuisance (Anonymous 1974). It has been extensively used in the U.S.A. and was adopted in the California Noise Standards for control of community noise. Dickinson & Large (1975) reported that CNEL was the best formula for assessing the reaction of the population towards noise. The original equation separates the day into three periods, day, evening, and night. This was done in the original formula by giving unit weighting to the day period, 3 to the evening period, and 10 to the night period (Wyle Laboratory 1971). In the present study, this formula was changed to conform to the local habit since most people enjoy an afternoon nap. An afternoon period (14.00–17.00 hr) was therefore inserted. The regression equations between CNEL using various weighting factors for the afternoon, evening, and night periods and the percentage of complaints are shown in Table 7. The correlation coefficient was higher with all CNEL values than that seen for the L values shown in Table 6. The introduction of weighting factors for the afternoon period proved to be an improvement on the original formula. It was seen that the coefficient of correlation was improving, with the higher factor up to a weighting of 9 in that period. After that, there was a slight reduction. It could be concluded that the afternoon period is as critical as the night period. This unit of weighting was adopted and used for estimation of the best weighting factor for the evening period. The original formula used a factor of 3 for this period. Factors starting from 1 up to 6 inclusive were used in estimating the correlation coefficient between CNEL resulting from the use of these factors and the frequency of complaints. The results are shown in the third part of Table 7. It should be noted that the morning period was given a value of 1 and the night period a value of 10 in the calculations. The best correlation was found when using a factor of 6 ($r = +0{\cdot}825$). This was fixed and the weighting for the night was attempted. Factors starting from 8 up to 13 were tried. The results are shown in the fourth part of Table 7. The highest correlation was found when using a factor of 8 or 9 for this period of the day.

To sum up, the new method of rating proved to be an improvement on the original CNEL equation, and it would better describe the reaction of the population in Kuwait to the community noise prevailing in the residential areas. The weight for the afternoon

$$\mathrm{CNEL} = 10 \log \left[ \frac{\left(\sum_{i=1}^{12} n_i \log^{-1}(SL_i/10)\right)_M + 9\left(\sum_{i=1}^{12} n_i \log^{-1}(SL_i/10)\right)_A + 6\left(\sum_{i=1}^{12} n_i \log^{-1}(SL_i/10)\right)_E + 9\left(\sum_{i=1}^{12} n_i \log^{-1}(SL_i/10)\right)_N}{N_{Total}} \right]$$

$SL_i$ : $= R + 5(i-1) - 2{\cdot}5$ in dBA. Note: This gives $SL_i$ the value of the *middle* of the interval assigned to that channel
n : Number of seconds, read from statistical analyzer
$(\ )_i$ : Value associated with a particular channel counter
R : The lowest value on the strip chart
$N_{Total}$ : Duration of the monitoring period in seconds—for 24 hr. $N_{Total} = 86400{\cdot}0$ sec
M : Morning
A : Afternoon
E : Evening
N : Night

**Fig. 4.** Community noise equivalent level recommended formula for Kuwait.

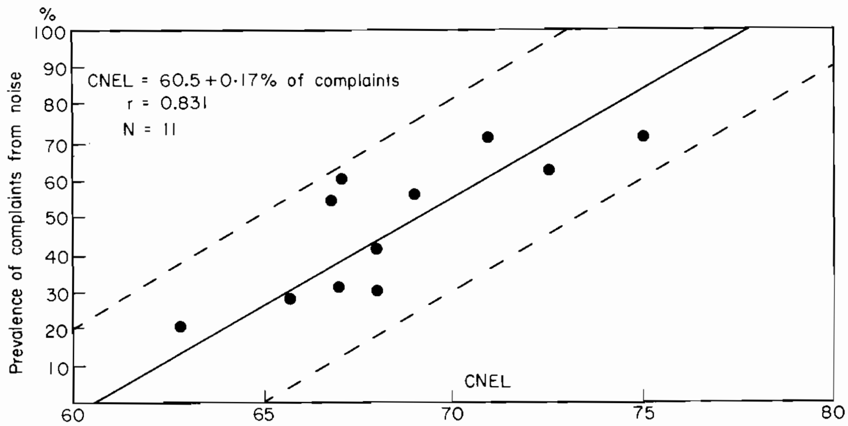


**Fig. 5.** Regression line between the prevalence of the complaints about noise in the different residential districts and the CNEL value using the recommended formula together with the 95% confidence limit.

was given a value of 9, though the figure 8 gave a slightly higher correlation coefficient. The suggested formula, together with the explanation for interpretation, is shown in Fig. 4.

The recommended level for residential districts in Kuwait, allowing not more than 10% of the population to be dissatisfied by the noise in these districts would be around 62 dBA. The regression equation presented in Table 7 opposite each formula could be used in estimating the percentage of people expected to be dissatisfied. The regression line together with the 95% confidence limit using the proposed formula is shown in Fig. 5. Correlation between this formula and the severity of complaints averaged over the people who reported that they were annoyed by noise in the various districts gave a value of r = +0·859 and +0·852 with a weighting of 8 and 9 respectively for the night period. Correlation between CNEL and the severity of the complaints averaged over the total population interviewed gave slightly lower values. Still it was highly

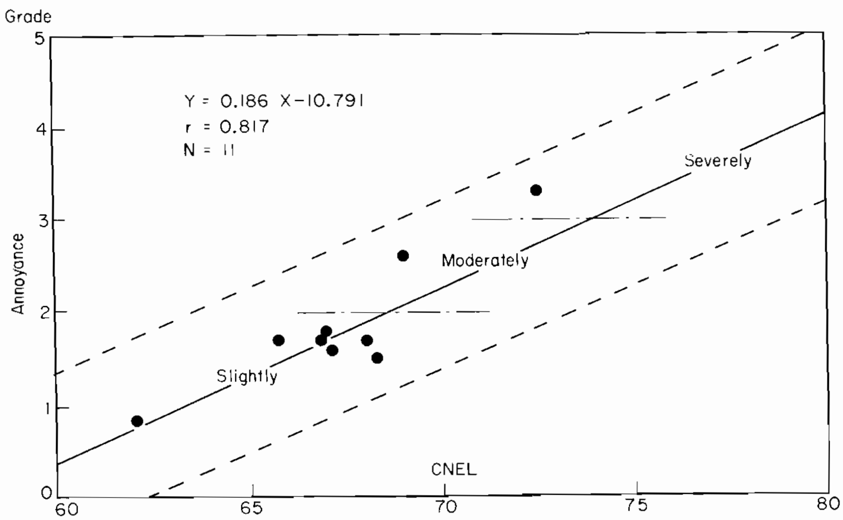


**Fig. 6.** Regression line between the CNEL and the severity of the complaints averaged over the total population interviewed in the various residential districts together with the 95% confidence limit.

significant. It seems that CNEL would effectively describe both the prevalence of annoyance from noise and its severity. The regression lines for the severity of annoyance against CNEL using factor 9 for the night period is shown in Figs 5 and 6. The regression line together with the 95% confidence level is shown in Fig. 6. The increase in severity of annoyance with higher CNEL is quite clear. The dose–response relationship shown in Fig. 6 is similar to that reported by Rylander *et al.* (1976).

Comparison of the findings in our survey with those reported by the Wyle Laboratory (1971) was not straightforward since the methodology of the calculation was different in both studies. However, the numerical value obtained by using the formula proposed for Kuwait was, on average, 2 dB higher than that obtained by using the original formula. No complaints are expected in Kuwait at a CNEL level of 56–65 (with an average of 60) which is 3 dB higher than the mean reported in the U.S.A. for no reaction, after introducing the necessary correction. Widespread complaints would be expected in Kuwait at a CNEL value of 72 (with a range of 69–74) which is also approximately 3 dB higher than the level expected in the U.S.A. It seems that people in Kuwait would tolerate exposure to noise which is 3 dB higher than the population in the U.S.A.

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**Table 1.** The mean noise level exceeded for the specified percentage of the time during the 24 hr at the measuring points in Maghreb Street and within the boundary of the airport (Kuwait, 1977).

| | Noise level (dBA) | | |
|---|---|---|---|
| | | Aircraft | |
| Noise percentile | Traffic (N=5) | Landing (N=2) | Takeoff (N=1) |
| $L_{95}$ | 49·9 | 43·6 | 44·0 |
| $L_{90}$ | 52·5 | 45·3 | 45·0 |
| $L_{50}$ | 69·7 | 52·3 | 51·2 |
| $L_{10}$ | 76·8 | 63·9 | 61·8 |
| $L_{5}$ | 77·7 | 66·7 | 66·8 |
| CNEL | | | |
| Min. | 74·2 | 43·1 | |
| Mean | 77·2 | 75·8 | 75·8 |
| Max. | 78·4 | 78·6 | — |

**Table 2.** Different L values for community noise prevailing in the various residential districts together with the mean number of peaks of noise exceeding the background by 10, 15 or 20 dBA and minimum, mean and maximum CNEL (Kuwait, 1977)

| Noise percentile (dBA) | Type of residential district | | |
|---|---|---|---|
| | Villa (N=10) | Apartment building (N=6) | Mixed (N=4) |
| $L_{95}$ | 42·2 | 44·7 | 40·7 |
| $L_{90}$ | 44·2 | 48·7 | 42·1 |
| $L_{50}$ | 52·8 | 57·4 | 51·5 |
| $L_{10}$ | 62·0 | 65·7 | 61·5 |
| $L_{5}$ | 64·8 | 67·6 | 65·6 |
| CNEL | | | |
| Min. | 62·7 | 65·6 | 63·0 |
| Mean | 67·5 | 68·4 | 67·5 |
| Max. | 75·0 | 72·5 | 69·0 |
| Peaks*(dBA) | | | |
| 10 | 37·2 | 36·6 | 30·8 |
| 15 | 23·1 | 18·8 | 18·3 |
| 20 | 21·2 | 18·7 | 13·8 |
| Total | 76·4 | 64·3 | 62·9 |
| Within 10 dBA of highest hourly peak | 15·7 | 17·0 | 10·7 |

*Above the background noise level.

**Table 3.** Distribution of the overall percentiles of the noise recorded in the morning, afternoon, evening, and night periods, according to the type of residential district (Kuwait, 1977)

| Noise percentile dBA | Morning (06.00–14.00) | | | Afternoon (14.00–17.00) | | | Evening (17.00–24.00) | | | Night (24.00–06.00) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Villa | Ap. B.* | Mixed | Villa | Ap. B | Mixed | Villa | Ap. B. | Mixed | Villa | Ap. B | Mixed |
| $L_{95}$ | 48·4 | 53·6 | 46·4 | 45·9 | 53·4 | 47·8 | 43·9 | 50·7 | 44·3 | 39·2 | 40·1 | 38·5 |
| $L_{90}$ | 49·2 | 54·3 | 48·6 | 48·2 | 53·9 | 48·7 | 45·1 | 53·2 | 45·6 | 40·4 | 42·2 | 39·1 |
| $L_{50}$ | 55·5 | 60·1 | 55·6 | 54·4 | 58·5 | 54·3 | 52·6 | 58·5 | 51·5 | 47·1 | 51·2 | 43·6 |
| $L_{10}$ | 63·1 | 67·3 | 63·9 | 62·3 | 66·9 | 65·3 | 62·0 | 65·3 | 57·9 | 59·6 | 57·8 | 51·8 |
| $L_5$ | 66·6 | 69·9 | 66·9 | 65·1 | 68·8 | 67·3 | 64·9 | 67·1 | 61·4 | 61·7 | 61·4 | 53·6 |

*Ap. B. = Apartment building.

**Table 4.** Correlation coefficient between the level of noise exceeded for a certain percentage of time in residential districts and the distance of the district from the International Airport, the density of population therein, and the traffic load in the vicinity (Kuwait, 1977).

| Noise percentile (dBA) | Density of population (N = 14) | Distance from airport (N = 14) | Traffic load (N = 12) |
|---|---|---|---|
| $L_{95}$ | 0·350 | 0·403 | 0·320 |
| $L_{90}$ | 0·394 | 0·477 | 0·299 |
| $L_{50}$ | 0·848** | 0·486 | 0·061 |
| $L_{10}$ | 0·750** | 0·417 | 0·053 |
| $L_5$ | 0·707** | 0·382 | 0·064 |

**$P<0·01$.

**Table 5.** Sources of noise reported by the indivuals complaining together with the degree of annoyance, in the various residential districts (Kuwait, 1977).

| | Type of residential district | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Villa | | Ap. B.* | | Mixed | | Total | |
| | No. | % | No. | % | No. | % | No. | % |
| Total complaints | 108 | 69·7 | 139 | 72·4 | 82 | 79·6 | 330 | 73·3 |
| Complaints about noise | 75 | 48·4 | 109 | 56·8 | 71 | 68·9 | 255 | 56·7 |
| Source | | | | | | | | |
| Aircraft | 34 | 45·3 | 6 | 5·5 | 67 | 94·4 | 107 | 41·9 |
| Transport | 58 | 77·3 | 102 | 93·6 | 53 | 74·6 | 213 | 83·5 |
| Neighbours | 9 | 12·0 | 25 | 22·9 | 10 | 14·1 | 44 | 17·3 |
| Air conditioning | 8 | 10·7 | 22 | 20·2 | 6 | 3·5 | 36 | 14·1 |
| Degree | | | | | | | | |
| Slight | 26 | 34·7 | 43 | 39·4 | 14 | 19·7 | 83 | 32·5 |
| Moderate | 22 | 29·3 | 42 | 38·5 | 11 | 15·5 | 75 | 29·4 |
| Severe | 19 | 25·3 | 22 | 20·2 | 25 | 35·2 | 66 | 25·9 |
| Very severe | 8 | 10·7 | 2 | 1·8 | 21 | 29·6 | 31 | 12·2 |

Ap. B.* = Apartment building.

**Table 6.** Regression equation between the various L values and the prevalence and severity of complaints about community noise together with the r values, the L values and the mean number of peaks of noise at various hours of the day (Kuwait, 1977).

| Prevalence of complaints | | | Severity of complaints averaged over | |
|---|---|---|---|---|
| Regression equation | | r | Total | +ve response |
| $L_{95} = 37{\cdot}42 + 0{\cdot}128 \times \%$ of complaints | | 0·529 | −0·244 | 0·143 |
| $L_{90} = 39{\cdot}61 + 0{\cdot}122 \times \%$ of complaints | | 0·529 | −0·268 | 0·100 |
| $L_{50} = 45{\cdot}39 + 0{\cdot}200 \times \%$ of complaints | | 0·679* | 0·277 | 0·172 |
| $L_{10} = 53{\cdot}50 + 0{\cdot}182 \times \%$ of complaints | | 0·670* | 0·286 | 0·161 |
| $L_5 = 57{\cdot}08 + 0{\cdot}166 \times \%$ of complaints | | 0·676* | 0·348 | 0·192 |
| Mean number of peaks | Morning | 0·644* | 0·457 | 0·394 |
| | Afternoon | 0.328 | 0·550 | 0·190 |
| | Evening | 0·148 | 0·168 | 0·371 |
| | Night | −0·476 | −0·563 | −0·126 |
| | Total | 0·251 | 0·345 | 0·369 |

*$P < 0{\cdot}05$.

**Table 7.** Correlation coefficient together with the regression equations between the percentage of complaints about noise in each of the residential districts and the community noise equivalent level (CNEL) using various weighting factors for the afternoon, evening, and night periods (Kuwait, 1977).

| CNEL | | | Prevalence of complaints: Regression equation | Prevalence of complaints: r | Severity of complaints averaged over: Total | Severity of complaints averaged over: +ve response |
|---|---|---|---|---|---|---|
| Original (no weighting) | | =58·4 | +0·163 × % of the complaints | 0·731** | | |
| Afternoon period | | | | | | |
| | 4 | =59·2 | +0·159 × % of the complaints | 0·776** | | |
| | 5 | =59·4 | +0·160 × % of the complaints | 0·783** | | |
| | 6 | =59·6 | +0·160 × % of the complaints | 0·791** | | |
| | 7 | =59·8 | +0·161 × % of the complaints | 0·791** | | |
| | 8 | =60·0 | +0·162 × % of the complaints | 0·800** | | |
| | 9 | =60·2 | +0·160 × % of the complaints | 0·810** | | |
| | 10 | =60·3 | +0·162 × % of the complaints | 0·809** | | |
| Evening period | 1 | =55·1 | +0·180 × % of the complaints | 0·781** | | |
| | 2 | =55·0 | +0·185 × % of the complaints | 0·793** | | |
| | 3 | =54·8 | +0·193 × % of the complaints | 0·803** | | |
| | 4 | =55·0 | +0·194 × % of the complaints | 0·811** | | |
| | 5 | =54·9 | +0·199 × % of the complaints | 0·817** | | |
| | 6 | =54·6 | +0·206 × % of the complaints | 0·825** | | |
| Night period | 8 | =60·3 | +0·191 × % of the complaints | 0·837** | 0·828** | 0·859** |
| | 9 | =60·5 | +0·170 × % of the complaints | 0·831** | 0·817** | 0·852** |
| | 10 | =60·2 | +0·160 × % of the complaints | 0·824** | | |
| | 11 | =60·9 | +0·165 × % of the complaints | 0·818** | | |
| | 12 | =61·0 | +0·166 × % of the complaints | 0·823** | | |
| | 13 | =61·8 | +0·164 × % of the complaints | 0·806** | | |

*$P < 0{\cdot}05$, **$P < 0{\cdot}01$.

## APPENDIX

Ministry of Public Health,
Public Health Department,
Occupational Health and
Industrial Pollution
Control Section

### SOCIAL STUDY FOR COMMUNITY NOISE EXPOSURE

Name Age

Address District Street Block

Job (head of household)

Family size

| *Member* | *Name* | *School year* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |

Reason for coming to Kuwait

Time of stay in Kuwait
—Car ownership in the family
—Air travels No./year
—Place of summer vacation

Housing conditions:
—Distance from the street
—Traffic load on the street
—House type: Traditional house Villa
Apartment
—Annexes to the house
Garden Yard
Garage Others

TV & Radio ownership:
—No. of TV sets
—No. of radio sets

Type of air conditioning
None Central
Units No.

Period of residence in the district Years

Cause of living in the district

Are there any annoying factors in the district?
Yes No

Factors of annoyance:

| | | |
|---|---|---|
| Traffic | School | Water supply |
| Power supply | Neighbours | Lack of recreation facilities |
| Noise | Overcrowding | |

Residential quarters:

Do you notice presence of noise in your district? Yes No

—Sources

Aircraft Traffic Neighbours A.C.

—Form of annoyance: does the noise ever cause:

Startle? Hesitancy to go to bed?
Wake you up? Interference with the telephone communication?
Interference with listening to radio/TV?
Flicker of TV picture?
Vibration of the house or household appliances?
Interference with relaxation?
Cause you to close the windows permanently?
Cause you to seek quietness away from home?
Interference with conversation?

Do you plan to move from the present house?
If yes—Why?

Any comments about the causes of noise:

| | |
|---|---|
| Human activities | Household applicances |
| Traffic | Radio and TV |
| A.C. units | Aircraft |

Recommended control measures:
Town planning
Setting building specifications
More quiet machinery
Changing the behaviour of the population
Others

Notes:

# الضوضاء في الكويت
# من النواحي الاجتماعية والبيئية

مصطفى الدسوقي و ابراهيم هادي
قسم الصحة المهنية ومكافحة التلوث الصناعي
وزارة الصحة العامة
الكويت

## خلاصة

تم قياس الضوضاء في ٢٩ نقطة ، تمثل تسع منها الضوضاء الناتجة عن مصادر محددة هي حركة المرور ، وحركة الطائرات في المطار الدولي ، أما باقي النقط فقد تم توزيعها داخل المناطق السكنية بحيث تمثل تعرض المواطنين ، فأخذت عشر نقط في احياء نموذجية حيث نوعية المساكن السائدة هي الفيلات المفردة ، وأخذت ست نقط في مناطق سكنية حيث نوعية المساكن هي العمارات السكنية ، بينما أخذت النقط الأربع الباقية في مناطق مختلطة يتواجد بها النوعان من المساكن .

واجريت القياسات لمدة ٢٤ ساعة باستخدام قياس ديسيبل أ ، وسجلت نتائج التوزيع التكراري للضوضاء السائدة في تمام الساعة السادسة صباحا والثانية ظهرا والخامسة مساء وفي منتصف الليل ، وبذا قسم اليوم إلى ٤ فترات . وتم حساب المستويات التي تجاوزتها الضوضاء في نسب مئوية من الوقت تبدأ من المستوى الذي تجاوزته الضوضاء فيما يعادل ١٪ إلى ٩٩٪ من الوقت في كل فترة .

وكان مستوى الضوضاء القاعدية في مناطق الفيلات ٤٤,٢ د . أ وفي مناطق العمارات السكنية ٤٨,٧ د . أ ، أما في المناطق المختلطة فقد بلغ ٤٢,١ د . أ . وكان مستوى الضوضاء متقاربا في فترات الصباح وبعد الظهر والمساء ، بينما انخفض المستوى كثيرا أثناء الليل (من منتصف الليل حتى الساعة السادسة صباحا) . وكان عدد المرات التي سجل فيها ارتفاع مفاجيء للضوضاء تزيد قيمته عن ١٠ أو ١٥ أو ٢٠ ديسيبل عن الضوضاء القاعدية وكذلك عدد المرات التي ارتفعت فيها الضوضاء في شريحة عرضها ١٠ ديسيبل عن أعلى مستوى سجل خلال الساعة أكثر تكرارا في المتوسط في مناطق العمارات السكنية منها في المناطق الأخرى ، وكان الارتباط واضحا بين المستوى الذي تجاوزته الضوضاء في عدد من النسب المئوية المحددة في كل منطقة من المناطق وكثافة السكان بها . أما الارتباط بين مستوى الضوضاء والبعد عن المطار أو حركة مرور السيارات في الشوارع الرئيسية المحيطة بالمنطقة فكان ضعيفا .

وفي نطاق الدراسة الاجتماعية تم استطلاع اراء المواطنين في كل منطقة من المناطق عن مصادر

الضيق بالمنطقة ، وقد تبين ان الضوضاء هي أكثر مصادر الضيق ذكرا (٥٦,٧٪) ، كما تبين ان الضوضاء الناتجة عن حركة المرور كانت أكثرها انتشارا (٨٣,٥٪) تليها الضوضاء الناتجة عن حركة الطائرات (٤٢٪) . ثم الضوضاء الصادرة عن الجيران (١٧,٣٪) تليها تلك الصادرة عن أجهزة التكييف (١٤,٣٪) .

وكانت مظاهر الضيق من الضوضاء أكثر ارتباطا بمظاهر التداخل في القدرة على الاستغراق في النوم (٤٧,٥٪) ، والاسترخاء (٤٨,١٪) ، والقدرة على الاستمتاع بمشاهدة الارسال التلفزيوني (٣٢,٥٪) . ولم يكن التداخل في القدرة على متابعة الحديث على نفس الدرجة من الأهمية . وكانت شدة الضيق متوسطة عند (١٦,٧٪) من المواطنين وشديدة عند (١٤,٧٪) منهم وبالغة عند (٦,٩٪) . وكانت نسبة الذين اشتكوا من ضيق بالغ أعلى في المناطق المختلطة القريبة من المطار .

وتبين ان السن وحجم الاسرة والمهنة ونوع المسكن أو وجود ملحقات له لم تكن ذات أثر في تفاعل المواطنين للضوضاء . وكان المستوى المادي للاسرة ، والجنسية ، هما العاملان الوحيدان اللذان كان أثرهما واضحا وملموسا ، كما كان بعد السكن عن الطريق من العوامل المؤثرة . ولم تظهر الدراسة اتجاه المواطنين للانتقال من المناطق السكنية لمجرد الشكوى من الضوضاء .

تبين أن كل المستويات التي تجاوزتها الضوضاء في النسب المئوية المختلفة من الوقت ، عدا تلك التي تجاوزتها الضوضاء لمدة ٩٠ أو ٩٥٪ من الوقت كانت مرتبطة ارتباطا قويا بمدى انتشار الشكوى ، أما شدة الشكوى فكانت مرتبطة بالمستوى الأعلى من الضوضاء ، بينما كان الارتباط بالمستويات الأخرى ضعيفا . وكان الارتباط بين المتوسط المتوازن للضوضاء البيئية في كل منطقة من المناطق وبين انتشار الشكاوي أو شدة الضيق الناتج عن الضوضاء أعلى من الارتباط مع كل المستويات المشار اليها ، وكان أعلى ارتباط بين معدلات الشكوى وبين المستوى المتوازن للضوضاء البيئية مع المستوى المحسوب على أساس المعادلة التي تعطى وزنا للضوضاء السائدة في فترة الظهيرة (من الساعة الثانية إلى الخامسة مساء) مساويا للوزن في فترة الليل (من منتصف الليل إلى الساعة السادسة صباحا) ، مما يشير إلى أن الحساسية للضوضاء في فترة الظهيرة لا تقل عن الحساسية للضوضاء في فترة الليل . وخلص التقرير إلى التوصية باتخاذ اجراءات محددة لتخفيض مستوى الضوضاء واجراء بعض الدراسات الأخرى لبيان تأثير حركة المرور وحركة الطائرات .