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THE PERCEPTION OF NOISE: A SURVEY STUDY AROUND JEDDAH INTERNATIONAL AIRPORT, SAUDI ARABIA

By

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ABSTRACT

The Perception of Noise: A Survey Study
Around Jeddah International Airport,
Saudi Arabia

By

Asaad Mohammed Atiyah

Despite tremendous increase in air traffic at Jeddah International Airport and concomitant increase in noise levels, one finds a profound lack of concern for such matters in current planning. This study of a sample of 770 residents, investigated the noise perception of people living within 7-kilometers of the airport.

Interviews focused on (1) spatial variation of noise levels by quarter, (2) noise perception and distance from the airport, (3) noise perception and length of residency, (4) length of residency and propensity to change residence because of noise, (5) willingness to change residence and potential destination, and (6) willingness to change residence as related to income.

The results of chi-square tests demonstrated that residential areas under the flight corridor and directly adjacent to the airport are most critically affected by noise. This pattern is not static during pilgrimage season. Shorter termed residency lessened noise tolerance and strengthened willingness to move, which was confined within city boundaries and directly income related.

ACKNOWLEDGMENTS

The writer wishes to express his sincere appreciation to Professor Stanley D. Brunn, Chairperson of the Master Committee, for his professional direction and countless hours of guidance in developing and implementing this study. Thanks are also extended to Professor Ian M. Matley and Professor Dieter Burnnschweiler for their willingness to assist in the completion of this thesis.

To the residents of Jeddah City, special thanks are extended for the special time spent during the interviews which made this study possible.

In addition, my family, friends, and colleagues at Michigan State University have been unselfish with their encouragement. I am grateful for their thoughtfulness and consideration.

DEDICATION

To my wife Refah who bore with me the hardships and to our two sons Mohamed and Mohanna who added meaning to our life, I lovingly dedicate this work.

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CHAPTER I

INTRODUCTION TO THE STUDY OF NOISE

Man has paid no mean price for his technological development and progress. If on the one hand his discoveries have shrunk distances between nations and bridged communication gaps, he has created innumerable ecological problems. It is true that one can have breakfast in Jeddah, lunch in London, afternoon tea in New York and dinner in San Francisco. But with all these advantages he has caused untold strain on his life.

The greatest price modern man has paid for his progress is in terms of loss of peace and quiet in the modern world.

> Noise and vibration have spread like environmental cancers in this age of over population, high industrial machine power and traffic density (Croome, 1977, p. xiv).

The noise level in urban societies has increased tremendously. With this increase, people exposed to this excessive noise have exhibited signs of sleeplessness, mental stress, and even such physical disorders as the inability to hear. Some experts have pointed out that noise interferes even with the sexual potency of those exposed to this ecological pollution. Such people show a nervous temperament and lack of mental concentration. In general, one can say that

> As the sound pressure level increases the effects spread from attitudinal to behavioral and ultimately physiological effects. Thus at levels above 130 decible, noise can

> cause death, certainly intense pain and permanent damage to the hearing mechanism (Langdon, 1975, pp. 2-3).

There are many factors in our modern environment today that contribute to noise pollution. One of the most important sources of urban pollution is traffic, even though a great deal has been done to reduce automobile noise. Cars today are almost noiseless, yet the cumulative effect of traffic and traffic noises counterbalances the gain in the reduction of noise that technology has made. Aircraft noise pollution, on the other hand, has been steadily on the increase.

> Disturbance caused by aircraft noise is the most serious problem associated with air transport operations. Over the next 15 years there should be a marked decline in the number of people adversely affected by aircraft noise. However, governments will continue to develop policies to reduce the impact of this nuisance and to seek international agreement on more stringent noise standards for aircraft (ITA Bulletin, 1978, p. 870).

The development of airports around almost all small-sized population areas has further added to the problem. With the development of airports and the landing and takeoff of large and small aircraft, the life of a region undergoes a considerable economic and demographical change. It is for this reason and its direct impact on the population adjacent to airports that continued study of noise pollution is important.

Statement of Problem

Noise pollution has been systematically studied in most advanced countries of the world. The ecological effects of noise produced by aircraft in Los Angeles, Chicago, New York and London have been

carefully studied and government agencies have been alerted about the findings. Unfortunately, similar studies have not been undertaken with the necessary seriousness in less advanced countries.

In Saudi Arabia and in Jeddah City especially, noise pollution is particularly serious because the airport is forced to handle an extraordinary volume of air traffic, particularly during the two months of the pilgrimage (Hajj). Secondly, the ecological consciousness that is part and parcel of current planning and legislation in advanced countries has not yet become recognizable in Saudi Arabia. The government agencies in Saudi Arabia are currently totally indifferent to this problem. Residents themselves have hardly paid any attention to the seriousness of the problem. Indeed, the ecological thinking of the country is in the rudimentary stage. People tend to accept noise pollution as a fact of life and they are not aware of its long-term effects.

The primary purposes of this study are twofold: (1) to focus on the perceptions of the people living in the noise polluted area, and (2) to discover what measures they want to take or do not want to take in regards to this aspect of their lives.

Objectives of Study

This study achieves three basic goals. First, even though noise pollution studies have been made with regard to large cities including London, Paris, Tokoyo, Los Angeles and Chicago, and their findings are readily available to the planners in Saudi Arabia, to date no study has been made with the active involvement and the perception of the local

population of the City of Jeddah. This study, it is hoped, will contribute to the residents of Jeddah City becoming active participants in the planning of their future airports.

Second, this study will introduce and provide, for the first time, an example of elements in the country's development. The planners, as a whole, have thus far concentrated almost exclusively on the symbols of progress to the utter disregard of human problems that might result from such progress.

Third, by presenting the perceptions and points of view of the residents around Jeddah International Airport, this study will alert the government and private agencies to conduct further research into the problems of development from a more comprehensive perspective. It is hoped that this study will become the basis for a closer look at and continued research into other ecological pollutions that both the developed and developing countries must guard against.

Justification of Study Within Geography

Ecological pollution has added a new dimension to the problems facing man in a modern metropolis. It has affected the quality of the human environment. The geographical and ecological dimensions of noise pollution have become a serious problem and a major theme in human geography. If geographers are concerned with the environmental perception of human beings which enable them to make decisions affecting their environment, then noise as a factor affecting these decisions is within

the domain of geography. In this regard, Tuan (1967) described geography as:

> The hub of geographical concern is often signalled by a pair of terms like 'Man and Land'; 'Land and Life'; 'Man and Environment'. These flexible expressions, however, also label the interest of workers in their field, not only the ecologists and the anthropoligists, but the philosopher and the theologian write on terms than can be surveyed under such titles as 'Man and Land' or 'Man and Nature'. For members of these geographical guilds, the lore area seems to lie in the spatial, mapable manifestations of the 'Man-Land' synergism (p. 4).

It is clear that the continual subdivision of knowledge and the living in a changing world of specialization has given way to the rise of a new branch of study called "Man-Environmental Studies". This branch of study is concerned with the investigation into the way people interact with an environment. In effect, this branch is related in many ways to other social and behavioral sciences, but as Rapoport, a Professor of Architecture and Anthropology (1977) indicates:

> Much of this work initially came from Geography because of its concern with how people make decisions affecting the earth. Thus, the concept of the perception of opportunities, hazards and resources come to play an important role (p. 25).

Geographers are mainly concerned with the spatial differentiation and/or association and properties of the environment. In this connection, Beck (1967), adds,

> Perception of the environment requires man to interpret the physical and social components of its stimulus field. Such an area of inquiry falls congruently into the disciplines of Geography and Psychology, which are concerned, respectively, with the physical perspectives of the stimulus field and with personal attributes arising out of functional and symbolical transactions between men and that field. These transactions further yield to the establishment of group attitudes, beliefs, and values associated with various domains of the environmental

> field. The physical and the interpersonal properties of the environment are distributed in space, and personal environmental space is shaped by the configuration of these properties. Personal systems of spatial meaning may yield important insights into individual perceptions of the environment (p. 18).

The main concern of this thesis is, from the point of view of a geographer, the physical and interpersonal properties of the environment vis-à-vis noise and their distribution in space around the Jeddah International Airport in Saudi Arabia. The thesis further examines the personal system of spatial meaning that the population living around Jeddah International Airport bring to bear upon the insight of the perception of the environment.

Organization of Study

The remainder of the study is divided into five chapters. Chapter II provides general information on aviation system of Jeddah International Airport. A review of pertinent literature is presented in Chapter III. The description of study area, hypotheses, means of data collection and sampling procedure, are outlined in Chapter IV. The analysis of resident's perception of the problem of aircraft noise is discussed in Chapter V. The last chapter provides the conclusions and recommendations.

CHAPTER II

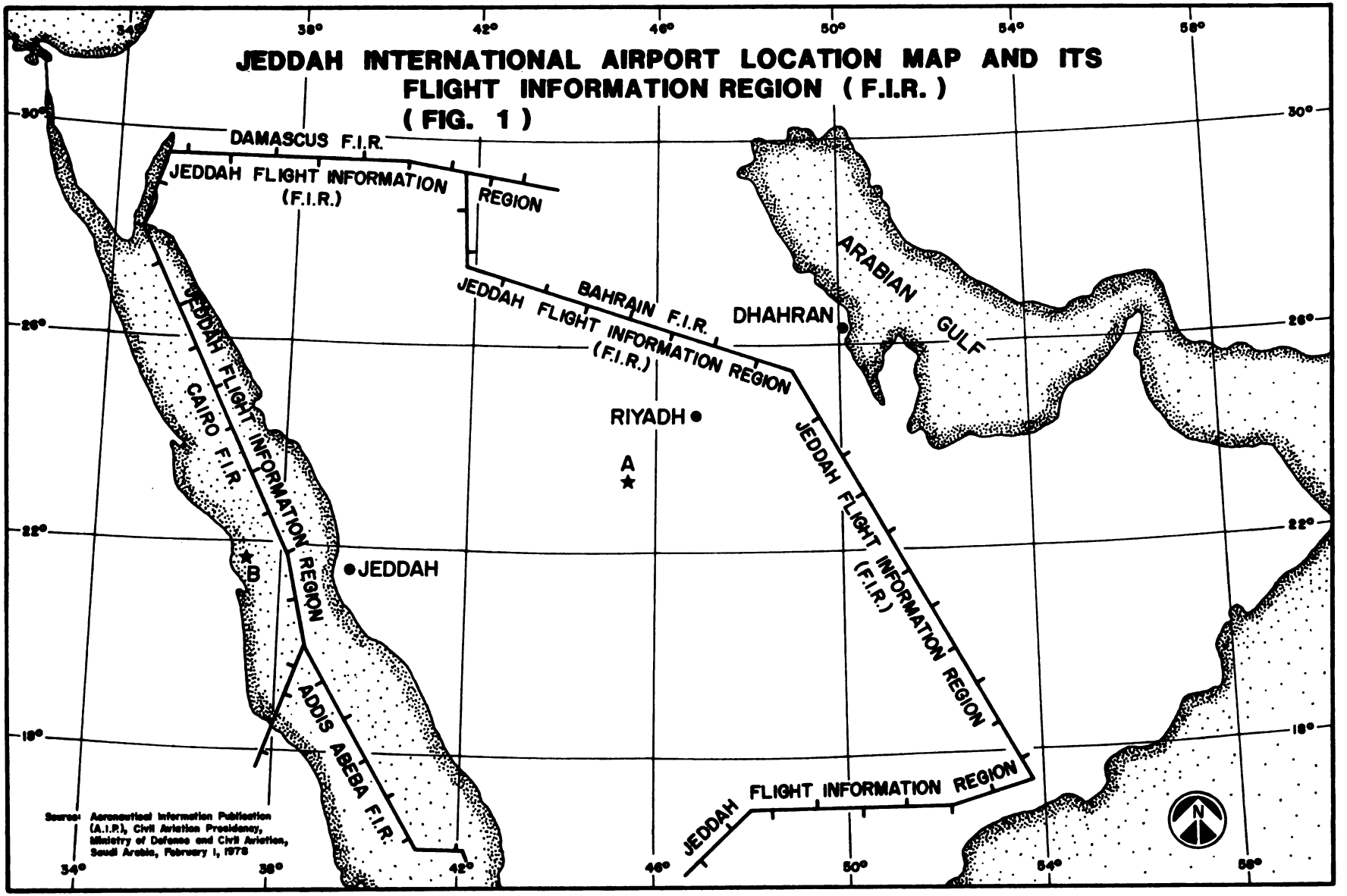
AVIATION SYSTEM OF JEDDAH INTERNATIONAL AIRPORT

The discussion of this chapter focuses on four topics related to the aviation system of Jeddah International Airport. They are: 1) Location and physical characteristics of Jeddah International Airport, 2) the pattern of air routes, 3) the eight existing airways which serve the airport, and 4) the hourly, daily, weekly and yearly distribution of aircraft operations.

Location and Physical Characteristics of Jeddah International Airport

The Jeddah International Airport is located at 21° 31' 12" North and 39° 12' 06" East (Figure 1). It has the widest range of flight information region (F.I.R.)* of any of the international airports in Saudi Arabia. The airport consists of two linear parallel runways that are also parallel to the Red Sea in that they run in a southeast-northwest direction. These runways are known as 15 Right/33 Left and

*Like any other flight information region (F.I.R.), this is an internationally known region to help a pilot to get necessary aviation information about the area in which he flies. These regions were given names which coincide with the name of an airport located within their boundaries. A pilot flying within the boundary of a flight information region must only contact that airport regardless of other nearer airports. For example, a pilot positioned on Point A (see Figure 1) must contact Jeddah International Airport, not Riyadh, and on Point B, he must contact Cairo, not Jeddah.


JEDDAH INTERNATIONAL AIRPORT LOCATION MAP AND ITS FLIGHT INFORMATION REGION (F.I.R.)
(FIG. 1)
DAMASCUS F.I.R.
JEDDAH FLIGHT INFORMATION REGION (F.I.R.)
BAHRAIN F.I.R.
JEDDAH FLIGHT INFORMATION REGION (F.I.R.)
ARABIAN GULF
DHAHRAN
RIYADH
A
JEDDAH
B
CAIRO F.I.R.
JEDDAH FLIGHT INFORMATION REGION
ADDIS ABEBA F.I.R.
JEDDAH FLIGHT INFORMATION REGION (F.I.R.)
JEDDAH FLIGHT INFORMATION REGION
Source: Aeronautical Information Publication (A.I.P.), Civil Aviation Presidency, Ministry of Defense and Civil Aviation, Saudi Arabia, February 1, 1978
N
34°
38°
42°
46°
50°
54°
58°
30°
26°
22°
18°

15 Left/33 Right. The orientation of the runways is determined by the wind factors. Ideally the runways should be aligned with the prevailing winds. The prevailing winds, according to the Jeddah Meteorological Station, are shown in Table 1. The wind direction and velocity over the

Table 1

Winds Direction and Average Speed at Jeddah City

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Direction	360	359	360	360	360	360	358	310	360	Var.	Var.	360
Average Speed	8	8	9	7	8	8	6	9	9	6	5	7

Direction in grades and speed in knots
Knot = 1.2 mile or 1.9 kilometer per hour
Var. = Variable

Source: General Metrological Department, Ministry of Defense and Civil Aviation, Jeddah, Saudi Arabia, 1978.

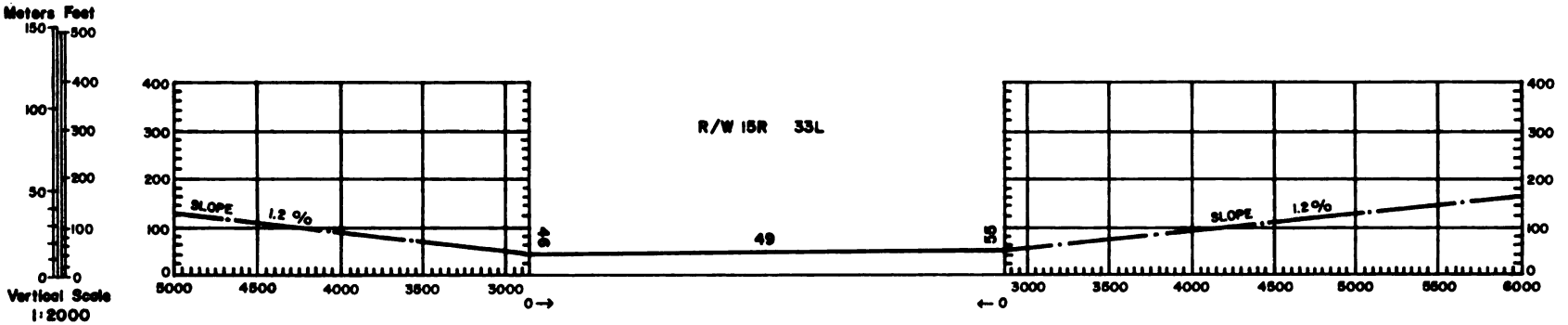
year definitely affect the layout of the airport's two runways. It is clear from Table 1 that the wind directions are north and northwesterly. The layout of the airstrips in a southeast-northwest direction and the prevailing north and northwesterly wind direction make the airport 90-95 percent operative all through the year. In other words, all landings and takeoffs follow the opposite direction of the wind; however, when the wind changes its direction and exceeds ten knots, the landing and takeoff procedures change accordingly.

The physical characteristics of these runways are depicted in Figures 2 and 3. The true bearing of both runways is 150° and 330°

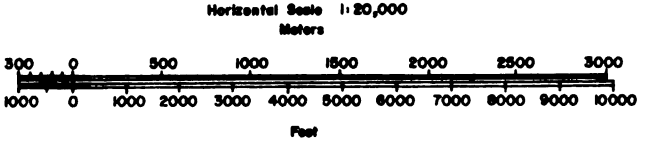
PHYSICAL CHARACTERISTICS OF RUNWAY 15 RIGHT/33 LEFT
(FIG. 2)

DIMENSION IN METERS, ELEVATION IN FEET

MAGNETIC VARIATION 1° E - 1966



BUILDING OR LARGE STRUCTURE	■
POLE, TOWER, ANTENNA, ETC.	●
TRANSMISSION LINE	—T—T—

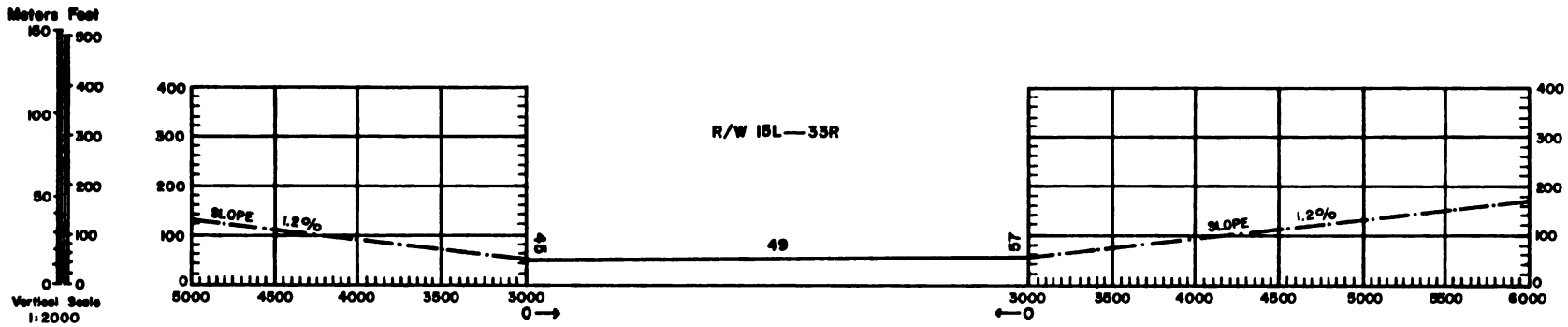


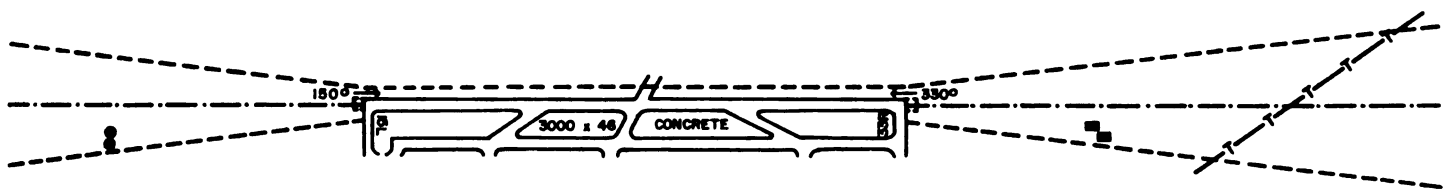
Source: AIP, Civil Aviation Presidency, Ministry of Defense and Civil Aviation, Saudi Arabia, January 1, 1978

PHYSICAL CHARACTERISTICS OF RUNWAY 15 LEFT/33 RIGHT
(FIG. 3)

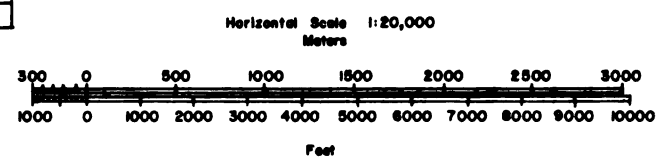
DIMENSION IN METERS, ELEVATION IN FEET

MAGNETIC VARIATION 1° E - 1966





BUILDING OR LARGE STRUCTURE	■
POLE, TOWER, ANTENNA, ETC.	●
TRANSMISSION LINE	—T—T—

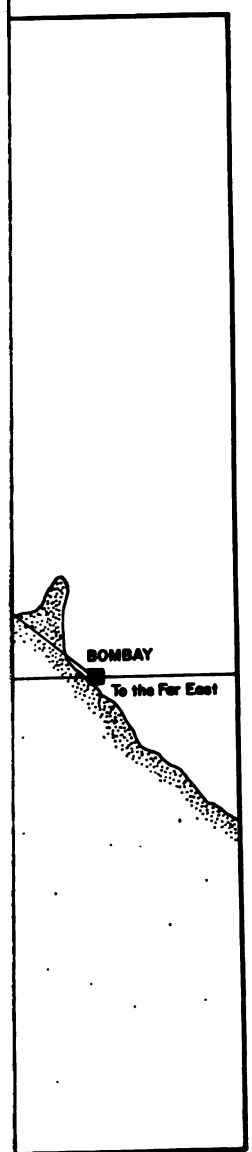


Source: AIP, Civil Aviation Presidency, Ministry of Defense and Civil Aviation, Saudi Arabia, January 1, 1978

with an allowance for the magnetic variation of 1^{o} east as determined in 1966. The highest elevation of both runways is 50 feet above mean sea level; however, the slope gradient of each varies slightly. The longitudinal profile of runway 15R/33L shows a slope gradient varying from 55 to 46 feet but that of runway 15L/33R is 57 to 45 feet. Both runways are 46 meters wide but runway 15L/33R is 3,000 meters long and 15R/33L is 2,865 meters long. Takeoffs and landings do not take place at the same time; under the operational procedures these are independent operations. The space separating the two runways is approximately 100 meters making simultaneous takeoff and landing dangerous. The runways are hard surfaced concrete and asphalt that can handle the incoming and outgoing traffic of such heavyduty aircrafts as the Boeing 747.

Air Route Pattern

In Saudi Arabia, two kinds of air routes--internal or domestic and external or international--exist (Figure 4). A close examination of this figure reveals that almost 65% of these air routes serve domestic and direct city-to-city connections; they also form a closely knit pattern connecting large provincial cities which are located far apart. The remaining 35% of the air routes are international; 63% of the international traffic following these routes involves crossing a water surface such as the Red Sea or Arabian Gulf. The pattern of the air routes clearly shows a concentration of traffic in terms of the size of the cities and their political and economic importance. The two nodes of concentration coincide with the two largest cities


BOMBAY
To the Far East

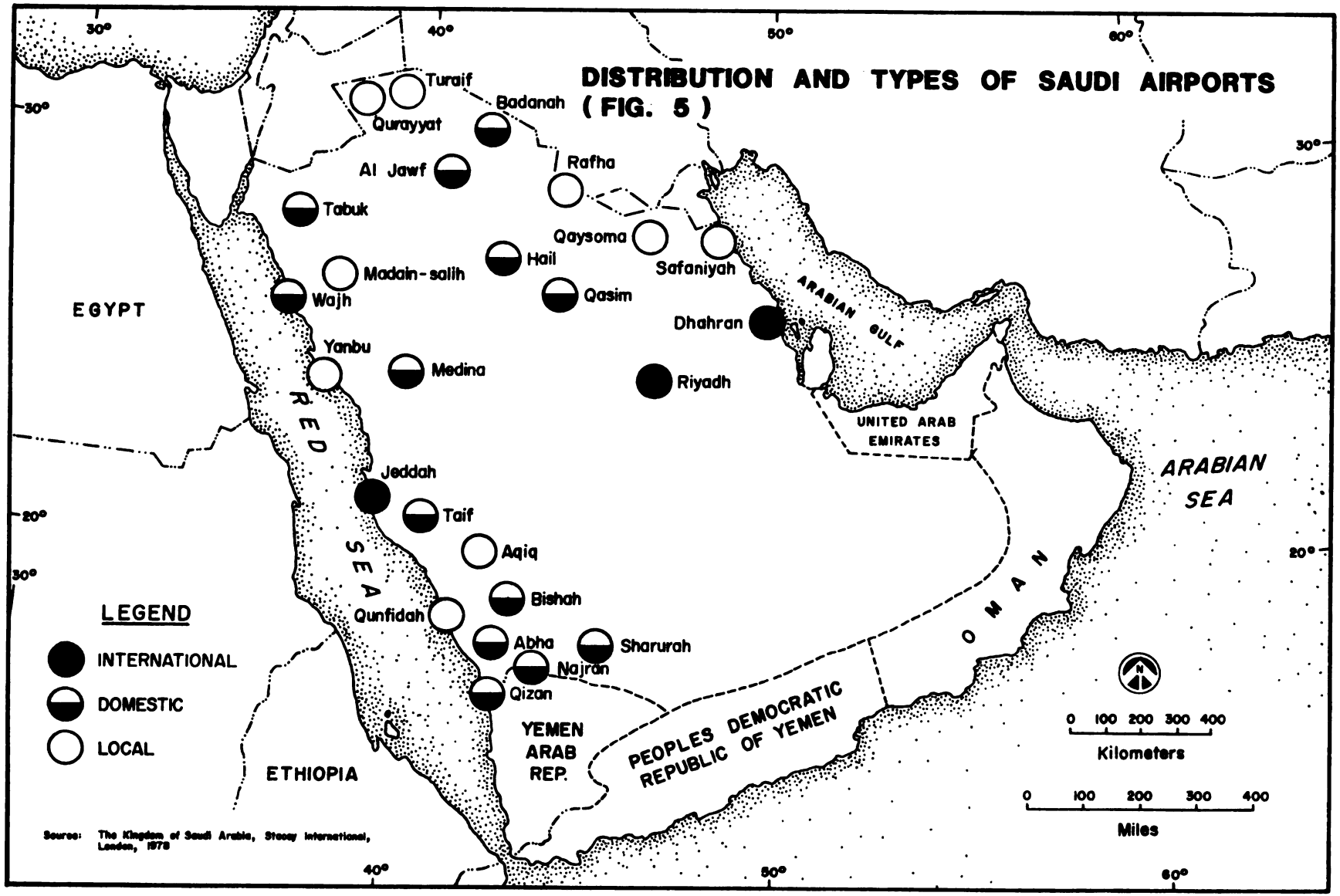
in Saudi Arabia, Jeddah--the major economic center, and Riyadh--the political center. The concentration of air traffic at Jeddah is much more marked than towards Riyadh, both domestic and international routes. This large number of routes focus on Jeddah because this city is closer to the major domestic and international nodes than is Riyadh.

Airways

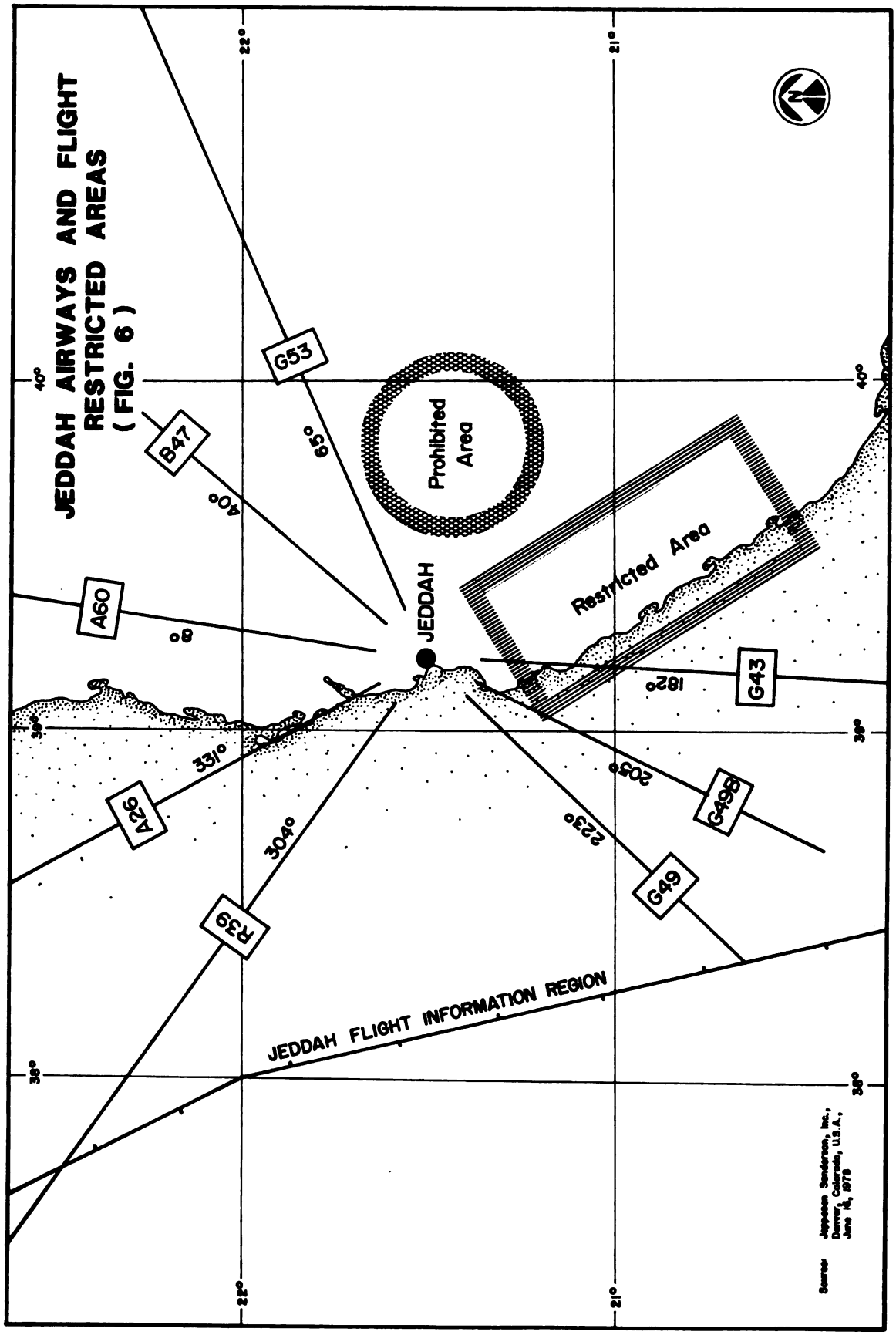
The Jeddah International Airport is served by the following eight international domestic onroute airways:

1) R 39 from the northwest (304°)
2) A 26 from the northwest (331°)
3) A 60 from the northeast (8°)
4) B 47 from the northeast (40°)
5) G 53 from the northeast (65°)
6) G 43 from the southwest (182°)
7) G 49-B from the southwest (205°)
8) G 49 from the southwest (223°)

The location of this system of airways has been determined by the existing distribution of the nation's 25 airports (Figure 5). Furthermore, the map of Saudi Arabia shows that there are no natural barriers in the way of these airways except in the case between G 53 and G 43 where there are human made barriers (Figure 6). The danger or restricted areas in the paths of the last two mentioned airways are bounded by lines joining the points 21° 25' North, 39° 25' East; 21° 12' North, 39° 02' East; 20° 28' North, 39° 32' East; and



Source: The Kingdom of Saudi Arabia, Stacey International, London, 1978


JEDDAH AIRWAYS AND FLIGHT RESTRICTED AREAS
(FIG. 6)
22°
21°
40°
38°
G53
B47
A60
A26
R39
G43
G49B
G49
065°
040°
080°
331°
304°
182°
203°
223°
Prohibited Area
Restricted Area
JEDDAH
JEDDAH FLIGHT INFORMATION REGION
Source: Jeppesen Sanderson, Inc., Denver, Colorado, U.S.A., June 14, 1978

20° 41' North, 39° 54' East; this is an area designated as a military firing zone. The second restricted area is within a radius of 5 nautical miles of 21° 26' North, 39° 49' East. The area around Mecca City prohibits air flights for religious reasons.

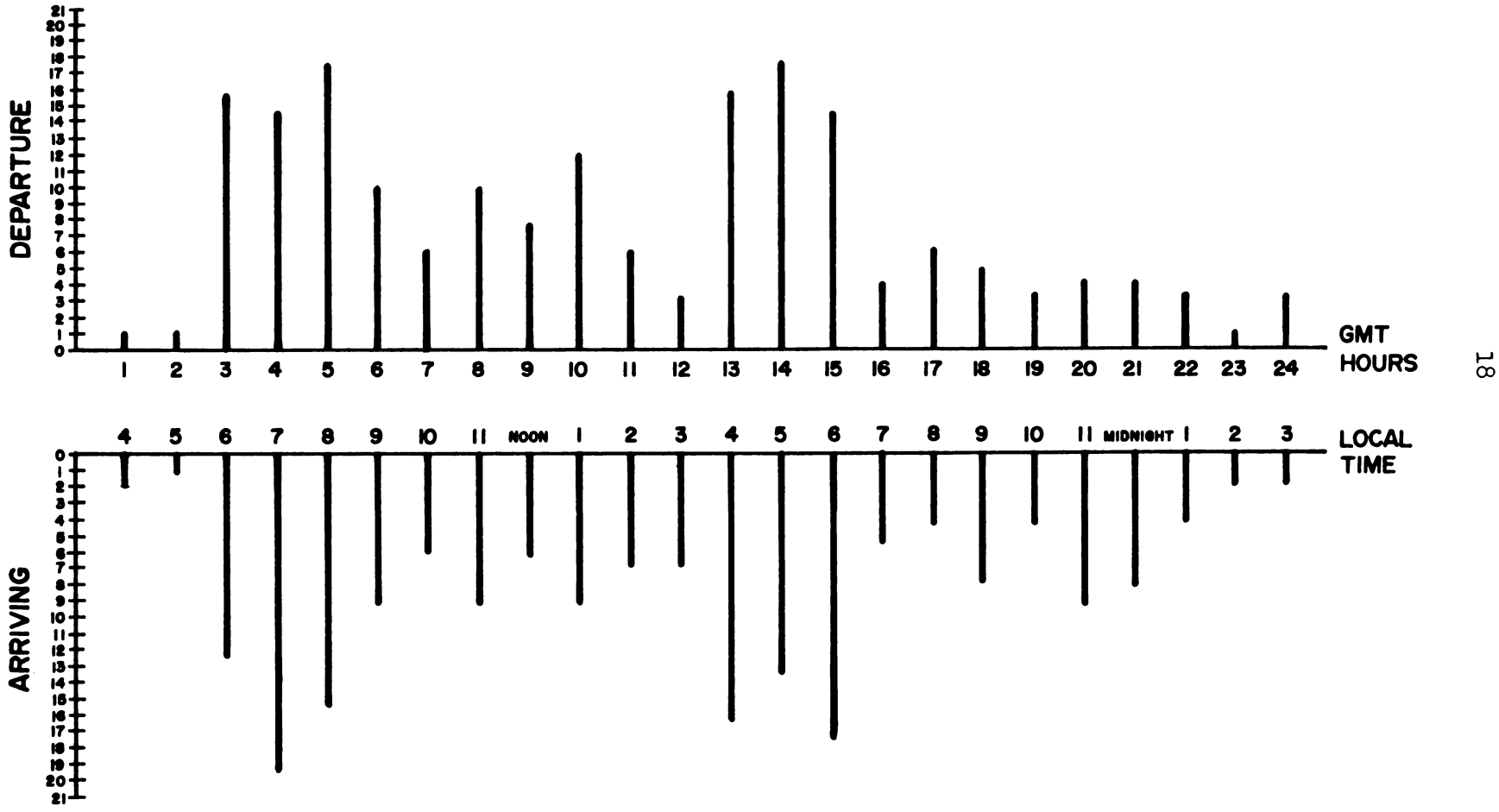
The volume of traffic along all air routes into Jeddah International Airport varies greatly.* Approximately 97% of all international traffic arrives and departs via airway R 39 to the northwest and G 49 to the southwest. The remaining air traffic, both for arrivals and departures, uses G 43 to the southwest. Eighty-four percent of all domestic air traffic is via A 60, B 47 and G 53 to the City of Medina, Hail, Gassim and Riyadh to the north-northeast and the City of Najran to the southwest. The rest of the domestic traffic, departs and arrives via G 43 to the southwest and A 26 to the northwest to the cities of Gizan and Wegh.

Aircraft Operation

The hourly distribution of aircraft traffic in a typical day at Jeddah International Airport is shown in Figure 7. This figure clearly shows six distinct peak hours out of the twenty-four hour working day. These hours are six, seven, and eight in the morning and four, five, and six in the afternoon. The figure further reveals two mini-peak hours around noon between 11 a.m. and 1 p.m. Between 1 and 5 in the morning, the pressure on the airport is the lowest. The weekly distribution of

*This information was obtained by visiting the Radar section of the Jeddah International Airport.

HOURLY DISTRIBUTION OF AIRCRAFT OPERATION AT JEDDAH INTERNATIONAL AIRPORT (FIG. 7)



Source: Data gained from the information desk at the Jeddah International Airport, March 3, 1979

air traffic at Jeddah International Airport and the traffic pattern of the average daily traffic during the two-month Hajj season for 1978 is shown in Table 2. It is clear from Table 2 that the air traffic on

Table 2

The Average Daily Air Traffic Operation of the Regular Time and the Two Months Hajj Time for 1978

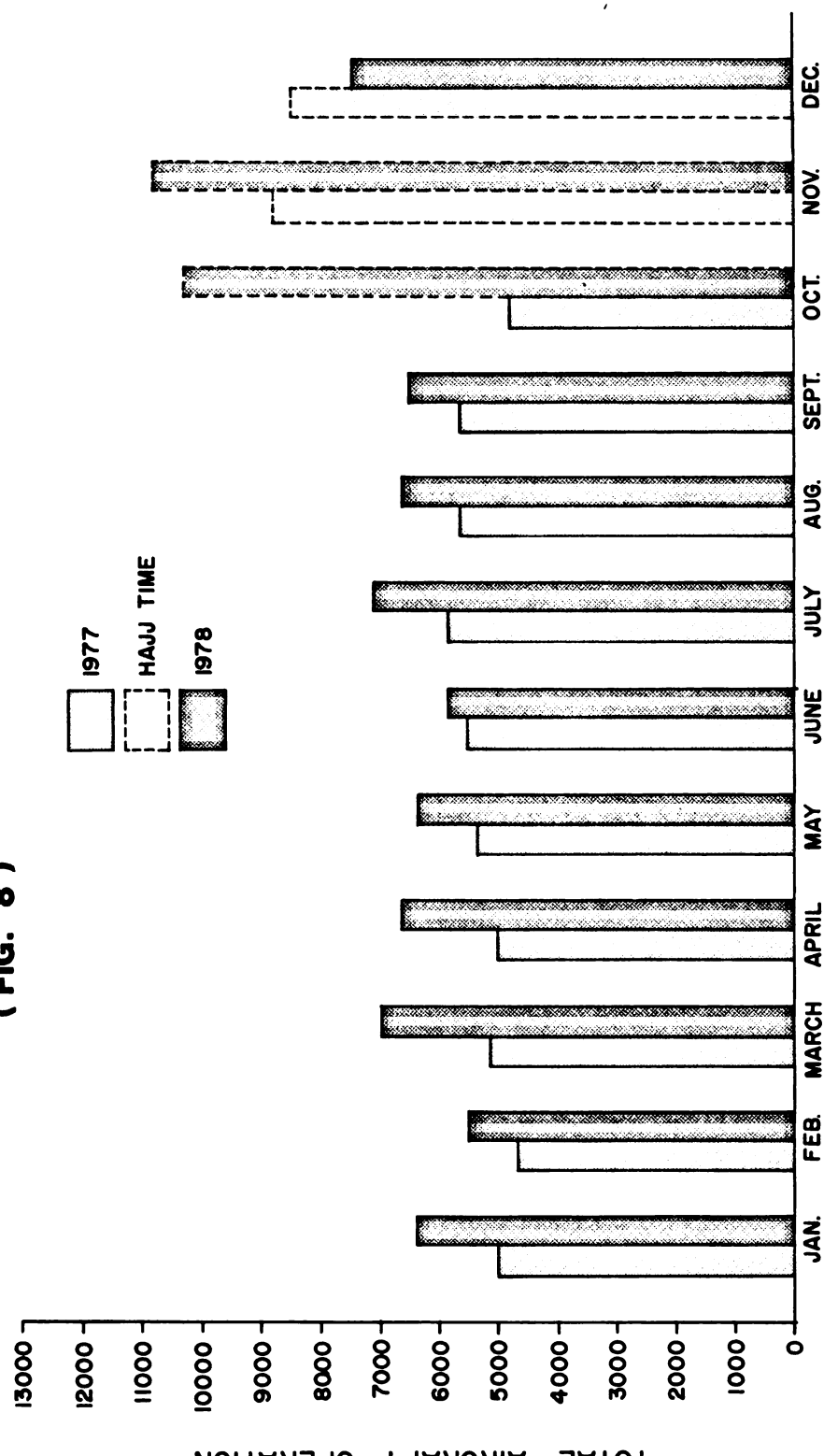
Weekdays	Regular Time (Average 10 Months)	Hajj Time (Average 2 Months)
Saturday	239	365
Sunday	233	353
Monday	222	351
Tuesday	214	358
Wednesday	246	370
Thursday) Weekend	188	341
Friday) Days	207	330

Source: Air Traffic Services (ATS), Department of Civil Aviation, the Ministry of Defense and Civil Aviation, Jeddah, Saudi Arabia.

Thursdays and Fridays, the Muslim weekends, drops considerably as compared with the regular weekdays. This drop in traffic on weekends is higher during the regular season than it is during the Hajj season. Furthermore, it must be observed that the traffic just before and after the weekends is the highest during the regular season as well as during the Hajj season. This can be explained by the fact that most users of the facility use air travel for business purposes.

The seasonal variation in air traffic in 1977 and 1978 at Jeddah International Airport is displayed in Figure 8. Two facts clearly stand out in this figure, namely that during the Hajj season, which spreads

SEASONAL VARIATION OF AIR TRAFFIC AT JEDDAH INTERNATIONAL AIRPORT (1977-1978)
(FIG. 8)



Source: Data gained from Airtraffic Services (A.T.S.), Dept. of Civil Aviation, Ministry of Defense and Civil Aviation, Saudi Arabia

over two months, Jeddah International Airport handles 20% of its annual traffic. It must be noticed that the Hajj season does not follow the Greogorian calendar cycle, but it is based on the lunar calendar which the Islamic countries follow. In 1977, the Hajj season comprised November and December while in 1978 it spread over October and November.* The level of air traffic operation in the non-Hajj season falls far below the slackest months of the Hajj season; this traffic is more pronounced only in Jeddah than in any other city in Saudi Arabia.

The volume of air traffic and passengers in 1977 and 1978 are shown in Table 3. This table clearly shows that both the number of

Table 3

Air Traffic and Passenger Volumes in 1977 and 1978

Year	Traffic Volume				Passenger Volume		
	Domestic	International	Local	Total	Domestic	International	Total
1977	34774	32829	3919	71522	2067964	3978993	6046957
1978	47110	38010	2785	87905	2976850	4570849	7547699
Difference	+12336	+5181	-1134	+16383	+908886	+591856	+1500742
% Increase	+35.5	+15.9	-28.9	+22.9	+43.9	+14.9	+24.8

Source: Air Traffic Services (ATS), Department of Civil Aviation, the Ministry of Defense and Civil Aviation, Jeddah, Saudi Arabia.

*The Islamic calendar is based on lunar rather than solar years. A lunar month is the time between two successive new moons, about $29\frac{1}{2}$ days, and the basic length of a lunar year is 354 days ($12 \times 29\frac{1}{2} = 354$), eleven days shorter than the normal Greogorian year.

passengers and the volume of air traffic were much greater in 1978 than in 1977. The year 1978 recorded an increase of 1.5 million passengers or 24.8% increase over 1977, and 16,000 air operations or 22.9% more than the previous year. This increase may be due to the fact that the pilgrims find air travel speedier than surface travel. The popularity of air travel can be further attributed to four factors: 1) the vigorous expansion of Saudi Arabian economy (Jeddah City manages most of the country's business and hence attracts local and overseas interests); 2) Jeddah City is the diplomatic center of the country where all embassies are located including the Saudi Arabian Ministry of Foreign Affairs (the rest of the government is located in Riyadh, the political capital); 3) Jeddah City performs the traditional role of gateway to the Muslim holy places (90-95 percent of the pilgrims coming by air arrive at Jeddah International Airport in the two-month Hajj season); and 4) Jeddah International Airport serves the school teachers moving in and out of the whole of the western region. Foreign teachers, who constitute 47 percent of the total teaching faculty can use only Jeddah International Airport for their vacation time.

Additional reasons for heavy pressure on Jeddah International Airport worth mentioning are:

1) The rapid economic growth, as the 1978 estimate shows, has increased the pressure on the Jeddah International Airport.
2) The growing population of Saudi Arabia, heavy immigration, and increasing tourist traffic outside the country.
3) The low fuel prices in Saudi Arabia has made many international airways divert their traffic to Jeddah.

The volume of domestic traffic is much greater than the international traffic (Table 3). This difference can be attributed to the facts that the only authorized national airlines (SAUDIA) has considerably augmented its fleet from one propeller aircraft to fifty-one big jet airliners in the last three decades. The number and type of aircrafts in use on the national routes are shown in Table 4. The advantages gained in speed and comfort by the introduction of the modern aircraft have popularized air travel. The introduction of the long-awaited express shuttle service between Jeddah and other major cities has made Jeddah the boarding point for places inside the country.

Table 4

The Number and Type of Aircrafts in Use on the National Routes

Aircraft Type	No.	Aircraft Type	No.	Aircraft Type	No.
Lockheed Tristar 1011	8	Boeing 737	17	Grumman Gulfstream	2
Boeing 747	3	Douglas DC-3	3		
Boeing 707	10	Apache 235	2	Cessnna 421-B	2
Boeing 720-B	2	Beechcraft A-100	2		

Source: Public Affair Division, Annual Report: 1978, Saudi Arabia Airlines (SAUDIA), Jeddah, Saudi Arabia

From the above description it is clear that air traffic at Jeddah will continue to increase and is likely to have both positive and negative effects on the rising urbanization and economic and

educational levels of the country. With the increase in the prosperity of the country, people will have more leisure time on their hands.

On the negative side, the rapid increase in air traffic will create certain environmental problems among which will be the increase in the volume of noise resulting from increased air traffic.

While people have become increasingly sensitive to noise pollution resulting from aircraft operations in both large and small sized cities in the developed world, these same residents recognize the importance of an international airport to the economy of the country. This is also to be expected as equally important in many developing countries. But in the case of Jeddah City, the problem is unique because in the first place the jet traffic has increased so rapidly, secondly because Jeddah experiences the extraordinary volume of air traffic during the Hajj season, and thirdly because the residential areas are built around three sides of the airport. The jet noise therefore affects every segment of the population.

Before discussing how residents perceive the existence and seriousness of aircraft noise around Jeddah International Airport, the next chapter will provide a review of pertinent literature to noise.

CHAPTER III

REVIEW OF LITERATURE

The destruction of the urban environment is solely attributed to human behavior and design. The invasion of noise of high level of intensity especially from multiple sources in almost every urban center in the world is one example of the environmental destruction which man has introduced into urban life; that invasion, along with other environmental destructive elements, threatens to strangle him.

Man and Noise

Concern for noise pollution is not new. Dasmann (1972), states that:

> Most primates are noisy animals and man is no exception. Anyone who has listened to a pack of baboons getting settled for the night in Africa develops a better perspective on the racket frequently heard in human gatherings. It is no news that cities are noisy places. The fact has been commented on since the Towers of Babel were first constructed. But in the technologically advanced sections of the world, noise pollution has reached new dimensions (p. 375).

Regardless of the diversity of the level of technological advancement, the above argument does not necessarily mean that people in real life, wherever and whenever they live, are in a totally silent environment. People rather are surrounded by the natural noises of winds, waters and birds, and by man-made music and traffic noises. Generally speaking,

Burns (1973, p. 7) states that "the more primitive the society, the less, in loudness and frequency of occurrence, is man-made sound likely to be." This generalization leads us to the conclusion that noise pollution is not only a contemporary characteristic of the developed world. This is because the tremendously accelerated progress attained in technology, which in part helps to create an environment of increased interpersonal communications, is spilling out and diffusing from the developed world. The implication of this diffusion is clear: people in less developed areas of the world are also absolutely dependent on advanced technology that is produced outside their own borders.

Technological Advancement and a Need for a Scientific Definition of Noise

Unfortunately, the word "noise" has come to be associated, especially in recent years, with almost any developed country, and demonstrated from a review of existing literature, there are very few studies dealing with the problem of noise in less developed countries. During the last two decades an enormous amount of literature dealing with noise pollution, its effect on human social behavior and property values has appeared in learned journals, especial studies and lay articles. In recognizing the effects of noise pollution, many agencies and individual studies have focused their attention on the solutions to the problems that stem from noise pollution.

Although Longdon (1975, p. 1) concludes that "it is not easy to define noise in a wholly satisfactory way," most studies begin with

the definition of noise. In distinguishing between noise and sound, Stafseth, Porter, Suet and Mader (1970), state that:

> to the scientist, noise and sound are identical. To the non-scientist citizen, however, the two are vastly different. Sound is a necessary and desirable condition of our daily existence, noise is not (p. 11).

This led the above research team to accept the definition of noise as "unwanted sound". In fact, this definition is commonly accepted; it has been used in numerous noise studies and, indeed, it is a layman's way of distinguishing noise from sound. In developing a scientific definition of noise in terms of the pressure the sound waves create on the human eardrum, a report by the State of Michigan Governor's Advisory Council for Environmental Quality in 1970 adds:

> The ear can sense an incredible power input range, one that spans from a threshold of hearing equivalent to one power unit, to a threshold of pain equivalent to ten trillion power units (p. 13).

Physiological Effects of Noise

It is clear from the above definition that there is a limit beyond which human audio systems can tolerate the pressure exerted by the external environmental pressures. At that level, as Berland (1970, p. 3) describes it, the sound becomes "obnoxious". It is necessary in studying the effects of noise to find a scientific procedure in which to measure the intensity of the sound emitted by a source. The unit of sound that is identified is called a decibel. A decibel is a measure of sound in terms of the human capacity to hear or perceive a sound wave. Expressed another way, it is a measure

of energy emitted by a vibrating source that has the capacity of exciting the human eardrum so that it can perceive that energy and interpret it. It has been found that the human ear can perceive sound energies between zero and 140 decibels. This range has been described by Theodore Berland in his Noise--The Third Pollution in this manner:

> The decibel is not a linear unit like the inch, but is a logarithmic unit like those on a slide rule. Thus, 10 db. is ten-fold the power of 1 db. This kind of a scale is necessary because of the incredible range of acoustic power which the human ear handles . . . about a billion--billion to one. It can hear sounds almost as faint as those produced by the thermal motion of molecules. It is comfortable with the 50 db. of a quiet office, but it can also hear a subway train screaming through its underground tunnel at 100 db., or a jet plane taking off nearby, whining 120 db. (p. 4).

Professor Tosi (1972, pp. 95-96) maintains that "from a hygienic point of view, it has been established that the tolerable level of noise should be kept below 85 db. at six miles apart from the source." He further adds that "if a person is exposed for a short moment beyond 160 db., the structures of the middle ear simply rupture."

It is clear from the above works that the limits of human endurance for sound lie between 140 and 160 db. Indeed, most scholars put the limit at 140 decibels. The variation in intensity of typical sources of community noise is described by Franken and Page (1972, p. 125) in the following table.

Table 5

Typical Sources of Community Noise Variation in Intensity

Representative Situation	Levels db(A)	Sources
	110	Jet Aircraft at 1000 ft.
	100	
	90	Trains and Subway at 50 ft. Trucks and Motorcycles at 50 ft.
Busy Urban Street	80	Power Mower at 50 ft.
	70	Buses at 50 ft. Automobiles at 50 ft.
300 ft. from heavy traffic	60	Air Conditioner at 20 ft.
Commercial Area	50	Power Station at 50 ft.
Quiet Suburb, day time Quiet Suburb, night time Quiet Rural, night time	40 30	
	20	

db(A) (A-Weighed Sound Level)

Source: Franken, Peter A., and D. Page, "Noise in the Environment," Environmental Science and Technology, Vol. 6, No. 2, 1972, p. 125.

The effect of noise of varying decibel intensities on various activities are compiled by Fuchs (1975, p. 388) in the following table.

Table 6

Human Subjective Evaluation. Effects and Sound Levels Related to Activities in Noise.

Activity	Effect	Evaluation	Levels db(A)	Observation
Manual Work	Trauma	Intolerable	135	Physiological
	Painful--P.T.S.	Risky	120	
	Deafening--T.T.S.	Unacceptable	90	
	Fatigue			
	Failures			
Mental Work	Distractions	Intrusive		Psychological
	Impossibility		80	
Communication	Interference	Uncomfortable		
Rest			70	
Music		Tolerable	50	
Relax	Interruption			
Sleep		Acceptable	40	

Source: Fuchs, G. L., "Subjective Evaluation of Transport Noise in Latin America," Journal of Sound and Vibration, Vol. 43, No. 2, 1975, p. 388.

It is clear from the above table that, even within the perceivable limits of the human ear, various levels of decibel intensities have a considerable effect on human activities ranging from sleep to manual work. The same study by Fuchs adds, however, that differing exposure,

life patterns and past experience of a surveyed social population lower the correlations with physical scale and indices.

The psycho-physical effects of noise have long been studied. Two of the earlier studies were conducted at Harvard and M.I.T. In 1955 Newman argued that, though noise has a nuisance value, man is capable of adapting to its interference; he quotes a famous experiment in an insurance company which put sound treatment in its offices and concludes that:

> In this case, the simple answer was that when they took some of the sound treatment down again and went back to hard walls, and after a short period of adjustment, work output stayed at the same level as when they had the sound treatment in (p. 19).

It is clear that such studies were generally observational and analytical and were not based on hard data. In another study, also published in 1955, Rosenblith argued that the effect of noise could not be studied through a simplistic stimulus-response format. The effects of noise are complex and require a careful data collection and analysis. Both studies indicate that very little attention was being paid to noise pollution in the 1950's as the problem had just begun to receive the attention of psychologists and engineers. In a more detailed study of the effect of aircraft noise conducted more than a decade later, Kryter (1966) states that:

> (1) Some people will be annoyed by sounds that others accept, and this difference in turn is influenced by what these individuals are doing from moment to moment. There is evidence, incidentally, that after an initial adjustment, a person becomes less rather than more tolerant of continued exposure to aircraft noise.
>
> (2) Community reaction is a relative matter. The seriousness and importance of the annoyance due to

> aircraft noise will undoubtedly be viewed in the light of the noise environment as a whole.
>
> (3) It is a matter of equities. This factor cannot be judged on a scientific basis; it is a matter of opinion concerning the rights of individuals to be protected from nuisances and the welfare of the community as a whole (p. 347).

The 1960's were marked by a large number of studies focusing on the psychological and physical effects of noise on human beings. In an article entitled "City Dwellers, Teenagers Face Deafness From Noise," published in Congressional Quarterly Weekly Report in April 1970, there were reports that high noise levels could result in serious medical problems. Among the effects of noise pollution on city dwellers listed are: 1) Noise causes hearing loss. Permanent damage occurs when a person is exposed to a sound level of 85 db. over a period of years. 2) American teenagers have been found to have hearing loss levels similar to that of 65 year olds. 3) Noise is reported to cause blood vessels to constrict, cutting off the flow of blood to important parts of the body. 4) Noise can affect the part of the nervous system which controls involuntary functions of the heart, blood vessels, muscles, and glands. 5) Unborn children have shown tendencies from harmful hormones caused by stresses on the mother due to noise. 6) Noise is believed to be responsible for epileptic seizures. The study further reports that a low-flying jet can generate energy equivalent to 115 decibels, and as a result of this state of affairs, 140 major American airports have been subjected to law suits, complaints and political agitations. This is one reason most airports in the United States are built 20 to 30 miles from the downtown parts of cities--to avoid

the problem of locating the use runways away from populated areas. Also, in this regard, it is interesting to note that in 1962 the Supreme Court ruled that airport operators were liable for damages resulting from aircraft noise. What is interesting about this governmental report is the fact that airport noise has become a major environmental pollutant, and that it is receiving the attention of almost all the major metropolises of the world. In another report entitled The Noise Around Us, issued by the United States Department of Commerce in 1970, it is stated that the number of miscarriages, death rates and the incidence of heart attacks are adversely related to noise environment in Europe, U.S.S.R., and the U.S.A.

A useful study by Cohen and others (1970) recorded the effect of steady-state noise conditions and concluded that the duration of steady-state noise exposure in mechanized industry are very likely causes of hearing loss. They define steady-state noise as "one essentially free of noticeable transients or sound bursts." They state:

> Noises which fluctuate in level or are subject to interruption or pauses also may qualify as steady-state sounds, provided that these alterations are not abrupt in nature (p. 614).

This definition is particularly useful when studying the effect of aircraft noise in its close environment.

Laboratory research by Hockey (1972) of Durham, England recorded the effects of noise on the efficiency of human work in the context of individual differences. It was found that extroverted people were more susceptible to the narrowing of attention than the introverts. The study states that noise:

> May have the effect of raising the level of arousal in the man, so that he feels more awake, more alert, or, in the extreme, more tense and subjectively stressed (p. 300).

Though the study includes this generalization, it also mentions there are differences in the response to noise arising out of personality traits. It further warns that such differences "should be borne in mind by any attempt to make sweeping statements about noise and its effects on people in general" (p. 303).

Psychological Effects of Noise

Noise can affect our attitudes toward neighbors and the neighborhood we live in. In a significant study by Foreman and others (1974), the authors examine the "Noise Level: Attitudinal Surveys of London and Woodstock, Ontario" via a questionnaire and through interviews. Their study, based on interviews with 800 householders concludes:

> Sixty-four percent of the respondents were bothered by noise to some extent. Only 3% of the people interviewed said that they were extremely bothered by noise and, on a scale of one to seven, where one was 'not bothered at all' and seven 'extremely bothered', seventy-three percent of the respondents were bothered to a degree of only 4 or less. Thus one can report that less than a quarter of citizens were really bothered by noise in their neighborhood (p. 20).

It was also important for the researchers to know at what time during the day and year the perception of noise is most bothersome. In this regard they state that noise:

> was seen as more of a problem during the day and evening by most people and not much of a problem from midnight

> to early morning . . . with respect to the comparison between weekends and weekdays, there was little difference. Fifty-four percent of the respondents found noise something of a nuisance on weekends and 55% found it somewhat bothersome on weekdays. Only 8% more respondents said noise was extremely more bothersome on weekends. Seasonally, summer was found to be the noisiest season, followed by fall and spring and then winter (p. 21).

Foreman, et al. listed the sources of bothersome noise; they conclude that the majority of the population of London and Woodstock were bothered by motorcycles, passing cars, transport trucks, squeeling tires, revolving engines, etc. This gives rise to the speculation that bothersome noises emanating from modern transportation methods, including the air-transportation, takes a heavy toll of man's anxieties in the modern urban world.

Definition of a Maximum Noise Area

Other studies that related to the findings of airport noise have been conducted. In a study published in England by Wickrama and others (1962), the authors concluded that:

> a retrospective study covering two years of admission to a psychiatric hospital shows that there is a significantly higher rate of admission, especially in certain diagnostic categories, from inside an area of maximum noise arising from Heathrow Airport than from outside this area (p. 1275).

Furthermore, they also assert that:

> This is a retrospective study, which measures only admission to a psychiatric hospital, and makes no attempt at exploring mental illness in the community. A further more detailed perspective study is planned.

> Several factors can govern whether a patient is admitted to hospital or treated in the community and we don't suggest that aircraft noise itself can cause mental illness. The results clearly show, however, that admission rate to Springfield Hospital are significantly higher from the M.N.A.* than from outside it, both for total person admissions and for first admissions (p. 1277).

In another pertinent study by Ando and others (1975) in Japan, they conclude that:

> The children from relatively noisy living areas tended, when performing tasks, to show occasional short periods in which they produced substantially less than their own average rate of work. A similar difference did not appear when working in noisy rather than quiet conditions, and it was considered to be something chronic about the children themselves. These results were independent of the sex of the subjects and the feelings of the subjects about aircraft noise (p. 683).

Physical Impairment Resulting from High-Level Noise

This study would therefore seem to indicate that some kind of chronic ailment in the performance of tasks is related to constant exposure to noise. Ando, et al. have projected that even a decrease in the birth weight of a child is possible if the pregnant mother is exposed to a long period of stay in a noisy neighborhood.

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*M.N.A. is the maximum noise area, and it is defined and mapped by authors as that where sound levels are above 100 PNdB. PNdB or the Perceived Noise Level in decibels, is defined by A. A. Walters as "the normal measure of loudness." He further states:

> It measures the loudness of aircraft noise but gives greater weight to the high-frequency tones--such as the high-pitched screech of turbo-jet engine--to which the human ear is most distressingly sensitive. This PNdB measure is the one that is used more or less universally in order to measure the loudness in terms of human experience (p. 19).

One of the earliest studies studying the effects of noise from commercial aircrafts around an airport was conducted by Cohen and Ayer (1964); it focused on the measurement of operational noise in the working areas and the evaluation of potential danger to hearing. The study attempted to determine the relationship between hearing losses of airport workers and their occupational noise exposure. It also attempted to determine the noise exposure the community living around the airport had to suffer. The study concluded that potential harmful noise levels were found at ground run-up, taxi and take-off operations, and in the area of engine test-cell facilities. Both jet and propeller aircraft produced annoyance noise levels in the residential areas with jet noise posing the greater problem. The conclusion of the study is as follows:

> Noise conditions in the ramp areas and in the jet and propeller engine test-cells reached the highest observable levels and were believed hazardous to hearing. The audiometric data of unprotected airport employees having a history of excessive exposure to operational aircraft noise showed greater hearing losses than those reported for a comparable group of persons with minimal noise exposure. Measurement of flyovers noise in areas surrounding an airport indicated the flyovers of jet aircraft to be more intense, more disruptive of speech, and more annoying than that of distant aircraft (p. 150).

Noise Levels in the Arrival and Departure Routes Over Airports

A study by Hurdle and others (1971) focused exclusively on the noise intrusion problem due to overflights of jet aircraft in the approach and departure air routes over communities in the Los Angeles metropolitan area. The study found that at least 10 peripheral

residential communities at distances of up to fifteen miles from the airport suffered noise level of 120 db. due to jet aircraft over-flights. Los Angeles International Airport handles 500 commercial jet aircrafts overflights every day. Many urban communities in the United States are subjected to about 100 overflights during the peak traffic period. That results in hundreds of thousands of individuals being subjected to noise annoyance every two minutes for about three hours duration. The noise levels from these aircrafts exceeds the allowable residential noise under most municipal codes, but usually no action is taken against these air-carriers.

The legal arguments of noise pollution have been presented in a test-case involving Haven V. Eastern Incorporated (Meyer, 1972). The study is significant because it attempts to focus on the legal aspects of noise pollution due to jet aircraft flights in the densely populated areas of the United States. It further points to the concerns of the population and its reaction against high noise levels. The problem in many parts of the United States has reached a level where the residential population is sufficiently disturbed to take an agitational approach to the problem. As a result of such litigations, an element of planning with a view towards reducing the noise level experienced by the population has become part and parcel of commercial flights, their routes, and the location of airports.

Another very thorough investigative report under the title "Effects Of Aircraft Noise on Man" by German investigators Fink and others (1975), focused on the following questions:

> (1) What social, psychological and psycho-physiological reaction does aircraft noise evoke; which effects on social, psychic and romantic well-being are ascertainable?
>
> (2) In which form can the relation(s) between exposure to aircraft noise (number, level, timing of flights and the effects on man can be described); to what extent are reaction variables predictable in terms of stimulus characterizations?
>
> (3) Are sociological, psychological, and physiological aspects of environment and personality (apart from the noise itself) coresponsible for intensity and quality of noise effects; which variables are apt to explain different reactions under the same exposure conditions (p. 335).

The study does not draw conclusions so much as presents the scientific measurement centering around the above questions. However, the study recognizes that "the individual hearing loss tends to grow with number and intensity of daily aircraft sound stimulation" (p. 346).

Noise--Its Effects on the Value of Property and the Mobility of Population

Another group of studies focus on the impact of aircraft noise on residential property. A study by Gautrin (1975) identified a number of economic factors other than noise that determine the value of land near airports. The writer states that:

> With the growth of Heathrow Airport, new employees or "users" will seek to locate themselves near the airport, trading the advantages of being near the airport against the noise (unless they are completely noise imperturbable). They will, of course, prefer quiet areas at equal distance from the airport. And one can effectively observe a greater population increase in quiet areas than in noisy areas at the same distance from the airport (the West Drayton area compared to the

> Hounslow area, for example). With the growth in housing demand, people seeking to buy a house would be prepared to pay as much as the difference in transportation savings, ceteris paribus. This difference in transportation saving should directly influence the housing market price, since we assume that there is a sufficient number of buyers who are employed by airport (p. 82).

From this observation, it is clear that the mobility of population to and from airport noise areas is to a large extent dependent upon economic factors, even though noise pollution is a factor. In an attempt to analyze the impact of aircraft noise on people's economic behavior, Walters (1975) states that:

> the quantity of quiet that we buy is largely associated with the decisions about the purchase of a house or where we decide to rent a hereditament. Thus if we wish to enjoy perfect peace from aircraft noise we would buy a house far from present or expected flight patterns (p. 3).

Another study by a geographer, Holsman, and a town planner, Aleksandric (1975) focuses on the relationship between aviation developments and residential land values in the area of Sydney Airport over the period 1959-1973; it hoped to ascertain the short- and longer-term effects of aircraft based externalities. It was found that in the short-term adverse effect on sale prices of residence are noted in airport areas, but in the longer-term prices display a similar trend in both airport and non-airport areas. The authors further found that areas respond differently to such externality impact according to their socio-economic character. This study basically advanced two hypotheses: (1) that higher income groups may have a different reaction to noise valuing peace and quiet more highly than lower income groups, and (2) that owing to the advent of externalities there will be a transfer of

residential land to higher rent uses in the airport area. It was assumed that since the low income group people tend to stay in the noise affected areas, they show greater tolerance of noise and less tendency to agitate for governmental action. They conclude:

> This study has provided an insight into both the nature and extent of the aircraft noise problem as it affects airport community residents, as well as how such an externality manifests itself in the property market prices in selected areas of Sydney.
>
> The evidence showed that in the short-run the onset of an adverse externality did bring about a decrease in property prices, usually after a period is allowed for a lag effect. Over the longer run, prices will eventually return to their original trend, and in some instances may even increase more rapidly than the general property market. Residents moving into the airport area, although perhaps no more sensitive to noise than those moving out, do seem to derive a higher utility from living in the airport area. It was found from the questionnaire that of those moving into the area, 33% said that they thought the value of their houses was increased by being close to the airport, while of those moving out, only 11% said the same. The majority of both groups stated that they thought the airport area had no effect on property prices.
>
> The existence of adverse effects only in the short-term indicates that such reactions are largely psychological in nature and do not last for an extended period of time. Despite this conclusion, adverse effects have been suffered at various time throughout the study period, and the probability of future "shock period" cannot be dismissed if new aircraft technologies, such as super-sonic jets, are introduced to Sydney. Government decisions on the location of a second international airport for Sydney, and on the future of the Sydney Kingsford-Smith Airport, will also have a direct bearing on the psychology of the market. Both short-run and long-term effects must be considered by all levels of government when making decisions about airport locations, airport growth and also about the growth of areas surrounding an airport. Furthermore, the study highlights the need to recognize the different types of socio-economic areas have varying reactions

> to the influence of externalities, and that such differences must also be taken into consideration in assessing the spatial impact of technological change (p. 407).

Mobility of People and the Aircraft Noise

The findings of this study by Holsman and Aleksandric confirms that even though noise has serious biological, psychological, social and attitudinal effects, people's choice with regard to mobility in relation to their proximity to the aircraft noise area is determined by a complex set of factors.

Along these same lines of inquiry, Wrigley (1976) in a letter to the editor of the Journal of Sound and Vibration, refers to a survey by I. P. Kedze of the University of Southampton, where the latter was trying to show the relationship between noise expectations of migrants* and distance from an airport. The survey by Kedze was based on a series of interviews with different socio-economic groups who moved into the rural area to the east of Luton Airport. Keeping in mind that such variables as noise level and period of residence were held constant, it was concluded from this survey that all groups have the inclination to respond to "noise better than expected" when close to the airport and "noise worse than expected" when farther from the airport. It was also concluded that the larger period of residence in the area covered by the survey preceding the time of the interview, the higher is the inclination to respond "noise same as expected."

*Migrants were defined as those households who had moved into the area since October 1972.

In summary, there seems to be considerable variation between noise expectations of old and new migrants and their distance from an airport.

Around major city airports, numerous problems exist. Stevenson (1977, pp. 214-217) using the Noise Exposure Forecast (NEF) methodology came up with a series of maps showing noise levels in different areas. One of these maps, for example, covered areas surrounding Chicago's O'Hare International Airport. It shows the more affected area's "inner contour lines" as having a NEF of 40, and the less affected area's "outer contour lines" as having a NEF of 30. In his explanation, Stevenson shows that in the 1960's it was estimated by the Federal Aviation Administration (F.A.A.) that between 1965 and 1975 the 30 NEF area around O'Hare would increase from 72 to 132 miles, thus increasing the affected population from 236,000 to 432,000, the affected schools from 86 to 142, and the affected area hospitals from 4 to 6. Similar maps were applied to Boston's Logan International Airport and to J.F.K. Airport in New York.

The table reproduced on the following page (Table 7) represents a comprehensive picture of the life around seven major airports in the United States and the community response to their life around those noisy airports. Several noteworthy relationships are apparent from a reading of this table. "Factors such as site of airport with respect to the adjacent community, direction of flight path, residential densities, and the availability of buffer zones or easement provide better correlations with noise level" (p. 19). In a graphical form, Plessas shows a common point of the attitude of all the low-income

Table 7

Selected Variables and Reaction To Airport Noise
in Seven Major Airport Noise-Impacted Communities

Variate	Airport						
	Chicago	New York	Los Angeles	Miami	Dallas	Boston	Denver
Volume Of Air Carrier Operation (1967)	574	404	385	231	222	186	129
Community Noise Rating	107	115	111	106	110	108	100
Average Distance Of Community from Airport (Mile)	8.0	5.6	5.4	4.4	5.0	4.5	5.0
% Annoyed By Airport Operations	24	67	40	27	24	56	14
% Of Complaints From Those Annoyed	5	22	12	2	2	13	3
% Of Respondents Aware Of Noise Before Moving	21	25	41	41	26	42	21
Noise Resilence	55	18	40	48	49	27	63
% Of Respondents Reporting Increase In Land Value	70	86	62	79	51	65	58
% Of Respondents Reporting Decrease In Land Value	9	4	17	4	22	16	15
% Of Respondents Reporting Airport Responsible For Increase In Land Value	12	6	34	13	19	14	17
% Of Respondents Reporting Airport Advantages Outweigh Disadvantages	55	53	43	86	56	61	70
% Of Respondents With Incomes $10,000 And Above	31	40	32	31	15	30	19
% Of Respondents With Incomes Above $4,000	7	5	19	17	39	12	19
% Of Respondents Who Own Houses	77	82	67	74	58	63	73
Average Years Respondents Have Lived In Neighborhood	11	13	9	10	10	19	8
% Of Respondents Who Know Of Neighbors Leaving Because Of Noise	5	21	16	9	8	14	19

Source: Plessas, D. J. "Airport Noise: Some Analytical and Policy Perspectives", Land Economics, 1973 (p. 18).

residents living around those major airports vis-à-vis airport noise. He indicates that "low-income groups are less likely than higher income groups to show distress with respect to noise; moreover, they are less politicized, less likely to bring pressure to bear on airport authorities" (p. 20). Another direct effect of airport noise on people, as shown in the previous table, is the percentage of respondents who know of neighbors leaving because of aircraft noise. Although there are possibilities of relating this spatial mobility with other variables mentioned in the table, they are not within the scope of the author's interest.

A Master's Thesis, "The Perception of Noise Around a Small Municipal Airport", by Tavallai (1978) studied the noise perception of residents living within a radius of two miles of the Lansing Capital City Airport, Michigan. She used such variables as income levels, age, length of residency, and distance from the airport to measure spatial variations. The study found that all its hypotheses were rejected. The hypotheses advanced were that:

> Those living within a two-mile radius that as length of residency increases, the level of negative perception of noise decreases; the lower the income level, the less they would perceive noise as nuisance; the older the people, the less they could tolerate noise; and that the farther they live from an airport the less would be their negative attitude toward noise (pp. 42-43).

The researcher explained her conclusions by stating that the conditions with regard to frequency of flights and types of aircrafts around a small airport are substantially different from those around Los Angeles and J. F. Kennedy Airports. Besides, areas around the above cited major airports are heavily populated, whereas between the residential areas of

Lansing Capital City Airport there are wide stretches of vacant land, farms, woodland, and industrial complexes.

CHAPTER IV

RESEARCH DESIGN AND METHODOLOGY

In this chapter six hypotheses are postulated regarding the residents' perception of aircraft noise around Jeddah International Airport, Saudi Arabia. Also, characteristics of the study area, sampling design, methods used to collect the survey data, and the development of the questionnaire are discussed.

Hypotheses

The following hypotheses formed the basis for this study. Some of them have been tested and substantiated in previous studies.

Hypothesis I: That people's perception regarding aircraft noise within the study area around Jeddah International Airport varies across the 24 Haras (quarters) surveyed.

Rationale: It is assumed that the people's responses to the problem of aircraft noise, rather than being self-directed, are controlled by different sets of factors. On the whole, it appears that in spatial terms, diversity would be achieved by having a mix of socio-economic patterns, house types, length of residence and different age categories and levels of education in each Hara. Moreover, people's knowledge, awareness and

experience are not limited to only one Hara. Finally, diversity of Haras in relation to their location vis-à-vis the airport and under the flight paths should reflect wide geographic variation.

Hypothesis II: That people who live closer to the airport perceive the problem of aircraft noise more negatively than those who live further.

Rationale: It is the implication that, whenever and wherever it is possible, people desire to remain distant from noise. Noise is postulated to be much more of an irritant to those living in proximity to its source. It is hypothesized that the perception of noise emanating from its source will decrease with increasing distance from the source, hence a distance-decay relationship. However, as the literature reveals, there are conflicting results regarding the level of annoyance or disturbance of noise and how it is perceived by people in regard to distance from the source. Previous research has revealed there is no significant inverse correlation between people's perception of noise and distance around a small sized airport, but the opposite situation has been found around major large-sized airports (see for example, Tavallai, 1978; and Plessas, 1973).

The Jeddah International Airport presently has an high increase in the frequency of flights to meet the high demand for air travel and currently is considered one of the major airports--similar in traffic volume to others such as Chicago, J. F. Kennedy and Heathrow. Furthermore, if the present siting is to be considered (only 3 kilometers from the city's central business district), there can be little doubt but

that as far as noise is concerned, this airport is seen as a noxious facility, especially for that segment of population which lives close to its boundaries.

Hypothesis III: That as far as the length of residency is concerned, those recent residents (in area less than 2 years) are more likely to perceive the noise levels more negatively than old residents.

Rationale: It is assumed that the relative importance of people's perception as a factor which directs, shapes and influences individual decisions toward the problem of aircraft noise is affected by their adjustment and adaption to the problem over a long amount of time. Even though human beings are distinctly more adaptable than other creatures, we still lack an exact understanding of how to measure the process of adaptation, especially to external noise stimuli.

The importance of considering adaptation will reflect how respondents feel toward the problem of aircraft noise independent of other factors such as proximity to the airport. That is, time spent in an area exceeds people's ability to cope with undesirable environmental problems.

Hypothesis IV: That recent residents within the study area have greater propensity to change their present residence because of aircraft noise than long-term residents.

Rationale: Desirable residential areas are those that provide a comfortable environment for people to live in. It is assumed that one aspect of having a comfortable residence is having it free of noise. It is argued also that the level of residential satisfaction in a high noise level area might be affected by the length of residency. That is, length of residency might be a direct result of a decision to change residence to avoid aircraft noise. This propensity to avoid airport noise does not necessarily mean other factors such as home ownership, economic level, family and social ties are ignored. Such factors might contribute to and show consistent association with this mobility behavior. The hypothesis tests whether the likelihood of changing a residence is reduced by the longer one remains in an area. In other words, recent residents may express their displeasure at living in an area they perceive as having high noise levels and decide to move elsewhere, theoretically where they perceive the noise levels to be lower.

Hypothesis V: That the segment of the population willing to move because of perceived high levels of noise will move away from the seven kilometers radius of the study area, that is, within other parts of the city but not beyond the city boundary.

Rationale: It is assumed that aircraft noise is a major irritant and especially bothersome to people living within the seven kilometer radius of the study area. Furthermore, living away from the noise-affected area offers a less noisy environment for those who are willing and able to move. It is suggested in this hypothesis that Jeddah City is still

perceived by those surveyed as a desirable place to live. Within the city's boundaries there are better economic conditions, better opportunities, as well as housing, schools and health services.

To shed light upon where to move, it is assumed that movers in choosing the potential destination base it on wise decisions, their process of changing their present residence relies on a logic which guarantees their remaining within the city but away from the noise affected area.

Hypothesis VI: That the propensity to move because of high levels of aircraft noise is greater among those with higher annual incomes. That is, the likelihood to consider changing residence is directly related to income.

Rationale: One may argue that the total cost of seeking a new residence is weighted against the mover's desire to live in a more comfortable residence. It is also assumed that a person's income level could exceed his mobility decision, that is, higher income people have a higher rate of mobility and make longer distance moves than lower income people. Those individuals with high incomes have a greater ability to search elsewhere for noise-free residential locations than those with middle or low incomes.

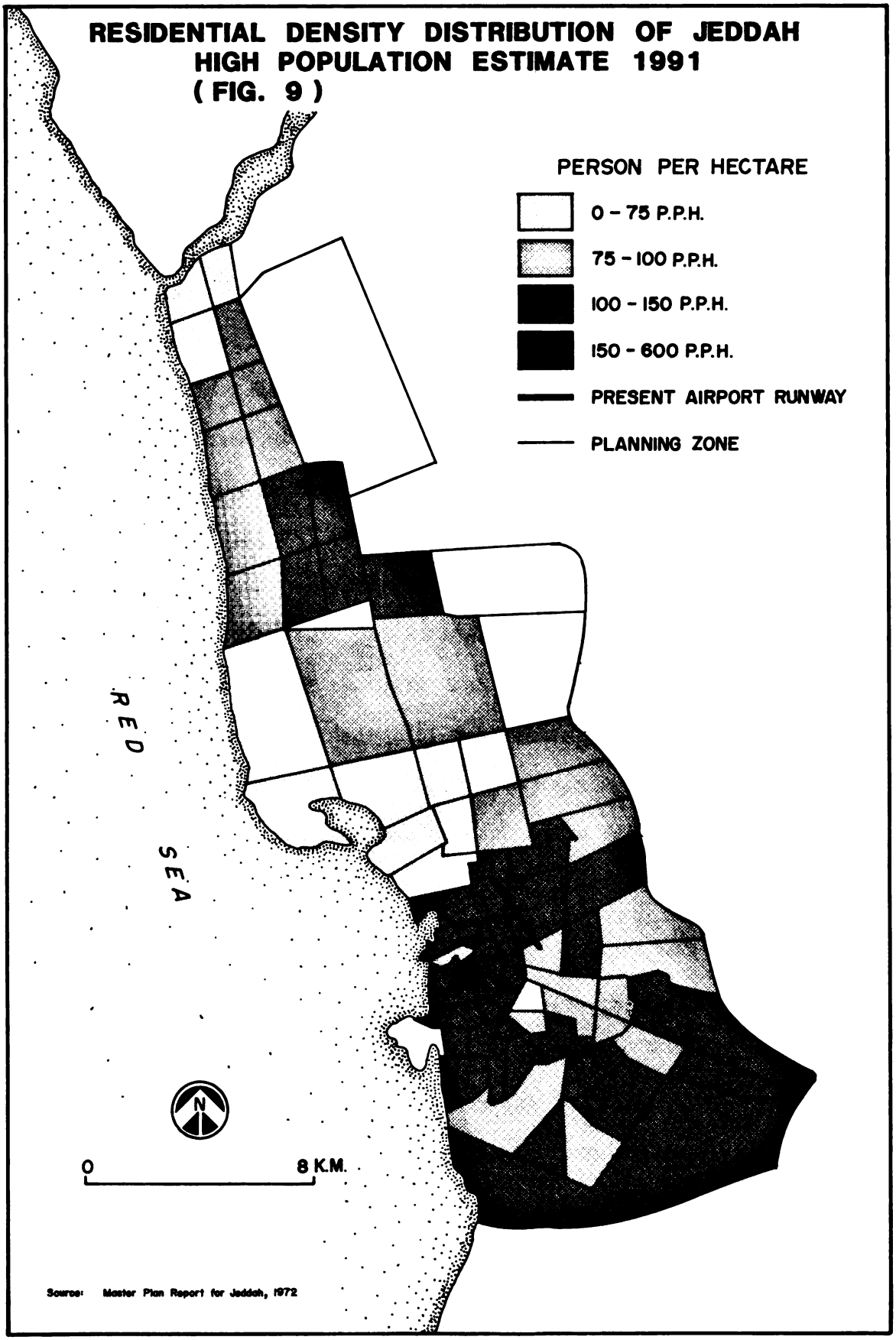
Study Area

In order to identify people's perceptions of aircraft noise around Jeddah International Airport, Saudi Arabia, a sampling of

residents was taken within a seven kilometer radius of the airport. This area includes 80-90 percent of the built-up area of the city. Inasmuch as there is no variation in the physical landscape (all level surface) and there is no protection offered by any natural or man-made barrier, it was felt that within this radius there would be a wide range of perceptions of aircraft noise.

The pattern of residential density within the city is difficult to display with a great deal of accuracy. This is because of the unavailability of accurate recent data about the city's population. Some general information is available in the report Alternative Urban Strategies: Jeddah, Taif and Yanbu, published in 1972. This source reveals that the highest density (450 persons per hectare) exists in the central commercial area of the city, a density of 170 in the southern portion of the city, and between 80-170 persons elsewhere in the city. Taking into consideration the date of this report, and the tremendous growth rate within the last decade, these figures do not describe present levels. These qualifications make it necessary to use only an estimation to clearly establish a picture of population numbers and residential density. The density levels of each Hara are shown in Figure 9. The map shows the residential density levels for the high population growth estimate proposed by the city's Master Plan Report's High Committee. The estimate used here is for a population of 1,650,000 in 1991. This estimate shows almost twice the present area covered by the city.

On the basis of having clearly identified the density levels in the study area, the sample is taken from the Hara (quarter) boundaries


RESIDENTIAL DENSITY DISTRIBUTION OF JEDDAH
HIGH POPULATION ESTIMATE 1991
(FIG. 9)
PERSON PER HECTARE
0 - 75 P.P.H.
75 - 100 P.P.H.
100 - 150 P.P.H.
150 - 600 P.P.H.
PRESENT AIRPORT RUNWAY
PLANNING ZONE
RED SEA
N
0
8 K.M.
Source: Master Plan Report for Jeddah, 1972

which were included in the city-wide socioeconomic survey undertaken by the Regional and Town Planning Department (Figure 10). Insofar as socioeconomic conditions are concerned, and on the basis of information available from the above mentioned survey, each Hara has a wide range of incomes represented in the majority of Haras. Only in Haras 21, 20, 18, 17, 15 and 14, is there a concentration of low incomes; that is, very few households with incomes over SR* 1,000 per month. Those six Haras mostly include the lower and lower middle classes; they are poor within the context of the general income level in the city. Side by side with the poor areas there are large middle and upper middle income groups in Haras 22, 16, 13, 12, 10, 8, 7, 6, 5, 4, 3 and 2. People in the remaining Haras constitute the upper class.

Utility services (water, electricity, etc.) are more pronounced in those Haras north of the city than in the south. Those who can experience the greatest degree of residential choice usually choose to live in the best areas while others must remain in the less desirable areas, including those in areas of high noise levels.

Sampling Design

In regard to selecting an adequate representative sample, theoretically the best procedure would be to select the households over a wide area. Choosing an appropriate procedure from which to draw a representative sample in a city such as Jeddah is a difficult

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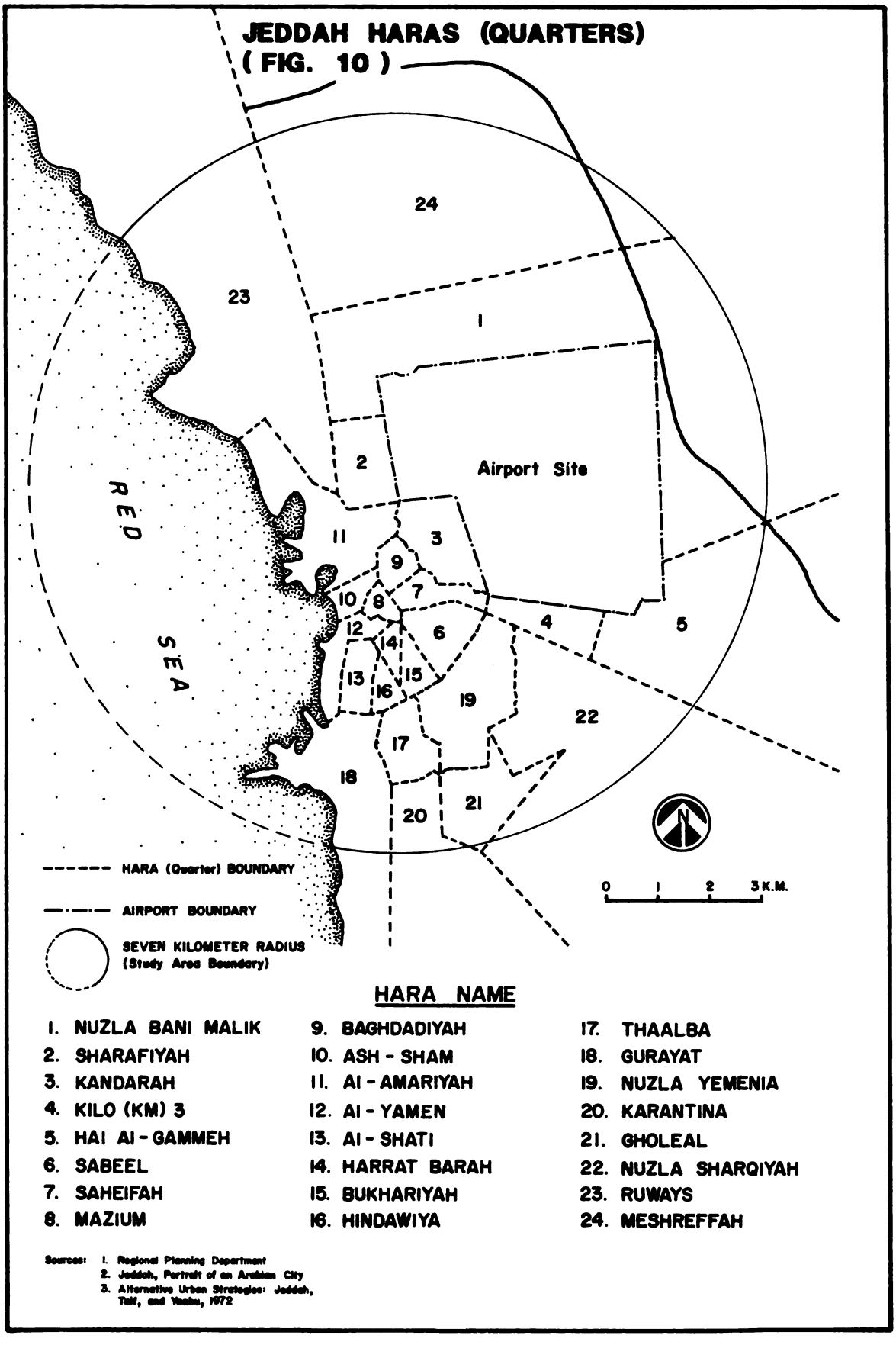
*One U.S. dollar equals 3.5 Saudi Riyals.



HARA NAME

1. NUZLA BANI MALIK
2. SHARAFIYAH
3. KANDARAH
4. KILO (KM) 3
5. HAI AI - GAMMEH
6. SABEEL
7. SAHEIFAH
8. MAZIUM
9. BAGHDADIYAH
10. ASH - SHAM
11. AI - AMARIYAH
12. AI - YAMEN
13. AI - SHATI
14. HARRAT BARAH
15. BUKHARIYAH
16. HINDAWIYA
17. THAALBA
18. GURAYAT
19. NUZLA YEMENIA
20. KARANTINA
21. GHOLEAL
22. NUZLA SHARQIYAH
23. RUWAYS
24. MESHREFFAH

Sources: 1. Regional Planning Department
2. Jeddah, Portrait of an Arabian City
3. Alternative Urban Strategies: Jeddah, Taif, and Yanbu, 1972

task. The procedure of going door-to-door (especially for a large sample) is impractical. This is simply because of the fact that it is impossible to locate the houses and to prepare household lists to serve as sampling frames. Furthermore, if the sample population is composed of scattered households, much time is spent in collecting the necessary volume of information. In order to achieve spatial variation in the people's perception regarding aircraft noise around Jeddah International Airport, a clustering type of sampling and a random selection among the clusters was administered. It was felt that there are great advantages in using such procedures, among which are:

1) Having an equally balanced chance for every individual type in the population to appear in the sample,
2) the availability of personnel,
3) easier accessibility to sample areas,
4) avoiding excess travel time and costs,
5) obtaining the advantages of better control and supervision in the field, and
6) the efficiency of locating focal points as sampling units.

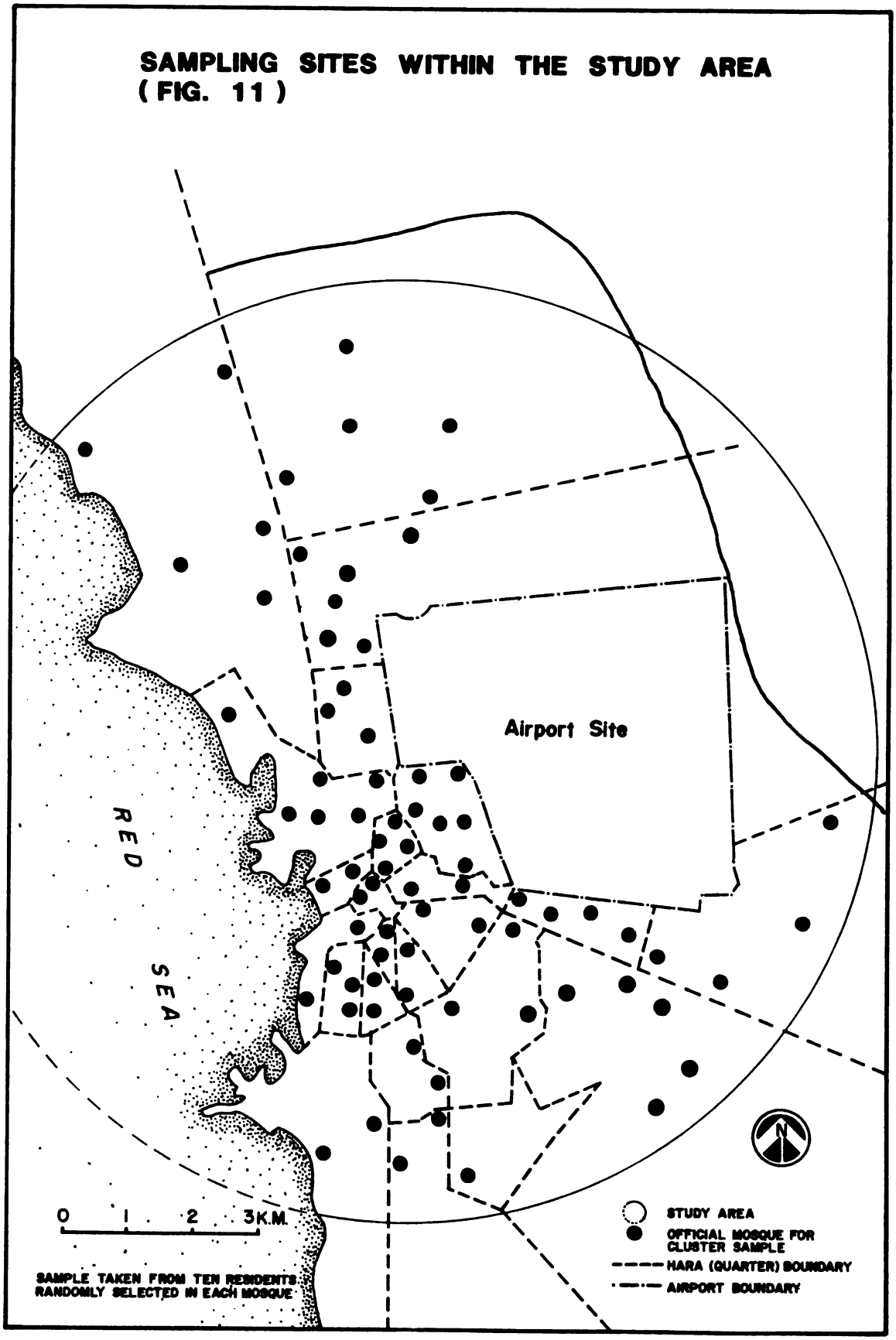
The focal points used for this purpose were all the official mosques* distributed in the study area. A list of mosques was provided

*The mosques and their tall minarets are one of the dominant features of the city's skyline. They are available to serve the religious needs of the people of Jeddah, but the importance of the mosque for discussion, study, relaxation and even overnight shelter for everybody regardless of his age and socioeconomic status is also of significance and importance. Furthermore, mosques are numerous and, although amplified speakers are used to carry the voice of the muezzen (the person who announces gathering for prayer) for much further distances, the distance between mosques is mainly determined by how far the muezzen's own voice would carry. Thus the justification of using mosques as focal points was to assure having little spatial variation in the social pattern and behavior of the people over considerable distance.

by the Jeddah Office of Ministry of Hajj and Wagfs. Seventy-seven mosques were identified and mapped in the twenty-four Haras within the study area (Figure 11). A randomly selected sample of ten residents in each mosque was deemed adequate. The sample was taken after finishing the prayer. The 770 interviews were conducted from December 1978 through March 1979. Five persons who had experience in conducting the city's population survey helped in conducting the interviews. Interview were also conducted in the evening to ensure the sample included people who worked during the day. Before proceeding with the interview, the interviewee was asked which Hara he resided in. It was found that some people regularly go to the nearest mosque but live in the neighboring Hara. In order to insure that everybody was included in the Hara he lived in, each interviewee was asked to give the name of his Hara.

Data Collection

In Saudi Arabia, when drafting a five-year development plan, a regional plan, a master plan for cities, etc., scientific research is carried out without any definite perspective in mind. That is, plans are carried out according to the government's requirements. Research workers in Saudi Arabia are isolated and have almost no identity; scientific research is still in its infant stages and the lack of accessibility to basic statistics and maps represents a fundamental obstacle to any research. This is a well-known problem, but it is quite obvious that the improvement needed to change the above situation will require time. In the meantime, however, the only practical


SAMPLING SITES WITHIN THE STUDY AREA
(FIG. 11)
Airport Site
RED SEA
0 1 2 3K.M.
SAMPLE TAKEN FROM TEN RESIDENTS RANDOMLY SELECTED IN EACH MOSQUE
N
STUDY AREA
OFFICIAL MOSQUE FOR CLUSTER SAMPLE
HARA (QUARTER) BOUNDARY
AIRPORT BOUNDARY

short-cut would be to carry out sample surveys and to try every way possible to effect better data collection.

Two major means were utilized to collect the needed data for this study: personal contact and a questionnaire. Every possible means was used to secure and collect available related data. Several agencies were contacted, among which were:

1) King Abdulaziz University at Jeddah City. It was found that environmental problems as an area of study is a relatively new field. Thus it is not surprising that the subject was not included in university programs in its various facilities. However, some useful information was obtained from the librar and the manager of the library was very cooperative.
2) The Jeddah municipality and the city planning office were visited. Necessary maps and some archival data were obtained.
3) The office of Air Traffic Services at the Department of Civil Aviation. Mr. Abdulaziz Al-Modian, the Director, was very helpful in providing the available data regarding air traffic operations.
4) The Civil Aviation Department. Mr. Mohamed Al-Dabbag, the A.T.C. program administrator, tried all ways possible to provide the desired information.
5) Jeddah Airforce Base. First Lieutenant Atta Al-Gohany was very helpful and cooperative in heading the team of data collectors regarding the physical measurement of aircraft noise.

Discussion of the Questionnaire

The purpose of the questionnaire was to investigate people's perception of the problem of aircraft noise. This questionnaire consisted of twenty-four questions, most of which were related to the dependent variable of this study--that is, the level of people's perception of aircraft noise. See Appendix for detailed copy of questionnaire.

Question (1): How far the people live from the airport.

The purpose of this question was to find out how far people live from the airport, for it was believed that the aircraft noise perception of people depends greatly on how far they live from the noise affected area. To answer this question, four choices were given, from which the interviewee was to choose one.

Question (2): Level of noise perception during regular time (non-Hajj time).

The tone of our argument lies in this question. The interviewee was asked to rate the extent of disturbance cause him by aircraft noise. Five choices were given.

Questions (3), (4) and (5): Effect of noise.

These questions were linked to the key question of our argument. They are designed to show whether aircraft noise has or has not had an effect on people's behavior; the answer is a choice between yes or no.

Question (6): Level of noise perception during the Moslem Hajj season.

This question is strongly linked to the key question. The Hajj season (which is only experienced in Jeddah City) is a busy season in terms of aircraft congestion so it is obvious that the level of noise during this season differs from any other time of the year. As in question two, to answer this question, five choices were given.

Question (7): Length of residence.

This question seeks to know the period of stay in the interviewee's present residence. Three choices were given to answer this question. As far as the adjustment to noise is concerned, in this question lies one of the independent variables which we believe has an effect on the level of noise perception.

Question (8), (9), (10) and (11): Concerned with spatial mobility, that is, leaving present residence.

Since it would usually be impractical to try to follow-up persons who have moved because of perceived high noise levels, it was necessary to ask the interviewee if there was any likelihood of his moving from his present residence. The answer to this question is either a yes or no. Furthermore, the scope of this question is intended also to cover the reasons for moving and the reasons for not moving; a ranking of such reasons is requested.

Question (12): Where to move.

This question concerns only those who have considered changing their residence. They are asked whether their possible move will be within or outside the city.

Questions (13), (14) and (15): Concerned with leaving present residence, but only temporarily during the Hajj season.

Questions (16), (17) and (18):

These were general questions designed to elicit opinions about the site of the airport and to see how familiar people are with the problem of aircraft noise.

Questions (19) and (20):

These questions were also general in nature, but are designed to determine whether the interviewee has ever suffered from a health problem due to aircraft noise, and whether he expects to suffer from one in the future.

Question (21): Concerned with type of housing.

This was one of the most useful questions as it provided information which could be related to the dependent variable and most of the independent variables.

Question (22): Age.

This question concerns a further independent variable--age. The interviewee was asked to locate himself in one of four age categories.

Questions (23) and (24):

These are two further independent variables. The interviewee was asked to specify first his educational level among a range of five choices and to state his annual income.

The questionnaire was developed in order to investigate the factors which the researcher hypothesized might be related to the problem of aircraft noise around Jeddah International Airport. The average interview lasted between 5-10 minutes. The questionnaire was only presented to males because in the Islamic religion it is difficult for a male interviewer to conduct an interview with a female member.

CHAPTER V

ANALYSIS OF PERCEPTION REGARDING AIRCRAFT NOISE

The purpose of this chapter is to examine the perception and related behavior of the people living around Jeddah International Airport vis-à-vis aircraft noise. Basic data were gathered through a questionnaire administered to residents within a seven kilometer radius of the airport. The discussion following focuses upon six topics, all of which are integrated into the hypotheses stated in the previous chapter. The topics discussed are: 1) how noise perception varies by Haras (quarters); 2) how noise perception varies with distance from the airport; 3) how noise perception varies with length of residence; 4) length of residency and the propensity to change residence because of aircraft noise; 5) the willingness to change residence and the site of potential destinations; and 6) the willingness to change residence vis-à-vis the level of income.

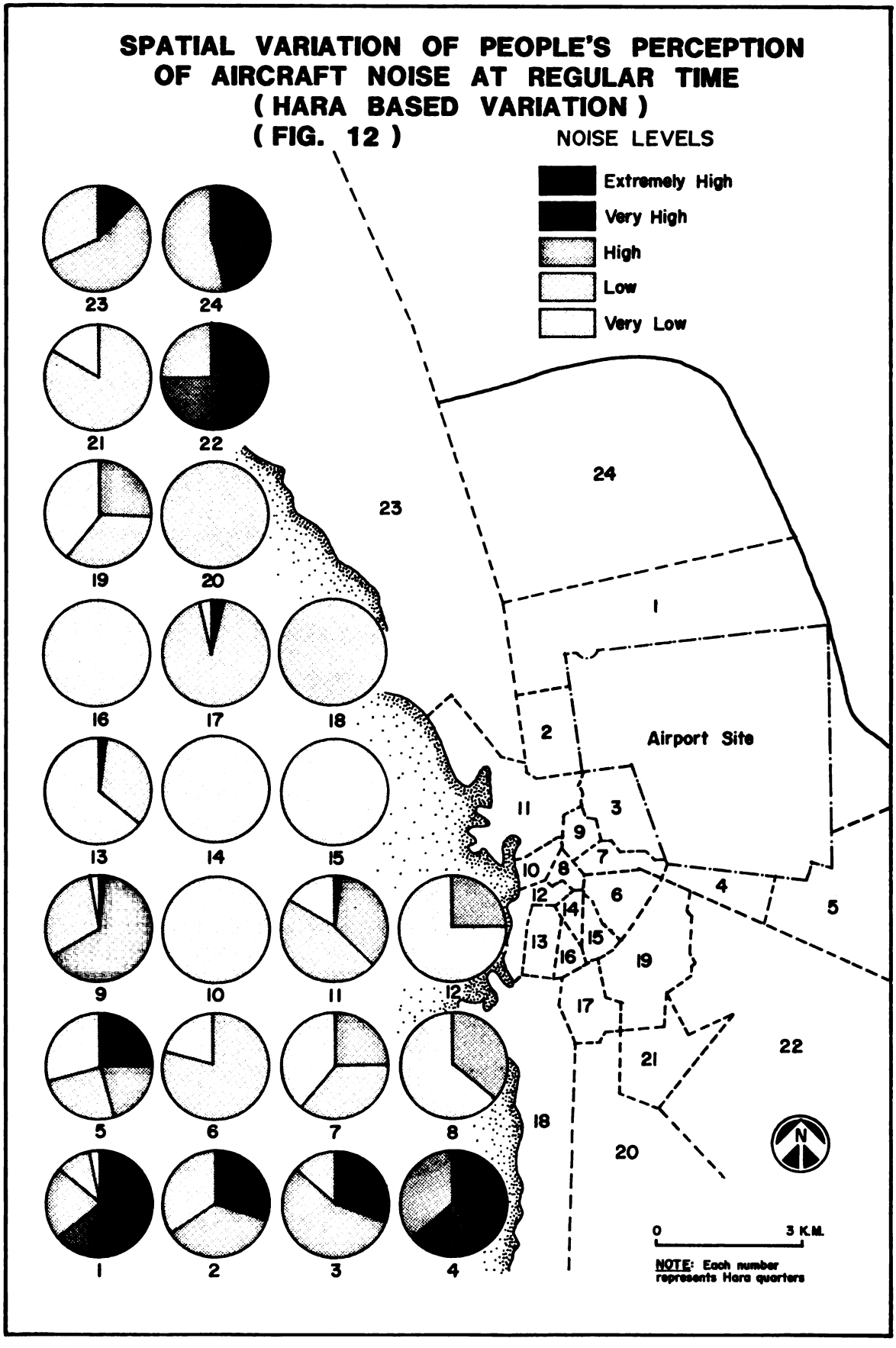
The data obtained from the questionnaire were converted to tabular form to facilitate analysis. In order to find the degree and nature of relationship between different independent and dependent variables, a series of chi-square tests were administered. For the purpose of this study, any relationship considered significant must meet the probability of $\leqslant 0.05$. The lower the probability than 0.05, the stronger would be the relationship. Furthermore, and most

importantly, a series of maps and a number of graphs were constructed to help examine the results and test the hypotheses.

The Spatial Variation of Noise Perception by Hara

It is postulated in the first hypothesis that people's perception regarding aircraft noise within the study area around Jeddah International Airport varies across the 24 Haras (quarters) surveyed. That is, some differences in people's noise perception levels are expected across these 24 Haras. The question to be raised is: Is it possible to classify the 24 Haras according to the level of noise perception of the sample population? In order to answer this question, noise levels in each Hara are illustrated in a series of figures.

The spatial variation of people's perception of aircraft noise at regular times is illustrated for each Hara in Figure 12. The figure shows that three different groups of Haras reveal homogeneity in the noise levels perceived. The first group shows that people in Haras 10, 14, 15, 16, 18 and 20 perceive a very low level of noise. The second group shows that the majority of people (65-75%) living in Haras 8 and 12 perceive aircraft noise as very low and 25-35% of them perceive it as a low level. The third group of Haras include those where 20-21% of the people living in Haras 6 and 21 perceive the problem of aircraft noise as very low and 79-80% of them perceive it as low. Those living in those Haras where aircraft noise is perceived as "low" and "very low" constitute only 24% of the sample; they are located west and south of the site of the airport.


SPATIAL VARIATION OF PEOPLE'S PERCEPTION
OF AIRCRAFT NOISE AT REGULAR TIME
(HARA BASED VARIATION)
(FIG. 12)
NOISE LEVELS
Extremely High
Very High
High
Low
Very Low
Airport Site
0
3 K.M.
NOTE: Each number represents Hara quarters

Another group of Haras shows homogeneity in the noise levels as perceived by the population surveyed. But, unlike the above mentioned Haras, people living in Haras 4, 22, and 24 perceive the problem of aircraft noise as high, very high, and extremely high. Thirty-five percent of the people living in Hara 4 consider aircraft noise levels to be extremely high. Another 30% rate it very high and 35% as high. This particular Hara shares a portion of the southern boundary of the airport. The majority of people (69%) who live in Hara 22 have a negative response to the problem of aircraft noise; they perceive it as very high while 26% perceive it as high. Only 6% perceive it as extremely high. Hara 22 is located south of the airport under the flying path corridor where the aircrafts constantly land. About 53% of the people living in Hara 24 perceive the problem of aircraft noise as high, 35% very high and 12% as extremely high. This Hara is located north of the airport under the take-off corridor. Those living in these three Haras constitute 18% of the total sample population.

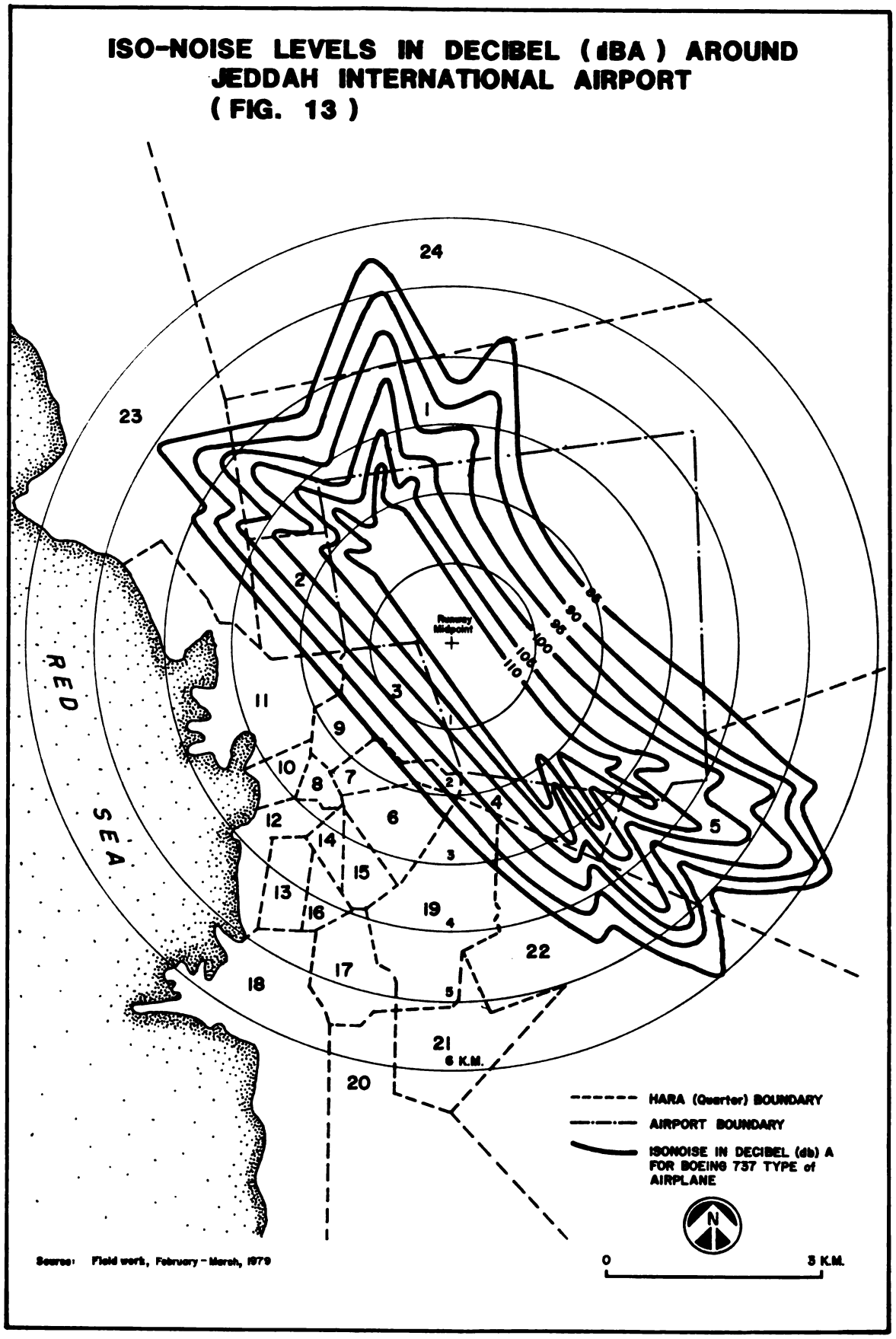
A further lack of homogeneity is apparent in the remainder of the Haras surveyed. Haras 1, 2, 3, 5, 7, 9, 11, 13, 19 and 23 show variations in the people's perception of aircraft noise that range from an extremely high level to a very low level. In other words, people's response to aircraft noise is varied rather than uniform in those Haras. Also, of those Haras, only Haras 1, 2, 3 and 5 which abut upon the northern, western and a part of the southern boundary of the airport show a higher percentage of negative perception as "extremely high" and "very high". On the other hand, Haras 7, 9, 11,

13, 17, 19 and 23 that are located farther away from the airport and any part of its boundaries show higher percentages of noise perception as "low" and "very low".

From the above description, the first hypothesis--that the people's perception regarding aircraft noise within the study area around Jeddah International Airport varies across the 24 Haras surveyed--was well supported. An interpretation of Figure 12 reveals three rather homogeneous groups of Haras and a further group of heterogeneous Haras. In other words, within the study area, it is clear that the perceived noise levels vary considerably among Haras.

A further explanation of the first hypothesis is shown in Figure 13. The iso-noise levels are based on the readings obtained by a hand-held Sound Level Meter which records the decibel level at specific sites. Locations for taking readings were roughly determined by visual observation within the residential area of each Hara. The measurement positions were selected at radial distances of 1-6 kilometers from the center of the main runway since the interest of this study is the noise levels in any part of each Hara and the noise levels at varying distances away from the airport itself. The readings taken at the selected sites were connected by lines to establish a boundary to identify critical noise areas around Jeddah International Airport. Figure 13 shows the physical measurement of noise as a result of the current operations of Boeing 737 type of jet aeroplane.*

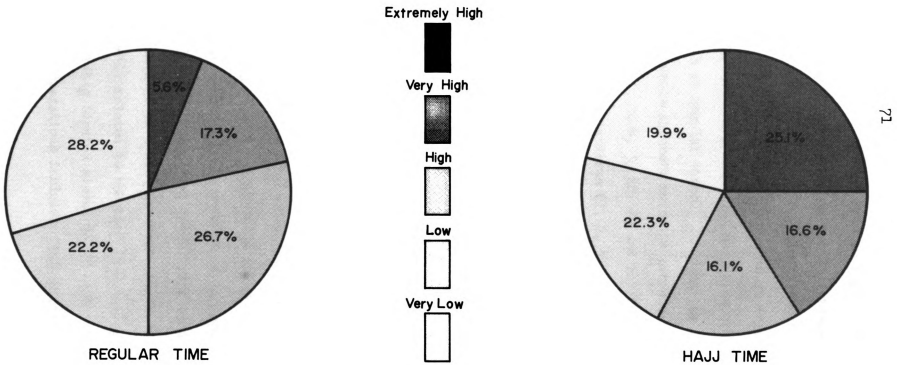
*This type of aeroplane was selected for measuring noise levels because it is considered by airport authorities as an aeroplane which has the noisiest type of engine. Also, it is the most frequent aeroplane arriving at and departing from Jeddah International Airport.


ISO-NOISE LEVELS IN DECIBEL (dBA) AROUND JEDDAH INTERNATIONAL AIRPORT (FIG. 13)
RED SEA
Runway Midpoint
24
23
1
2
3
11
9
10
8
7
12
14
15
13
16
6
4
19
22
17
18
5
21
6 K.M.
20
90
95
100
105
110
HARA (Quarter) BOUNDARY
AIRPORT BOUNDARY
ISONOISE IN DECIBEL (db) A FOR BOEING 737 TYPE of AIRPLANE
N
0
3 K.M.
Source: Field work, February - March, 1979

Nine Haras, 1, 2, 3, 4, 5, 7, 22, 23 and 24, experience noise between 85-110 dB(A). These Haras are primarily located north, west and south of the airport. Among those Haras, only one (#3) is located at a distance of 1-2 kilometers; the rest are located at a distance of 2-6 kilometers. The highest noise levels are associated with Haras 1, 4, 5, 22 and 24 only where the jet aeroplanes fly over at lower altitudes. That is, those Haras have the misfortune to be located directly under the flight path to the south of the airport at the landing approach and to the north where the departure routes are located. These measurements indicate that Haras 1 and 4 are subjected to noise levels between 100-110, Hara 5 between 85-110, Hara 22 between 85-100 and Hara 24 between 85-95 dB(A). These Haras are exposed to the most critical noise levels. The existing built-up area is seriously affected. It is unfortunate that there are 21 educational and 7 health institutions located in these Haras over which jet aircraft fly from early morning to late at night.

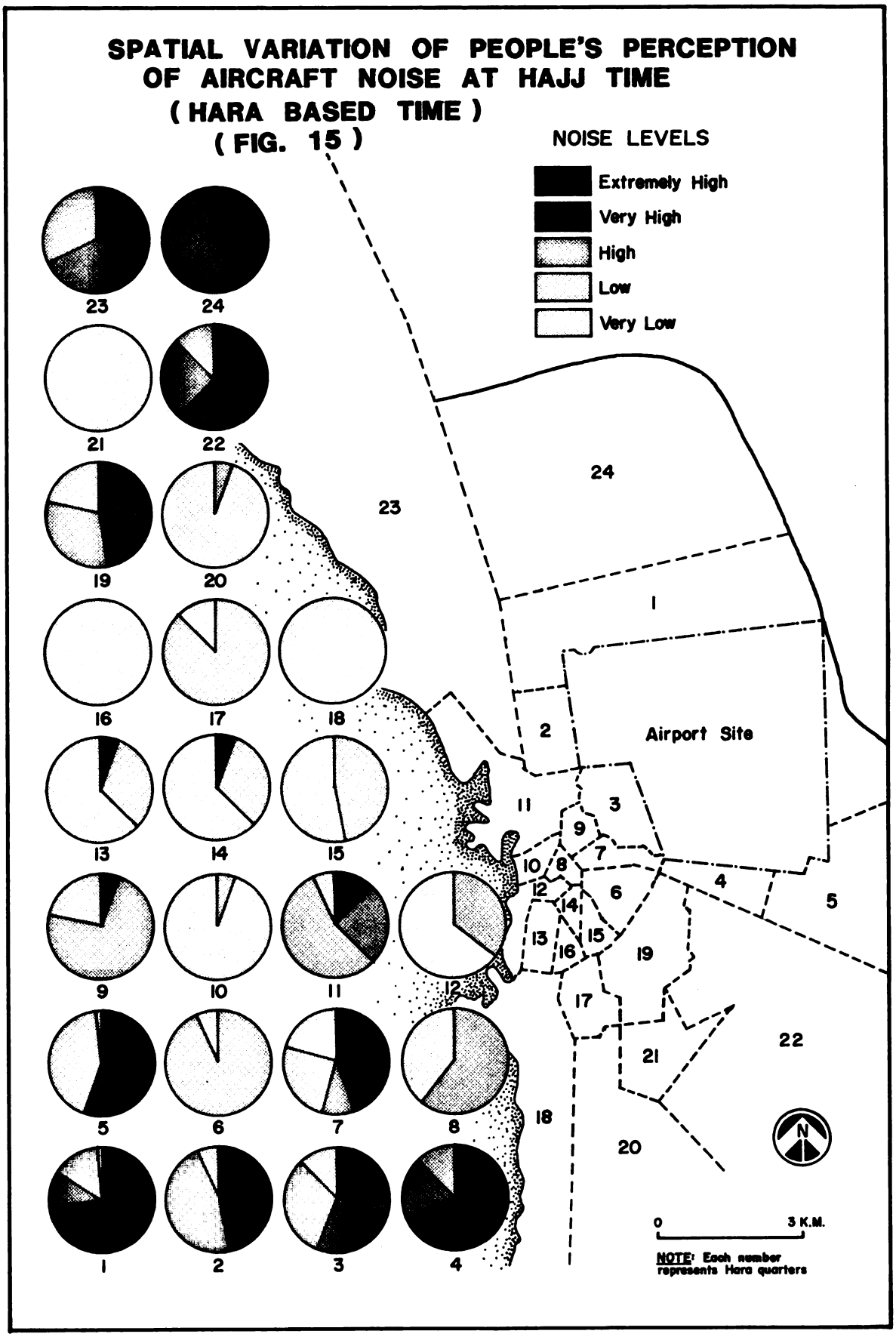
A comparison between the noise levels as perceived by people during the regular time versus the Hajj (Pilgrimage) time is shown in Figure 14. The percentage of respondents who perceive aircraft noise as being extremely high during Hajj time is 25% as against only 6% at regular times. On the other hand, while 28% perceive aircraft noise as very low at regular times, only 20% perceive it at this level at Hajj time. Looking specifically at the noise levels perceived during Hajj time presents a different picture of the spatial variation of people's perception of aircraft noise around Jeddah International Airport. The spatial variation of the perception of aircraft noise

NOISE LEVELS AS PERCEIVED AT REGULAR VERSUS HAJJ TIME
(FIG. 14)



during Hajj time is illustrated for each Hara in Figure 15. A comparison of the patterns presented in Figures 12 and 15 reveals a great deal of dissimilarity. In general, the negative perception of aircraft noise at Hajj time is greater in areal extent than at regular times. This means that certain Haras of the city at Hajj time are exposed to more aircraft noise than at regular times. In comparing the two figures, one finds that while aircraft noise is perceived as extremely high only in seven Haras (1, 3, 4, 5, 22, 23 and 24) during regular times, the number includes twelve Haras (1, 2, 3, 4, 5, 7, 11, 14, 19, 22, 23 and 24) during Hajj time. On the other hand, while aircraft noise is perceived as very low in six Haras (10, 14, 15, 16, 18 and 20) at regular times, the number is reduced to only three (16, 18 and 21) during Hajj time.

On the whole, it appears from the preceding description that aircraft noise, as perceived by people in both regular and Hajj time and as physically measured in decibel levels, varies across the 24 Haras surveyed. During regular times, the spatial variation within the city is considerably less than during the Hajj period. This is notably so because of the tremendous increase of the frequency and duration of aircraft flying during Hajj time. Within these two months, the period of Hajj time, the frequency of aircraft operations incoming and outgoing at Jeddah International Airport is almost three times greater than the rest of the year. An average of seven operations per minute is experienced. A problem directly related to the high levels of perceived noise is the airport's being located almost in the middle of the city. This means that aircraft operations including taking-off, landing, taxi


SPATIAL VARIATION OF PEOPLE'S PERCEPTION
OF AIRCRAFT NOISE AT HAJJ TIME
(HARA BASED TIME)
(FIG. 15)
NOISE LEVELS
Extremely High
Very High
High
Low
Very Low
Airport Site
N
0
3 K.M.
NOTE: Each number represents Hara quarters

maneuvers and engine-testing in a test cell give the most dominant noise and affect a much wider area in the vicinity of the airport. These noise operations have led to an erosion of the urban environment and to difficulties for the policy formulators responsible for achieving an ideal separation of residents from Haras affected by airport noise.

It has been noted that the frequency of aircraft operations and the geographical situation of the airport are important factors in determining the spatial variation of aircraft noise as perceived by people within and/or between Haras. However, it should be stressed that such factors as distance from the airport, length of residency, and people's awareness are also important. They are important in that they are at least partly cummulative in understanding the perceptual process of aircraft noise around Jeddah International Airport.

Noise Perception and Distance From Airport

It is hypothexized that people who live closer to the airport perceive the problem of aircraft noise more negatively than those who live further away. Before presenting the survey results, it should be pointed out that some of the noise level categories were combined so as to eliminate those cells in the matrix with zero frequencies. The survey results, summarized in Table 8 and illustrated in Figure 16, show that those living within closer distances, such as less than two kilometers from the airport, perceive the problem of aircraft noise more negatively than those living further away.

ASSOCIATION BETWEEN NOISE LEVELS AS PERCEIVED AND DISTANCE FROM AIRPORT AT REGULAR TIME (FIG. 16)

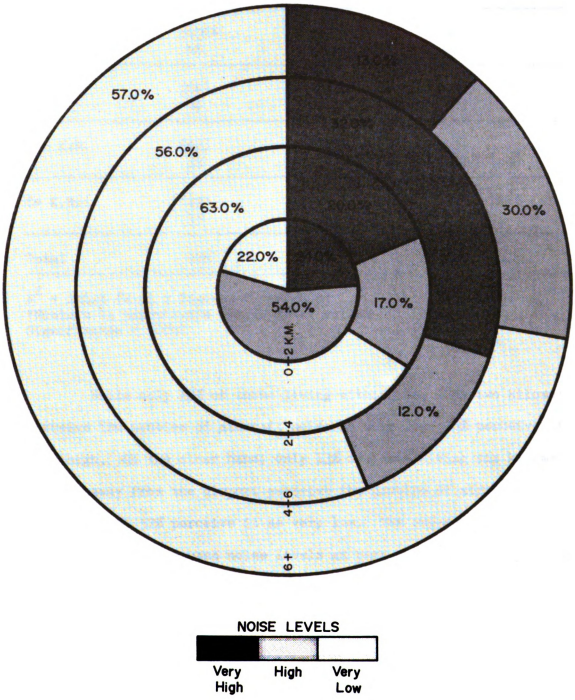


Table 8

Association Between Noise Levels Perceived and Distance From Airport at Regular Time

	Very High	High	Very Low	Total
0-2 K.M.	(43)* 46	(51) 102	(96) 42	190
2-4 K.M.	(64) 56	(75) 47	(141) 176	279
4-6 K.M.	(42) 59	(24) 22	(93) 104	185
6+ K.M.	(27) 15	(31) 35	(59) 66	116
Total	176	206	388	770

X^2 = 116.8 (with 6 Degrees of Freedom)
*Numbers in parentheses are expected values
Significance = .0001

While only 22% of those living within less than two kilometers perceive the problem of aircraft noise as very low, 24% perceive it as very high. On the other hand, only 13% of those living six kilometers or more away from the airport perceive the problem of aircraft noise as very high and 57% perceive it as very low. The chi-square results show the relationship between noise levels as perceived and distance from airport to be significant at the .000. level. This result supports the second hypothesis.

The relationship between distance from airport and noise levels perceived is great when considering the noise perception at Hajj time. The survey results summarized in Table 9 and illustrated in Figure 17 show that 45% of those living less than two kilometers from the airport perceive the problem of aircraft noise as very high while only 16% perceive it as very low. However, there is no significant diversity of perception for those who live further from the airport. Among those who live six or more kilometers away from the airport, 47% perceive the problem of aircraft noise as very high; almost the same percentage (46%) perceive it as low. This means that as more frequent aircraft

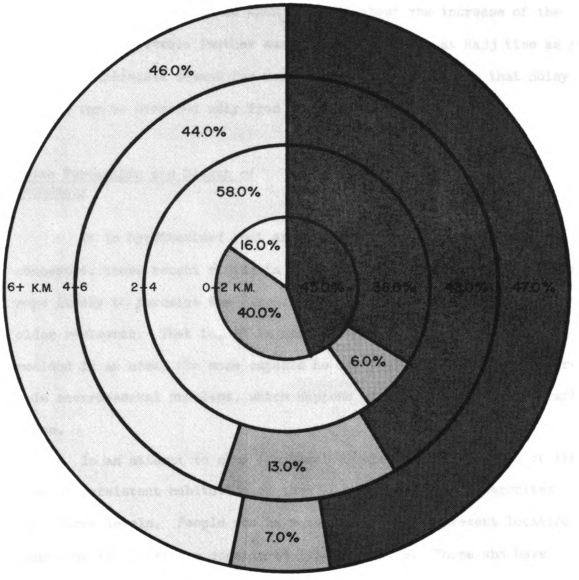
Table 9

Association Between Noise Levels Perceived and Distance From Airport at Hajj Time

	Very High	High	Very Low	Total
0-2 K.M.	(79)* 85	(31) 75	(80) 30	190
2-4 K.M.	(116) 101	(45) 17	(118) 161	279
4-6 K.M.	(77) 80	(30) 24	(78) 81	185
6+ K.M.	(48) 55	(19) 8	(49) 53	116
Total	321	124	325	770

X^2 = 138.3 (with 6 Degrees of Freedom)
*Numbers in parentheses are expected values
Significance = .0001

ASSOCIATION BETWEEN NOISE LEVELS AS PERCEIVED AND DISTANCE FROM AIRPORT AT HAJJ TIME (FIG. 17)



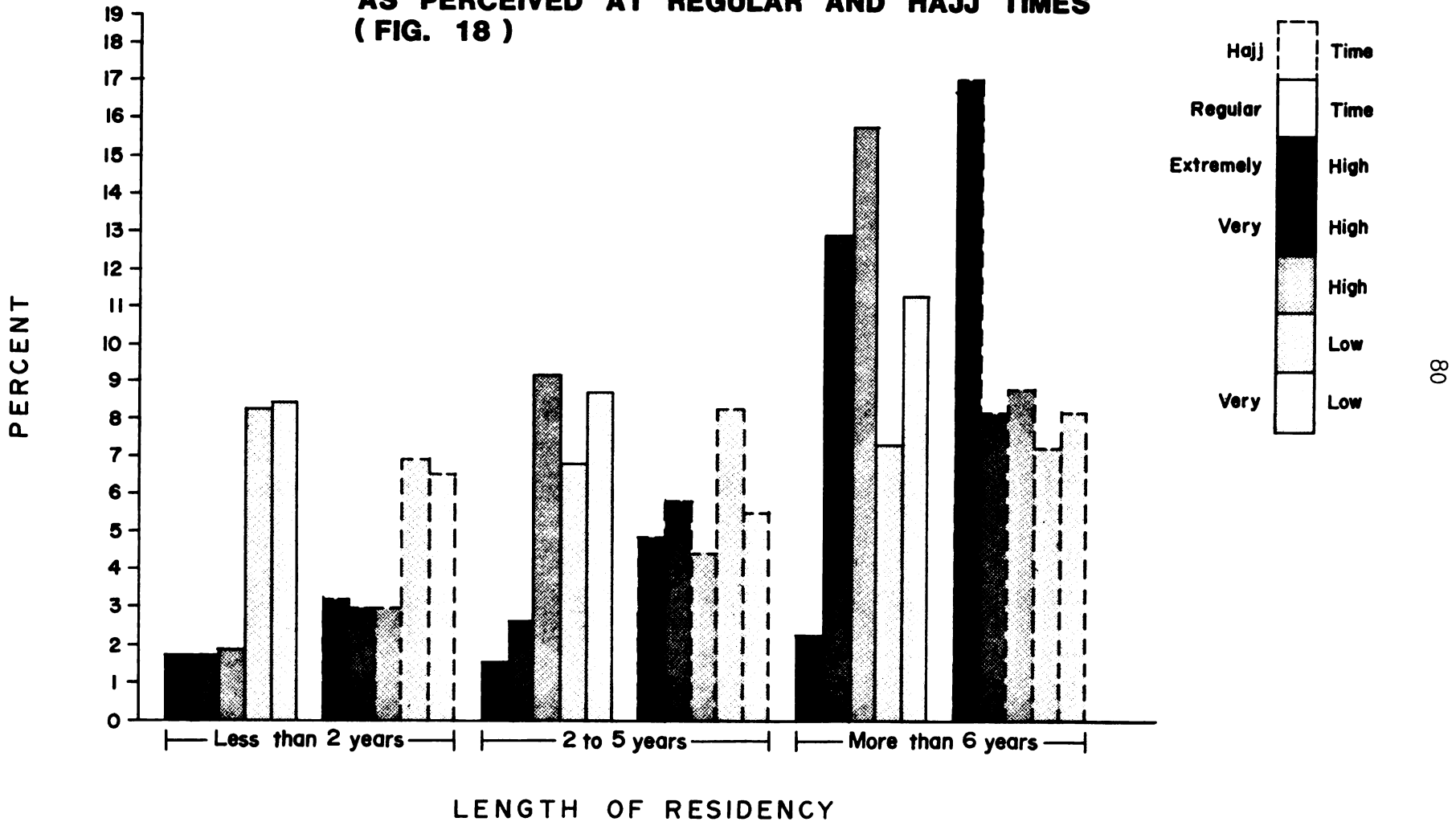
operations are demanded, as at Hajj time, the aircraft noise levels are higher, more continuous, and more people living at apparently greater distances from the airport are affected. This finding is absolutely critical and is most important to both airport and local planning authorities. They should be knowledgeable about the increase of the perceived noise levels further away from the airport at Hajj time as a result of increased demand for more aircraft operations so that noisy traffic can be directed away from the residential areas.

Noise Perception and Length of Residency

It is hypothesized that as far as the length of residency is concerned, those recent residents (in area for less than two years) are more likely to perceive the airport noise levels more negatively than older residents. That is, it is assumed that the longer a person has resided in an area, the more capable he is of adapting to its undesirable environmental problems, which happens in this case to be aircraft noise.

In an attempt to show the level of adaptation, an index of the span of persistent habitation of the 770 respondents is categorized into three levels. People who have resided at their present locations less than two years are considered less adaptable. Those who have lived at their address six and more years are considered more adaptable. In between these two groups are those who have lived two to five years at their present address. A graphic portrayal of the data in Figure 18 reveals a comparison of the relationship between length of residency

ASSOCIATION BETWEEN LENGTH OF RESIDENCY AND NOISE LEVELS AS PERCEIVED AT REGULAR AND HAJJ TIMES (FIG. 18)



and noise perception at both regular and Hajj times. The survey results, summarized in Tables 10 and 11 show that 22% of the sample population have resided at their present address less than two years, 29% between two to five years, and 49% for six and more years.

Table 10

Association Between Noise Perception at Regular Time and Length of Residency

	Less than two years	2-5 Years	6 or more years	Total
Extremely High	(10)* 14	(12) 12	(21) 17	43
Very High	(30) 14	(38) 20	(66) 99	133
High	(46) 15	(59) 70	(101) 121	206
Low	(38) 63	(49) 52	(84) 56	171
Very Low	(48) 64	(62) 67	(107) 86	217
Total	170	221	379	770

X^2 = 99.4 (With 8 Degrees of Freedom)
*Numbers in parenthesis are expected values
Significance = .0000

Within the psychosocial and psychological frameworks that individual adaptation to the problem of aircraft noise occurs, Table 10 reveals that 33% of those who have resided for less than two years perceive aircraft noise as extremely high while 30% perceive it as very low. There is almost no difference in the noise levels as perceived by those who have resided at their current address for six or more years. While 40% perceive aircraft noise as very low, the same percentage perceive it as extremely high. An examination of Table 10 further reveals that while 8% of those who have been in residence for less than two years perceive aircraft noise as extremely high, only 5% of those who have resided for six or more years at their present address perceive it at this level. In other words, those people who have resided for less than two years at their present locations perceive the problem of aircraft noise more seriously than those who have resided where they do at present for six and more years. The chi-square results show the relationship between length of residency and perception of aircraft noise to be significant at the .0000 level. This result supports the third hypothesis.

A further explanation of the question raised in this third hypothesis is given by considering the relationship between length of residency and perception of aircraft noise during Hajj time (Table 11). Examining this relationship at Hajj time has importance in that it presents the opposite picture of the situation at regular times (shown in Table 3). The chi-square results in Table 11 show the relationship between length of residency and perception of aircraft noise at Hajj time to be significant at the .0000 level. But unlike the

situation of noise levels and length of residency at regular times, Table 11 shows that 35% of those who have resided for six or more years at their present address perceive aircraft noise as extremely high while only 16% perceive it as very low. On the other hand, 29%

Table 11

Association Between Noise Perception at Hajj Time and Length of Residency

	Less than two years	2-5 Years	6 or more years	Total
Extremely High	(43)* 24	(55) 38	(95) 131	193
Very High	(28) 22	(37) 44	(63) 62	128
High	(27) 22	(36) 34	(61) 68	124
Low	(38) 53	(49) 63	(85) 56	172
Very Low	(34) 49	(44) 42	(75) 62	153
Total	170	221	379	770

X^2 = 60.7 (With 8 Degrees of Freedom)
*Numbers in parenthesis are expected values
Significance = .0000

of those who have resided for less than two years at their current location perceive aircraft noise as very low and only 14% as extremely high. This means that, although there are more people at Hajj time than at regular times, who have become resigned to aircraft noise, they remain extremely unhappy with the problem and experience severs problems adapting to the conditions regardless of how long they have lived in the area.

In general, it should be mentioned that the description of the data collected concerning the relationship between noise perception and length of residency failed to take into account all the factors which might affect one's perceptual process. The attempt was made to determine the relative importance of the time span of habitation and its affect on adaptation to the problem of aircraft noise. In other words, it must be emphasized that the author does not claim that the relationship existing between the respondents' perception of aircraft noise and length of residency is necessarily a reflection of reality. However, it is simply a reflection of a manner in which reality has been interpreted.

Length of Residency and Propensity of Changing Residence Because of Aircraft Noise

It is hypothesized that recent residents within the study area have a greater propensity for changing their present residence because of aircraft noise than long term residents. In an attempt to determine this degree of geographical mobility, respondents were asked to express

their willingness whether or not they would move, that is, respondents were counted as potential movers if they had expressed their willingness by answering "yes" to the questions concerning mobility.

The survey results, summarized in Table 12, reveal that 86% of the respondents are willing to continue living where they are now residing. On the other hand, only 14% of the respondents regard living at their present address and consider their location as disadvantageous.

Table 12

Relationship Between Length of Residency and the Desire to Move

	Yes	No	Total
Less than 2 years	(23)* 38	(147) 132	170
2-5 years	(30) 39	(191) 182	221
6 or more years	(52) 28	(327) 351	379
Total	105	665	770

X^2 = 26.5 (With 2 Degrees of Freedom)
*Numbers in parenthesis are expected values
Significance = .0000

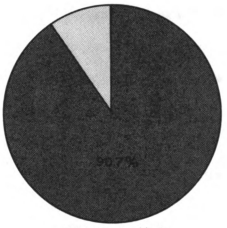
This result indicates that, although all respondents are permanent residents within the seven kilometers radius around Jeddah International Airport, the vast majority are less concerned and almost oblivious to aircraft noise despite its existence. The willingness of a large

percentage of residents to remain and not to move out is not easily understood. However, it appears to a great extent that residents lack knowledge of the nature of aircraft noise but still express an unwillingness to move because of it. It is found from the survey that out of the 770 respondents, 99% have never received any information regarding aircraft noise through the different means of mass media or through other social and academic institutions. Moreover, only 20% of the respondents discussed the problem of aircraft noise with family members and 18% with friends. Most respondents (61%) have never discussed it with family or friends or with official authorities.

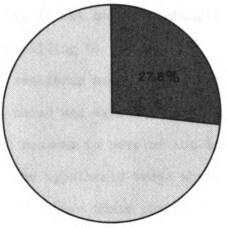
The differences in response between those who have decided to remain in their present residence and for those who have expressed their willingness to change their residence probably stems from some other factors than length of residency. A contrasting set of factors were considered by questions dealing with reasons for moving and reasons for not moving. By far the most important response for moving was the question of an environmental factor, that is, annoyance caused by aircraft noise. At a somewhat lower level of importance were other factors such as distance from place of work and availability of urban facilities.

Before discussing the reasons to move or not to move, a discussion about noise levels as perceived and the desire to change residence is in order. The relationship between the perception of aircraft noise and the propensity to change residence is illustrated in Figure 19. This figure shows that there is a strong relationship between noise levels as perceived and the consideration to change residence. Almost 91% of those who perceive aircraft noise as extremely high

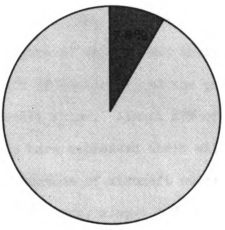
NOISE LEVELS AS PERCEIVED AND PROPENSITY TO CHANGE RESIDENCE
(FIG. 19)



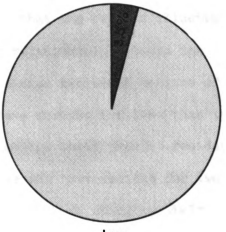
Extremely High



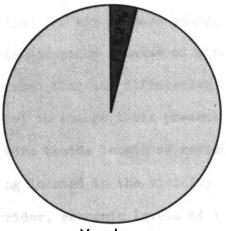
Very High



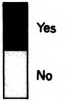
High



Low



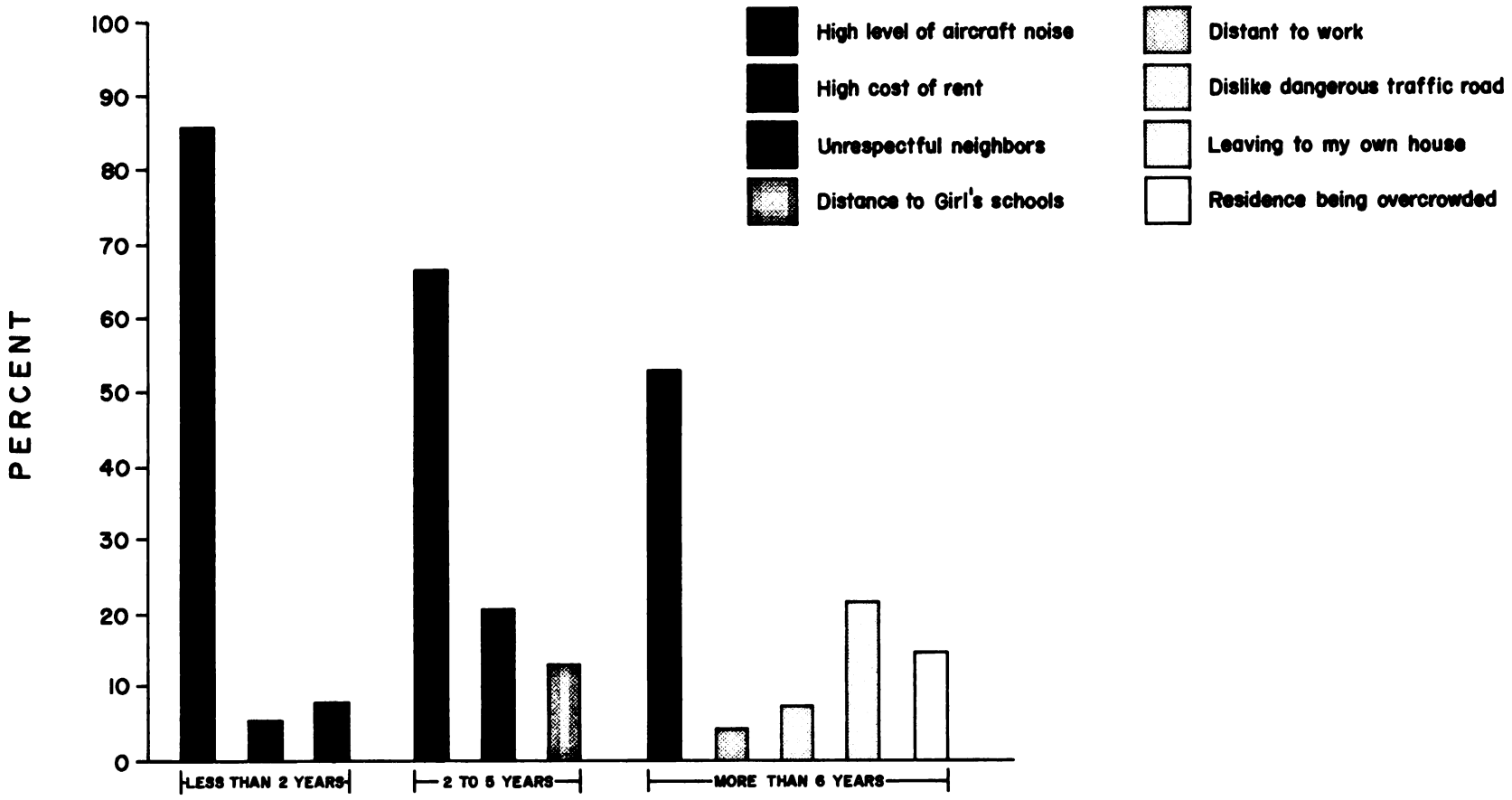
Very Low



consider changing their residence whereas only 9% of them are willing to remain where they have resided. On the other hand, almost 97% of those who perceive aircraft noise as very low do not consider changing their residence. Only 3% in this group are willing to move.

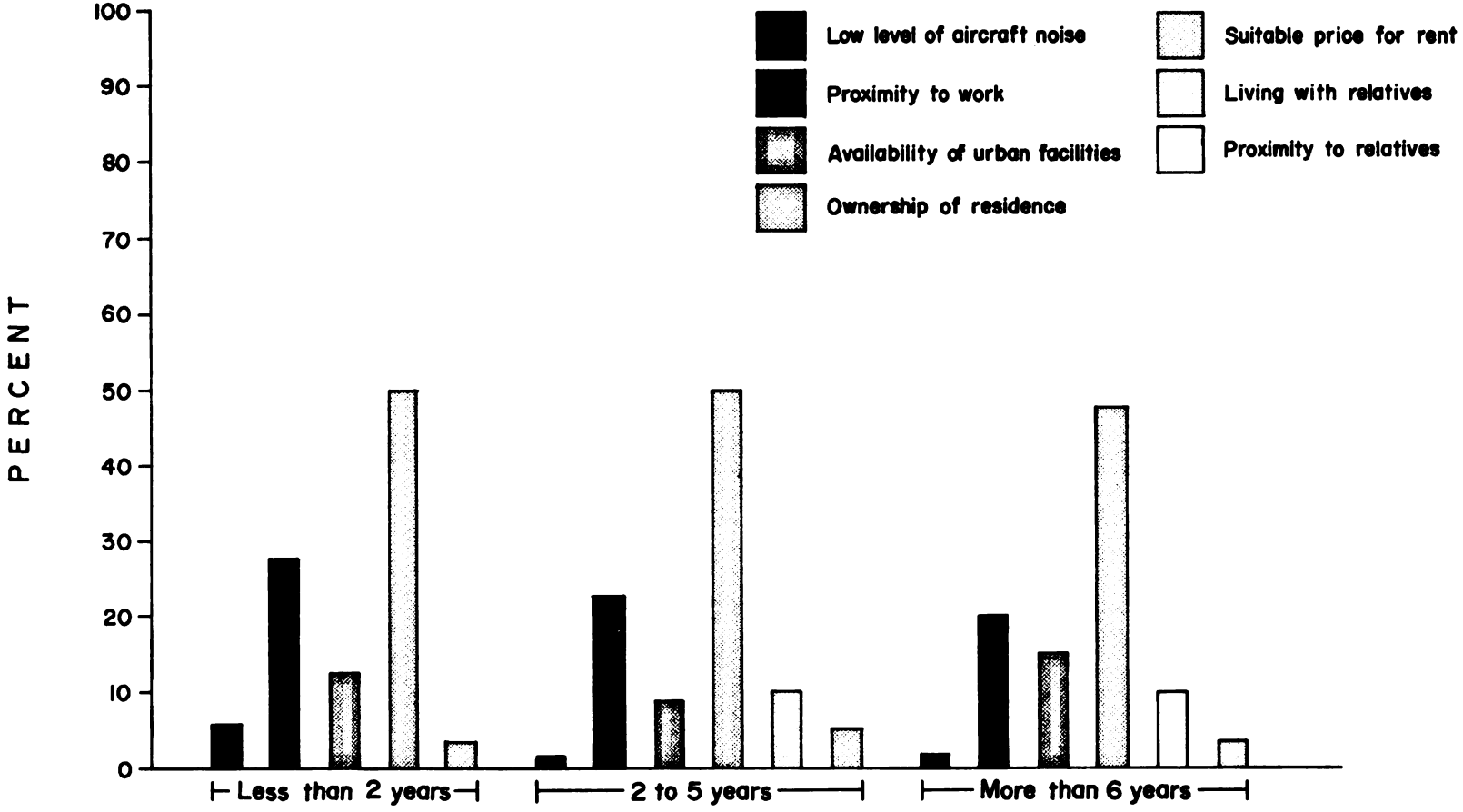
The relationship between length of residency and the propensity for changing residence because of aircraft noise was examined next. Association between length of residency and reasons to move or not to move is illustrated in Figures 20 and 21. The hypothesis tests whether recent residents have a greater propensity to change their present residence because of aircraft noise than those who are long term residents. This hypothesis is supported in that the results illustrated in Figure 20 reveal that there is a strong relationship between the length of residency and the propensity to change residence because of aircraft noise. Almost 87% of those who have resided for less than two years have expressed their willingness to change their present residence only because of aircraft noise. Among those who have resided for two to five years, almost 67% of them have the choice of changing their present residence because of aircraft noise. But, among those who have resided for six or more years, only 53% of them are willing to change their occupancy because of aircraft noise. In general, it should be stressed that the differences in the respondents' willingness to change or not to change their present residence probably stems from other factors beside length of residency. These include factors such as being located in the vicinity of the airport or under the flight path corridor, economic levels of the residents and the residents' adaptation to noise which might affect their decision regarding future habitation.

LENGTH OF RESIDENCY AND REASONS FOR CHANGING RESIDENCE (FIG. 20)



Furthermore, one might infer several reasons for willingness to change residence with increased length of residency. A contrasting set of reasons was found when examining length of residency and reasons for not moving (see Figure 21). The ownership of the house was found the strongest reason for desiring to remain in the present residence. This factor is especially important in that the overall cost of purchasing a new residence in a noise-free area might be far beyond the ability of area residents. As the results illustrated in Figure 21 reveal, ownership of the house was an important reason for 50% of both those who have resided for less than two years and those who have resided for two to five years. Another important reason which reduces the people's willingness to change their present residence because of aircraft noise was proximity to place of work. It was important to almost 27% of those who have resided for two to five years and 22% of those who have resided for six or more years. Other important reasons were found to be "living with relative" and "proximity to relative". Living with relatives was considered as an important reason for not changing one's residence by 10% of both those who have resided for two to five years and those who have resided for six or more years. Proximity to relatives was also considered an important reason only among almost 4% of those who have resided at their present address for six or more years. This finding suggests that people's willingness to change residence or not tends to be affected by the close ties they maintain with their relatives; such residents consider sociocultural reasons as important factors to resist a change from their present residence.

LENGTH OF RESIDENCY AND REASONS FOR NOT CHANGING RESIDENCE (FIG. 21)



Willingness to Change Residence and Potential Destination

Following the results obtained by verifying the fourth hypothesis, it is hypothesized that the segment of the population willing to move because of perceived high levels of aircraft noise will move away from the study area (seven kilometers radius of the airport), that is, within other parts of the city but not beyond the city boundary.

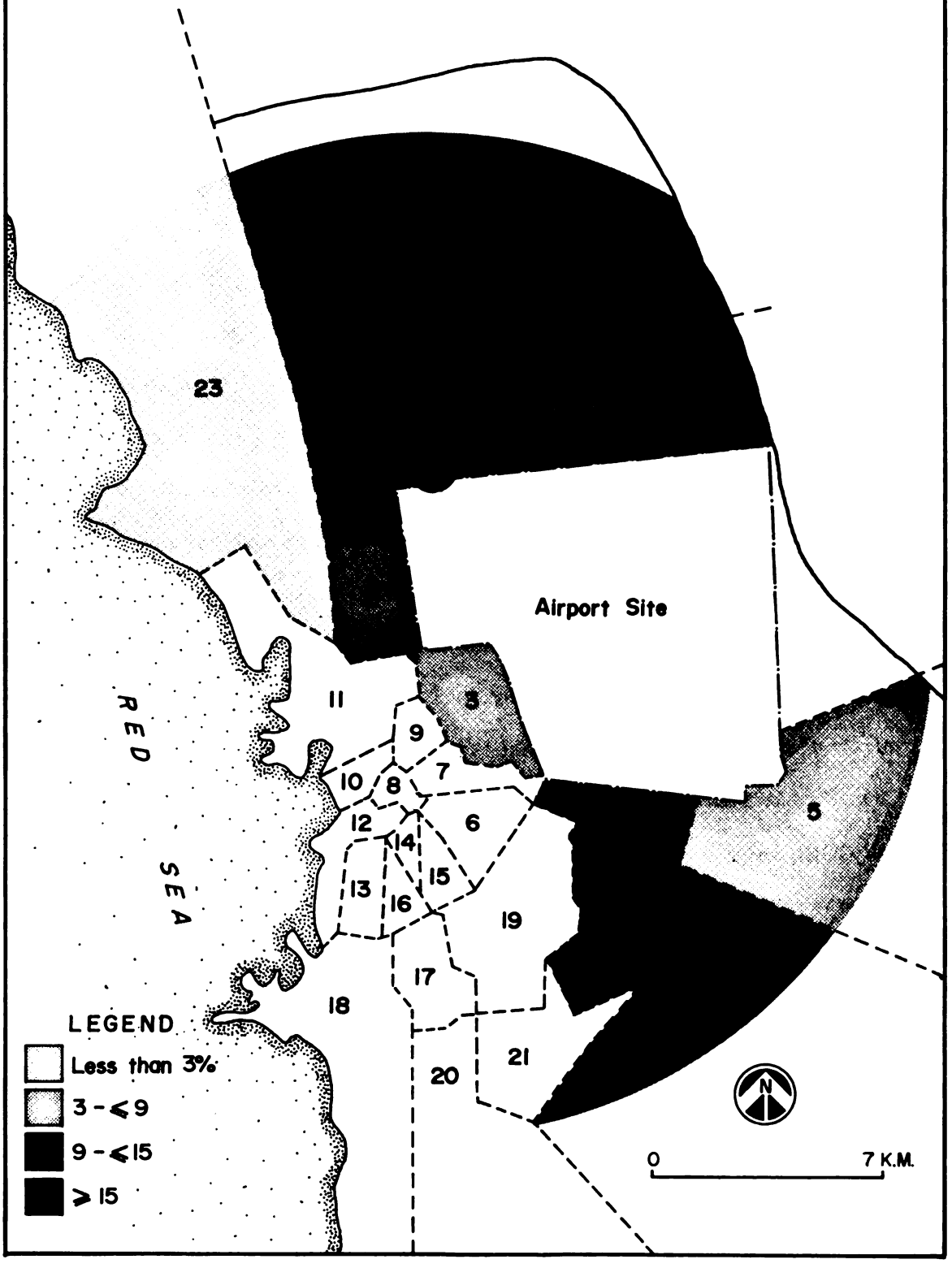
The survey results, summarized in Table 13 and illustrated in Figure 22, reveal that those people who are willing to change their residence because of aircraft noise live in only 8 Haras among the 24

Table 13

Aircraft Noise and Willingness of Residential Change Within and Outside Jeddah City by Haras

Hara No.	Within the City	Outside the City	Total
1	12 (16.2%)	0	12
2	7 (9.5%)	0	7
3	6 (8.1%)	0	6
4	11 (14.9%)	1 (1.3%)	12
5	6 (8.1%)	0	6
22	11 (14.9%)	3 (4.0%)	14
23	2 (2.7%)	0	2
24	13 (17.6%)	2 (2.7%)	15
Total	68 (92%)	6 (8%)	74

PERCENTAGE OF MOVERS BECAUSE OF AIRCRAFT NOISE BY HARA (FIG. 22)



Haras surveyed. Almost 64% are willing to change their present residence because of aircraft noise. Half live only in Haras 1, 4, 22 and 24. The results of Table 13 and Figure 22 further revealed that the rest (36%) of those willing to change their present residence because of aircraft noise live in Haras 2, 3, 5 and 23, which are relatively adjacent to the previous Haras. The explanation of this result is that those people who are willing to change their residence reside in Haras affected by high levels of aircraft noise, particularly those Haras which share the airport with its boundary and those which are located under the flight path corridor.

The relationship between a willingness to change one's present residence and locational selectivity within the city boundary was examined next. The results summarized in Table 13 and Figure 23 support the hypothesis that the segment of the population willing to move away from the study area, that is, within other parts of the city but not beyond the city boundary. The results reveal that 92% of those willing to change their present residence because of aircraft noise find residency within the city boundary attractive, whereas 8% are willing to move beyond the city boundary. In other words, different geographical locations within the city boundary provide different advantages in terms of choosing a noise-free residence for the majority of the people willing to change their present residence because of the intensity of aircraft noise. There are seven potentially attractive locations in four Haras (5, 18, 20 and 23). A significant majority (six out of seven) of these locations are beyond the seven kilometer radius of the airport; only one location is within this radius (Hara


CITY
PREFERRED DESTINATION WITHIN THE STUDY AREA WITHIN THE CITY
DESTINATION OUTSIDE THE CITY

No. 3). The direction of this last location is southwest of the airport and it has the advantage of being located far away from the flight path corridor. These results reveal that distance is clearly a vital factor affecting the mover's choice of destination. However, this is extremely questionable, and to qualify this, one must demonstrate the need for more detailed study of personal characteristics, spatial and socio-economic factors.

Willingness to Change Residence and Income

It is hypothesized that the propensity to move because of high levels of aircraft noise is greater among those with higher annual incomes. That is, the likelihood to consider changing residence is directly related to income. One would predict that higher income groups have a wider choice of residential locations as well as the ability to pay higher costs for the purchase of a residence in a noise-free area. By examining the survey results summarized in Table 14, one can notice that more than half of the sample population (55%) is classified as having SR 25,200-33,599* followed by almost 21% as having SR 16,800-25,199 annual income. Within the context of the present general income level of the city, these results are considered to belong to the middle and upper middle classes. On the other hand, less than 2% of the sample population belong to the upper classes, those earning SR 42,000 or more annually. This result is not surprising in that people with higher

*One U.S. dollar equals 3.5 SR.

Table 14

Willingness To Change Residence And Income

	SR 8,400	Percent	8,400 to 16,799	Percent	16,800 to 25,199	Percent	25,200 to 33,599	Percent	33,600 to 41,999	Percent	42,000	Percent	Total
Yes	2	.3	2	.3	10	1.3	65	8.4	19	2.5	7	.9	105
No	33	4.3	22	2.9	148	19.2	359	46.6	96	12.5	7	.9	665
Total	35	4.6	24	3.2	158	20.5	424	55	115	15	14	1.8	770

Source: Field Survey

annual incomes have already had the greatest degree of residential choice to live in a less noisy area. The relationship between willingness to change the present residence and income is also described in Table 14. The available data fails to support this hypothesis, in that only 6% of those who belong to the upper class are willing to change their residence. On the other hand, the majority (62%) of those who are willing to change their residence belong to the upper middle class followed by 18% of the lower middle class. This means that neither the very poor nor the very rich are willing to change their present residence. This finding is also not surprising in that the upper class people with higher income have the chance to keep their residence comfortable and live in houses that are better designed to control noise. On the other hand, lower class people with lower income level are restricted to noisier areas in that their economic situation does not help them to provide a better residence in a noise-free area.

Summary

This study has reached certain answers as to how people living in the 24 Haras around Jeddah International Airport respond to the noise pollution due to regular and frequent air flights. In the main, it has been found that the residents' perception of aircraft noise varies considerably across the 24 Haras around the airport, though within these 24 Haras groups of homogeneous and heterogeneous Haras have been identified with respect to the respondents' perception of this noise pollution.

Those inhabitants of the 24 Haras who live within a 2-kilometer radius of the airport have largely recorded their perception of the aircraft noise as negative, and the people falling beyond the 2 kilometer limit have tended to be evenly divided between negative and low rating of its nuisance value. This study, furthermore, examined the relationship between noise perception during regular versus Hajj times and length of residency by dividing the resident population into three groups: (1) those in residence for less than two years, (2) those in residence between 2 and 5 years, and (3) those in residence six or more than six years within the 7 kilometer radius around the airport. The first group was found to be less adaptable to the noise than the third group. However, during Hajj time, the perception of those who have resided for six or more years becomes sharply negative, while the first group appears more resigned to the noise, though unhappy with it.

Another finding indicates most permanent residents of the 24 Haras living within a 7 kilometer radius around the airport hardly contemplated change of residence due to aircraft noise. Only 10% of the 770 respondents expressed their willingness to change their present occupancies because of aircraft noise. However, the rate of this geographical mobility is sharply higher among those who negatively perceive the aircraft noise as extremely high. Ninety-one percent of these residents do contemplate changing their residence and only 9% of them are willing to continue to live with the noise-affected areas. Those willing to change their present occupancies because of the intensity of aircraft noise still prefer their future habitation to be within the city not beyond its boundary. It was further

found that the longer the period of residency the less the propensity to change residence.

Finally, it was found that the very poor and the very rich classes of residents are indifferent to the idea of moving. This may be due to the poor people's financial inability to move and the rich people's capacity to provide for themselves the noise reducing devices and/or compensating comforts.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Research on noise pollution has received the attention of concerned social scientists, physiologists, engineers and government agencies for more than thirty years. Among many professions, it is generally agreed that noise pollution creates serious physiological, psychic and social ills. It disturbs normal rest and sleep, upsets children and pets and disrupts the normal mode of living. In a broad sense, noise pollution creates a subjective feeling of annoyance and effects the quality of our environment.

Sound levels are claimed to be increasing in both intensity and areal coverage as technology and engineering generate more powerful machines for use in our everyday lives. One of the main and dominant sources of noise is caused by aircraft operations. The problem of aircraft noise began to take shape in the late 1940's and early 1950's. This was due to the introduction of jet aircraft and its ultimate use at a mass level by both military and commercial services. Therefore, as the use of jet aircraft kept increasing, the problem of aircraft noise is continually getting worse, and the reason for this is the increasing use of aircraft services accompanied by an increase in the density of population around airports.

Jeddah City has one of the most heavily used airports in the world. The holiest of places of Muslim pilgrimage, Mecca, is located

in Saudi Arabia, and the Jeddah International Airport is the only airport in the country that caters to the millions of Muslim Pilgrims who converge on the city annually from all over the world. Jeddah, besides being the most important international airport in Saudi Arabia, has to handle almost all the incoming and outgoing traffic to different centers in the country during both the Hajj (Pilgrimage) and non-Hajj periods. This fact alone has subjected the local population to growing and continuous doses of excessive noise.

Conclusions

It is unfortunate that no governmental agency or private organization within Jeddah City or Saudi Arabia has done much so far to protect the population around the airport from the ill-effects of the heavy bombardment of aircraft noise. Indeed, in the planning and the expansion of the international airport, the human dimension of noise pollution is woefully ignored and absent. Add to this that no concern has been made to determine the total noise exposure of areas near the take-off and landing flight paths, and there is a lack of planning needed for well-based policy decisions, either for the immediate or the more distant environs of the airport, or in respect to operational restrictions that may be desirable.

In order to make a valuable contribution to the development of airport planning policy, the main purpose of this study has been to examine the perception of the people living in the noise polluted area around the Jeddah International Airport and thereby to acquire useful

insights into the people's attitudes and responses to aircraft noise variation within a spatial context. Specific hypotheses tested were: people's perception of aircraft noise would vary across the 24 Haras (quarters) surveyed; the closer the residents to the airport, the greater the negative perception of noise; the more time people spent living in the noise polluted area, the less would be their negative perception toward the noise; the less time people spent living in the noise polluted area, the greater their propensity to changing their present residence because of aircraft noise; the destination selectivity for potential movers would be away from the seven kilometers radius but within the city boundary; and the propensity to move would be greater among those with higher annual incomes.

An analysis of the data revealed that the frequency of aircraft operations and geographical location of the airport were important factors in determining the spatial variation of aircraft noise as perceived by people within and between Haras. Due to the increased demands for air traffic, especially during the Hajj period, Jeddah residents revealed a higher negative perception toward aircraft noise than during the non-Hajj period. A much higher negative perception was expressed by those living in the Haras located directly under the flight path to the south of the airport at the landing approach and to the north where the departure routes are located. In spatial terms, aircraft noise was postulated to be much more of an irritant to those living in the proximity of the airport. The raw data for Jeddah identified an inverse relationship between noise levels as perceived and distance from the Jeddah International Airport.

Another factor that has affected Jeddah residents' perception of aircraft noise is the time span for which they have lived at their present location within the high noise polluted areas. Basically, three points have emerged from this discussion: First, those who have spent less time living in their present locations perceive the problem of aircraft noise more seriously than those who have resided around the airport for a longer time. Second, since the aircraft noise during the Hajj time is continuous and heavy, Jeddah residents, though they are extremely unhappy with the noise and experience severity of it, ultimately adapt themselves to the conditions regardless of how long they have lived there. Third, residents who have lived in the area for less than two years have a greater propensity to change their present residence because of aircraft noise than those who have lived there for a long time.

Another question of some importance raised in this study is whether aircraft noise is a factor affecting the respondents' choice of future residence. It was found that only 10 percent of the 770 respondents are willing to change their present occupancies because of aircraft noise. This degree of geographical mobility is much less than that observed in more advanced countries. Consistent with the finding of Walters (1975, pp. 107-112), the noisy areas around Los Angeles International Airport have an average of 50 percent more movers than the quiet area. Aircraft noise has been responsible for the movement being some 25 percent in the airport noise affected area in Toronto. In Hayes, London, one of the noisy local authority areas near Heathrow Airport, the rate of movement is between 20-30 percent. This lower

rate of mobility among residents in Jeddah may be explained by the fact that people with higher incomes have already moved out of the noisy areas to quieter ones and that the vast majority of the people belonging to the lower income group have a limited choice to change residence because of their economic situation. In addition, most low income residents, owing to illiteracy, are unable to perceive the seriousness of the problems arising out of a constant exposure to noise. Even information from the print media cannot easily reach them because of the illiteracy. Their ability to own a house in close proximity to the place of work and retain strong sociocultural ties with or close to relatives is very important in explaining the low rate of potential mobility.

Recommendations

On the basis of knowledge of the respondents' perception of aircraft noise around the Jeddah International Airport, the investigator is in a position to make the following recommendations:

1. Due to the increased demand for aircraft operations, especially during the Hajj period, additional airports in the region need to be constructed to relieve the traffic congestion over Jeddah City. However, this construction should be achieved without creating the congestion from which Jeddah International Airport is trying to escape.

2. Since effective planning must always conform to the behavioral attributes of the people involved, it is difficult and unwise to implement short and long range planning without taking into consideration the attitudes, perceptions and spatial behaviors of the people directly affected by those plans.

3. Research on the harmful effects of aircraft noise should continue and include other urban areas of the developing world where there is currently a lack of understanding of the interfaces existing between man-environment relationships.

BIBLIOGRAPHY

BIBLIOGRAPHY

Books

Alexandre, A. and J.-Ph. Brade (1975) "The Social Cost of Noise", In Road Traffic Noise, By A. Alexandre, J.-Ph. Barde, C. Lamure, and F. J. Langdon, Applied Science Publishers Ltd., London, pp. 70-84.

Beck, Robert (1967) "Spatial Meaning and the Properties of the Environment", In Environmental Perception and Behavior, Ed. by David Lowenthal, The University of Chicago, Department of Geography, Research Paper No. 109, Chicago, Illinois, pp. 18-41.

Berland, Theodore (1970) Noise - The Third Pollution, The Public Affair Committee, Public Affairs Pamphlet No. 449, New York.

Brail, Richard K. (1978) "Impact of Transportation Technology On the Environment", In Sourcebook On the Environment: A Guide to the Literature, Ed. by Kenneth A. Hammond, George Macinko, and Wilma B. Fairchild, The University of Chicago Press, Chicago, Illinois, pp. 187-203.

Burns, William F. (1973) Noise and Man, printed in Great Britain by William Clowes and Sons, London.

Croome, D. J. (1977) Noise, Buildings and People, printed in Great Britain, Pergamon Press, London.

Dasman, Raymond F. (1972) Environmental Conservation, John Wiley and Sons Inc., Toronto, Canada.

Dunipaco, Robin and others (1978) The Kingdom of Saudi Arabia, Stacy International, London.

Hewitt, Kenneth, and F. Kenneth Hare (1973) Man and Environment, Washington, D.C.; Association of American Geographers, Resource Paper No. 20.

King, Richard L. (1973) Airport Noise Pollution: A Bibliography of Its Effect On People and Property, The Scarecrow Press, Inc., Metuchen, New Jersey.

Kryter, K. D. (1970) The Effect of Noise On Man, Academic Press, New York.

Langdon, F. J. (1975) "Noise and Man", In Road Traffic Noise, by A. Alexandre, J.-Ph. Barde, C. Lamure, and F. J. Langdon, Applied Science Publishers, Ltd., London, pp. 1-26.

Pesce, Anglo (1974) Jeddah: A Portrait of an Arabian City, Falcon Press, London.

Rapoport, Amos (1977) Human Aspects of Urban Form: Towards a Man-Environment Approach to Urban Form and Design, Pergamon Press, Oxford, England.

Saarinen, Thomas F. (1969) Perception of Environment, Washington, D.C.; Association of American Geographers, Resource Paper No. 5.

Smith, Charles L. (1970) Noise Unwanted Sound: Bibliography, Berkeley California.

Stevenson, Gordon M., Jr. (1972) "Noise and Urban Environment", In Urbanization and Environment: The Physical Geography of the City, Ed. by Thomas R. Detwyler and Melvin G. Marcus, Duxbury Press, Belmont, California.

Tosi, Oscare (1972) "Noise: An Environmental Pollution", In Environmental Quality Now or Never, Ed. by Charles L. Sanclemente, S. I. M. Special Publication No. 5, published by Continuing Ed. Service, Michigan State University, East Lansing, Michigan, pp. 94-101.

Tuan, Yi - Fu (1967) "Attitude Toward Environment: Themes and Approaches", In Environmental Perception and Behavior, Ed. by David Lowenthal, The University of Chicago, Department of Geography, Research Paper No. 109, Chicago, Illinois, pp. 4-17.

Walters, A. A. (1975) Noise and Price, Oxford University Press, England.

Young, Robert K. and Donald J. Veldman (1977) Introductory Statistics for the Behavioral Science, Holt, Rinehart and Winston Inc., printed in U.S.A.

Articles

"City Dwellers, Teenagers Face Deafness From Noise", Congressional Quarterly Weekly Report, Vol. 28, No. 16, April 7, 1970, pp. 1035-1038.

"How Today's Noise Hurts Body and Mind", Medical World News, June 13, 1969, pp. 42-47.

Alberg, C. F. "Airports, Noise and Town Planning", Journal of Sound and Vibration, Vol. 43, No. 2, 1975, pp. 363-374.

Alexander, A. "The Social Impact of Aircraft Noise", Traffic Quarterly, Vol. 28, No. 3, July, 1974, pp. 371-388.

Ando, Y., Y Nakane and J. Egawa. "Effects of Aircraft Noise On the Mental Work of Pupils", Journal of Sound and Vibration, Vol. 43, No. 4, 1975, pp. 683-691.

Bauman, K. "Aircraft Noise In Edmonton, Alberta", The Albertan Geographers, No. 8, 1972, pp. 19-25.

Bentil, J. K. "Environmental Improvement Through Noise Control in the European Community", Journal of Planning and Environment Law, January, 1978, pp. 16-27.

Bishop, Dwight E. "Reduction of Aircraft Noise Measured in Several School, Motel and Residential Rooms", The Journal of the Acoustical Society of America, Vol. 39, No. 5, 1966, pp. 907-913.

Bragdon, Clifford R. "Urban Planning and Noise Control", Sound and Vibration, Vol. 7, No. 5, May, 1973, pp. 26-32.

Branch, Melville C. "Urban Airtraffic and City Planning: A Case Study of Los Angeles County", Traffic Quarterly, Vol. 27, No. 3, July, 1973, pp. 377-397.

Cohen, Alexander and Howard E. Ayer. "Some Observations of Noise at Airports and in the Surrounding Community", American Industrial Hygiene Association, Vol. 25, March-April, 1964, pp. 139-150.

_____, Joseph R. Anticaglie and Herbert H. Jones. "Noise-Induced Hearing Loss: Exposures to Steady-State Noise", Archives of Environmental Health, Vol. 20, No. 5, May, 1970, pp. 614-623.

Dickinson, P. J. and J. B. Large. "The Problem of Modeling Community Noise", Journal of Sound and Vibration, Vol. 43, No. 2, 1975, pp. 419-427.

Donley, Ray. "Community Noise Regulation", Sound and Vibration, Vol. 13, No. 2, February, 1969, pp. 12-21.

Eldred, K. M. "Assessment of Community Noise", Journal of Sound and Vibration, Vol. 43, No. 2, 1975, pp. 137-146.

Fidell, Sanford. "Nationwide Urban Noise Survey", The Journal of the Acoustical Society of America, Vol. 64, No. 1, July, 1978, pp. 198-206.

Finko, H. O., R. Martin, R. Guski, B. Rohrmann, R. Schumer and A. Schumer-Kohrs. "Effect of Aircraft Noise on Man", Journal of Sound and Vibration, Vol. 43, No. 2, 1975, pp. 335-349.

Foreman, J. E. K., M. A. Emmerson and S. M. Dickinson. "Noise Level Attitudinal Surveys of London and Woodstock, Ontario", Sound and Vibration, Vol. 8, No. 12, December, 1974, pp. 16-22.

Franken, P. A. and G. Jones. "On Response to Community Noise", Applied Acoustics, Vol. 2, No. 4, 1969, pp. 241-246.

Gautrain, Jean-Franscois. "An Evaluation of the Impact of Aircraft Noise On Property Values With a Simple Model of Urban Land Rent", Land Economics, Vol. 51, No. 1, February, 1975, pp. 80-86.

Glass, David C., Bruce Reim and Jersome E. Singer. "Behavioral Consequences of Adaptation to Controllable and Uncontrollable Noise", Journal of Experimental Social Psychology, Vol. 7, No. 2, 1971, pp. 244-257.

Goodfriend, Lewis S. "Noise in the Community: Where It Comes From, What It Sounds Like, and Why It Sounds That Way", Noise Control, Vol. 4, No. 2, March, 1958, pp. 22-28.

Goodman, Robert F. and Bruce B. Clary. "Community Attitudes and Action in Response To Airport Noise", Environment and Behavior, Vol. 8, No. 3, September, 1976, pp. 441-470.

Harr, Charles M. "Airport Noise and the Urban Dweller: A Proposed Solution", The Real Estate Appraiser, Vol. 34, 1968, pp. 21-25.

Hinchcliffe, Ronald. "Population Surveys and Noise", International Audiology, Vol. 5, No. 3, 1966, pp. 314-322.

Hockey, G. R. "Effects of Noise On Human Efficiency and Some Individual Differences", Journal of Sound and Vibration, Vol. 20, No. 3, 1972, pp. 299-304.

Holsman, A. J. and V. Aleksandric. "Aircraft Noise and the Residential Land Market In Sydney", Australian Geographer, Vol. 13, No. 6, November, 1977, pp. 401-408.

Houle, Gregory F. "Toward The Comprehensive Abatement of Noise Pollution: Recent Federal and New York City Noise Control Legislation", Ecology Law Quarterly, Vol. 4, 1974, pp. 109-144.

Hurdle, P., S. R. Lane and W. C. Meecham. "Jet Aircraft Noise In Metropolitan Los Angeles Under Air Route Corridors", The Journal of The Acoustical Society of America, Vol. 50, No. 1, July, 1971, pp. 32-39.

Karan, P. P. and W. A. Bladen. "Geographical Aspects of Environmental Pollution in India", Geoforum, Vol. 7, No. 1, 1976, pp. 51-57.

Kope, E. W., K. R. Matschat and E. A. Muller. "Abstract of a Procedure For the Description and Assessment of Aircraft Noise in the Vicinity of an Airport", Acustica, Vol. 16, 1965/1966, pp. 251-253.

Kryter, K. D. "Scalling Human Reaction to the Sound From Aircraft", Journal of the Acoustical Society of America, Vol. 31, 1959, pp. 1415-1429.

_____. "Psychological Reactions To Aircraft Noise", Ekistics, November, 1966, pp. 345-352.

Little, John W. "Human Response To Jet Engine Noises", Noise Control, No. 3, 1961, pp. 11-13.

Meklin, John M. "It's Time To Turn Down All That Noise", Fortune Magazine, Vol. 80, No. 5, October, 1969, pp. 130-133, 190, 195.

Meyer, Michael B. "Air and Noise Pollution Surrounding Airports: East Haven V. Eastern Airlines, Inc.", Environmental Affairs, Vol. 1, No. 4, March, 1972, pp. 862-881.

Newman, E. B. "Psycho-Physical Effects of Noise", Noise Control, Vol. 1, No. 4, July, 1955, pp. 16-21.

Page, Richard A. "Noise and Helping Behavior", Environment and Behavior, Vol. 9, No. 3, September, 1977, pp. 331-334.

Pietrasanta, A. C. and K. N. Stevens. "Noise Exposure in Communities Near Jet Air Bases", Noise Control, Vol. 4, No. 2, March, 1958, pp. 29-36.

Plessas, Demetrius J. "Airport Noise: Some Analytic and Policy Perspective", Land Economics, Vol. 49, 1973, pp. 14-21.

Rosenblith, Walter A. "Effects of Noise On Man: Problems For Study", Noise Control, Vol. 1, No. 4, July, 1955, pp. 22-27.

Schuster, James J. and Mary A. Kaiser. "The Effect of Proposed Transportation Facility On Noise Levels In Suburban Community", Environmental Letters, Vol. 8, No. 3, 1975, pp. 211-234.

Sutton, P. "Noise and the Community", Annals of Occupational Hygiene, Vol. 14, June, 1971, pp. 109-117.

Thomson, Adam. "Air Transport and the Environment", Institute of Transportation Journal, Vol. 34, No. 10, May, 1972, pp. 385-397.

Vencklasen, Paul S. "City Noise - Los Angeles", Noise Control, Vol. 2, No. 3, 1956, pp. 14-19.

Wesler, E. "Community Noise Survey of Medford, Massachusetts", The Journal of the Acoustical Society of America, Vol. 54, No. 4, 1973, pp. 985-995.

Wickrama, I. A., M. E. A'Brooke, F. E. G. Gattoni and C. G. Herridge, "Mental Hospital Admission and Aircraft Noise", The Lancet, Vol. 2, December 13, 1969, pp. 1275-1277.

Wrigley, N. "Distance From An Airport and the Noise Expectations of Migrants", Journal of Sound and Vibration, Vol. 49, No. 1, 1976, pp. 137-140.

Young, R. W. "Don't Forget the Simple Sound Level Meter", Noise Control, Vol. 4, 1958, pp. 42-43.

Theses

Carr, Cheryl D. "The Effect of Tenure and Type of Dwelling On Subjective Response To Traffic Noise", McMaster University, Master's Thesis, 1978.

Tavallai, Simin. "The Perception of Noise Around A Small Municipal Airport", Michigan State University, 1978.

Government Reports and Documents

Defense Mapping Agency Aerospace Center, St. Louis Airforce Station, Missouri. Flight Information Publication, Area Planning: Europe - Africa - Middle East, AP/2, October, 1978.

Saudi Arabia Airlines (SAUDIA), Public Affair Division. Annual Report, Jeddah, Saudi Arabia, 1978.

Saudi Arabia, Ministry of Defense and Civil Aviation, Civil Aviation Presidency. Aeronautical Information Publication (A.I.P.), January, 1978.

Saudi Arabia, Ministry of Finance and National Economy, Central Department of Statistics. Statistical Year Book, Riyadh, Saudi Arabia, 1977.

Saudi Arabia, Ministry of Interior, Municipal Affairs, Regional and Town Planning Department, Alternative Urban Strategies: Jeddah, Taif and Yanbu, Jeddah, 1972.

_____. Master Plan Report for Jeddah, Jeddah, 1972.

Saudi Arabia, Ministry of Planning. Second Development Plan, 1975-1980.

Stafseth, H. E., et al. "Noise Pollution", In Second Annual Report, prepared for the Governor's Advisory Council for Environmental Quality. William G. Milliken, Governor, State of Michigan, Executive Office, Lansing, December 15, 1970.

U.S. Department of Commerce. Noise Around Us, COM 71-00147, 1970.

APPENDIX

APPENDIX

The Questionnaire

1. How far do you live from the main terminal of the airport?

   (1) 0-2 K.M.
   (2) 2-4 K.M.
   (3) 4-6 K.M.
   (4) 6+ K.M.

2. To what extent does aircraft noise bother you?

   (1) Extremely High
   (2) Very High
   (3) High
   (4) Low
   (5) Very Low

3. Does aircraft noise disturb your normal conversation?

   (1) Yes
   (2) No

4. Does aircraft noise interfere with listening to the radio or television?

   (1) Yes
   (2) No

5. Does aircraft noise disturb your sleeping or relaxation?

   (1) Yes
   (2) No

6. To what extent does aircraft noise bother you during Pilgrimage (Hajj) time?

   (1) Extremely High
   (2) Very High
   (3) High
   (4) Low
   (5) Very Low

7. How long have you lived in your present residence?

   (1) Less than two years
   (2) 2-5 years
   (3) 5+ years

8. Are you considering moving from your present residence?

   (1) Yes
   (2) No

9. If yes, is it due to:

   (1) High level of aircraft noise
   (2) Distance to work
   (3) Lack of urban facilities
   (4) All of these
   (5) Other reason(s), please specify _____, _____, _____

10. If no, is it due to:

   (1) Low level of aircraft noise
   (2) Proximity to work
   (3) Availability of urban facilities
   (4) All of these
   (5) Other reason(s), please specify _____, _____, _____

11. If yes or no, and you have chosen more than one reason, please rank them in order. Give number (1) for your most important reason.

12. If you considered moving your present residence, would you be willing to move:

   (1) Within the city (please give name of quarter)
   (2) Outside the city (where _____)

13. Only during the Hajj season, are you in the habit of leaving your residence temporarily?

   (1) Yes
   (2) No

14. If yes, is it due to:

   (1) High level of aircraft noise
   (2) Shortage of urban facilities
   (3) Overcrowded
   (4) All of these
   (5) Other reason(s), please specify _____, _____, _____

15. If you have considered leaving your residence temporarily during the Hajj season, would you like to move:

(1) Within the city (please give name of quarter)
(2) Outside the city (where _____)

16. Do you think the site of the airport is ideal?

(1) Yes
(2) No
(3) I don't know

17. Have you ever discussed the problem of aircraft noise with:

(1) Member of your family
(2) Friends
(3) Airport authority
(4) All of these
(5) None of these

18. Have you ever heard or read about the problem of aircraft noise through:

(1) Newspaper
(2) Radio or TV
(3) Mosque
(4) All of these
(5) None of these
(6) Other sources, please specify _____, _____, _____

19. Did you consult a physicial because of a health problem resultant from aircraft noise?

(1) Yes
(2) No

20. Do you expect a future health hazard because of aircraft noise?

(1) Yes
(2) No
(3) I don't know

21. Is your house made of:

(1) Concrete
(2) Wood and bricks
(3) Shacks

22. What is your age?

(1) Less than 18
(2) 19-34
(3) 35-50
(4) 50+

23. What is your educational level?

(1) Illiterate
(2) Elementary school graduate
(3) Intermediate school graduate
(4) High school graduate
(5) College graduate
(6) Higher

24. What is your annual income?

For the interviewer, please identify

Hara No. _____
Mosque No. _____

جامعة الملك عبد العزيز بجدة
كلية الآداب والعلوم الانسانيـــة
قسم الجغرافيـــا

استفتـــــاء

١) كم يبعد سكنك من البوابة الرئيسية لمدينة جدة الدولى ؟
أ ـ صفر ـ ٢ كيلو ب ـ ٢ ـ ٤
جـ ـ ٤ ـ ٦ د ـ ٦ فأكثر

٢) الى اى مدى ضوضاء الدائرات تسبب لك الازعاج ؟
أ ـ عالى الى اقصى حد ب ـ عال جدا
جـ ـ عال د ـ منخفض هـ ـ منخفض جدا .

٣) هل ضوضاء الدائرات تسبب لك انقطاع وقتى فى محادثتك مع الاخرين ؟
نعم ..... لا .....

٤) هل تؤثر على استماعك للراديو او مشاهدتك للتليفزيون ؟
نعم ..... لا .....

٥) هل تؤثر على نومك أو استرخائك ؟ نعم ..... لا .....

٦) الى أى مدى ضوضاء الدائرات تسبب لك الازعاج فى فترة الحج ؟
أ ـ عال الى اقصى حد ب ـ عال جدا
جـ ـ عال د ـ منخفض هـ ـ منخفض جدا

٧) ما هى فترة سكنك فى منزلك الحالى ؟
أ ـ اقل من سنتين ب ـ ٢ ـ ٥ جـ ـ ٥ فأكثر

٨) هل انت آخذ فى الاعتبار ان تحول من سكنك الحالى ؟ نعم ـــ لا ـــ

٩) اذا كان جوابك بنعم على ذلك بسبب :
أ ـ ازعاج عال من ضوضاء الدائرات ب ـ بعد المسافة الى العمل
جـ ـ النقص فى الخدمات العامه د ـ كل ذلك
هـ ـ اسباب اخرى ـــــــ ، ـــــــ ، ـــــــ

١٠) اذا كان جوابك " لا " على ذلك بسبب :
أ ـ ازعاج منخفض من ضوضاء الدائرات ب ـ قرب المسافة الى العمل
جـ ـ توافر الخدمات العامه د ـ كل ذلك
هـ ـ اسباب اخرى ـــــــ ، ـــــــ ، ـــــــ

١١) من فضلك اعط ترتيبا تنازليا للاسباب التى اخترتها فى جوابك السابق رقم (١) للسبب الاهم :
(١) ـــــــ ، (٢) ـــــــ ، (٣) ـــــــ
(٤) ـــــــ ، (٥) ـــــــ ، (٦) ـــــــ

١٢) اذا كنت قد اخذت فى الاعتبار التحول من سكنك السابق الى اين تنوى السكن .
أ ـ داخل مدينة جدة (من فضلك اعط اسم الحى ـــــــ)
ب ـ الى ضواحى جدة (ـــــــ)

١٣) فقدا في فترة الحج ، هل اعتدت ان تحول من سكنك الحالي بشكل موقت ؟
نعم ، لا .

١٤) اذا كان جوابك بنعم ، اعطي ترتيبا تنازليا لاسباب ذلك رقم ١ للسبب الاهم
أ ـ مدى ازعاج عال من ضوضاء الدائرات ، ب ـ نقص في الخدمات العامة
جـ ـ الازدحام الشديد د ـ اسباب اخرى ، ، ،

١٥) اذا كنت قد اخذت في الاعتبار التحويل من سكنك الثابت بشكل موقت في فترة الحج ، الى اين تنوي السكن .
أ ـ داخل مدينة جدة (من فضلك اعطي اسم الحي)
ب ـ خارج مدينة جدة (أين)

١٦) هل تعتقد ان موضع الدار الحالي يتصف بالمثالية ؟ نعم ، لا
لا ادري .

١٧) هل سبق لك ان تحدثت عن مشكلة ضوضاء الدائرات مع :
أ ـ احد افراد العائلة ، ب ـ اصدقاء ، جـ ـ مسئول الدار
د ـ كل اولئك ، هـ ـ لا احد .

١٨) هل سبق لك ان سمعت او قرأت عن مشكلة ضوضاء الدائرات من خلال :
أ ـ الصحف اليومية ، ب ـ الراديو ، جـ ـ التليفزيون ، د ـ المسجد
هـ ـ كل ذلك و ـ لا شيء من ذلك ، ز ـ غير ذلك من خلال ،
، ، ، .

١٩) هل سبق لك ان تعرضت لفحص طبيب من اجل مشكلة صحية نتجت عن تأثير ضوضاء الدائرات ؟ نعم ، لا .

٢٠) هل تتوقع في المستقبل التعرض لمشكلة صحية نتيجة ضوضاء الدائرات ؟
نعم ، لا ، لا ادري ، اجابة اخرى ،

٢١) كم عمرك ؟ أ ـ اقل من ١٨ سنه ، ب ـ ١٨ ـ ٣٤ ، جـ ـ ٣٥ ـ ٥٠ ، اكثر من ٥٠

٢٢) من اي مواد البناء تعتبر سكنك الحالي ؟
أ ـ الخرسانه المسلحة ، ب ـ البلوك الخشب ، جـ ـ اخشاب .

٢٣) ما هو مستواك التعليمي ؟
أ ـ لا اقرأ ولا أكتب ، ب ـ مرحلة ابتدائية ، جـ ـ مرحلة متوسطة
د ـ مرحلة ثانوية ، هـ ـ مرحلة جامعية ،ودراسات عليا .

٢٤) ما هو دخلك الحالي السنوي ؟

شكرا لتعاونك

رقم الحي

رقم المسجد