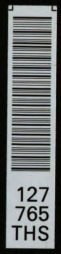


THE PERCEPTION OF NOISE AROUND A SMALL MUNICIPAL AIRPORT

By

Simin Tavallai

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Geography

1978

ABSTRACT

THE PERCEPTION OF NOISE AROUND A SMALL MUNICIPAL AIRPORT

By

Simin Tavallai

A number of studies have been done measuring the effects of noise around major metropolitan airports. Nearly all conclude that noise has serious effects on the human population. The objective of this study is to extend our knowledge in the area of human perception of noise with an investigation of the area around the Lansing Capital City Airport, which is a comparatively small airport. Since people's perception is related to a variety of factors, interviews were conducted around the Lansing Capital City Airport in August 1977 in order to measure the perception of noise and its relationship with variables such as age, income, distance from airport, and length of residency.

The findings reveal that there is little or no significant relationship between noise and selected socioeconomic characteristics. In other words, distance, length of residency, income, and age have almost nothing to do with the negative perception of noise around a small municipal airport.

DEDICATED

To My Parents

ACKNOWLEDGMENTS

I would like to express my appreciation to Dr. Stanley Brunn, Chairman of my thesis committee, for his guidance and encouragement in this research. I gratefully acknowledge the contributions of Eleanor Boyles, and Diane Brunn, whose aid and encouragement helped me forge ahead with this study. I would also like to express my gratitude to Lansing Capital City Airport personnel for providing useful materials and information. Last but not least, to my husband, for his help in conducting the survey interviews.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I
INTRODUCTION TO THE STUDY OF NOISE

Life in the city is confronted with an endless round of obstacles, conflicts, and inconvenience. Urban man encounters excessive noise, air pollution, and overcrowding. One of the unfortunate results of rapid growth in a highly mechanized and urban society has been the gradual increase of noise levels to which the urban dwellers are constantly exposed. In fact, the right to enjoy quietness is being eroded by the largely unavoidable noise of our industrial society. City noise, whether from transportation or industrial sources, may even be described as torture.

One of the main components of noise is that of aircraft, in particular that of jet planes. Aircraft noise has become increasingly prevalent in U.S. urban communities especially in the last ten to fifteen years as a result of advances in aviation technology, increase in the quantity and the frequency of air travel, and suburbanization of formerly sparsely populated rural-urban fringe areas. Vast residential communities have sprung up in the vicinity of nearly all busy airports. Airplane noise is a problem during take off and landing operations and when the airplane passes over communities at a low altitude (less than 600 feet). It is little wonder that noise from aircraft operations is a nuisance

to people living in the immediate vicinities of airports and especially those near and on the major flight paths. The effect of airport noise would vary from very intense immediately beyond the airport property boundary and those where low altitude and frequent flight path areas are nearby to a minimum where aircraft noise is that of a normal background noise level and where the frequency of overflight is low. Generally, complaints over excessive noise tend to be heard or are legally filed by those who live near the airport who experience higher noise exposure and display a higher negative awareness of operations. It is reasonable to assume that the variations in flight paths and altitudes would result in different degrees of annoyance and eventually different perception levels.

Statement of the Problem:

A great deal of research has been done about the effects of noise around major metropolitan airports including Los Angeles International Airport (LAX) and John F. Kennedy (JFK). All studies concluded that noise has serious effects on the human population including interruption with the daily habits such as sleep and communication and a devaluation of properties. The objective of this study is to extend our knowledge in the area of human perception of noise with an investigation of the area around the Lansing Capital City Airport, which is a fairly small airport, and to compare the

results with those found around huge airports.

This study can be justified within a geographical context since it focuses on man's interaction with the environment. In this case it is the perception of noise, how it varies, how it affects behavior, and what kinds of spatial patterns are exhibited are the major questions. The core of this study is to discern how people perceive noise and if people perceive or feel it as a nuisance. Since people's perception is related to a variety of factors, this study attempts to provide some answers to some specific questions, some of which have been raised from a review of existing literature. Is there any relationship between the perception people have of noise on their socio-economic characteristics, in particular their income level? To what extent might people's perception be tied with their age? Does distance from the airport affect one's perception of noise? To what degree can the length of residency be a determinent factor in people's perception of airport noise? How do the people perceive noise as a factor for devaluation of their properties? Answers to these questions were sought in interviews, conducted around the Lansing Capital City Airport in August 1977.

Noise and Environment:

For a better understanding of the effects of noise some definitions of noise itself are necessary. Anastasi and Bolt (1964) pointed out that noise is any sound which has harmful effects, causes annoyance, and destroys performance. Alex Baron in his book entitled The Tyranny of Noise (1970, p. 46) mentioned that

> in conventional terms, sound may be classified as noise when it damages the hearing mechanism, causes other bodily effects detrimental to the health and safety, disturbs sleep and rest, interfers with conversation or other forms of communication, annoys or irritates.

Kryster (1970) declared that among the factors affecting the degree of annoyance are some properties of sound such as intensity, frequency, periodicity, and unexpectedness. People have individual responses to noise. As Pietrasanta (1955, p. 265) has pointed out "one man's music might be another man's noise."

Unwanted sound or noise is regarded as stressful and can adversely affect man in various ways. People will express their reaction to noise according to the degree of annoyance. Interference with sleep, interference with listening, disturbance of sleep, and physical damage to hearing are some of the negative consequences of being exposed to long periods of high intensity noise. Stevens (1961) concluded that complaints due to flyover noise mainly occur in the evenings as a result of the interruption of sleep and relaxation. Other negative

effects of noise are the physical, physiological, emotional, and psychological consequences. Baron (1970, p. 45) stated that

> the sound signal is transmitted via the brain, to almost every nerve and organ of the body. Therefore, sound influences not only the hearing center of the brain, but the entire physical, physiological, and psychological make-up of the human being.

Damage to hearing might be treated as yet another negative effect of excessive noise. The amount of hearing loss depends on the nature of sound as well as individual characteristics. Another possible negative effect of excessive aircraft noise may be the devaluation of the residential properties. Haar (1968) pointed out that airport proximity diminishes property value. There were over one thousand law-suits related to noise at nineteen airports in 1962; the damages amounted to more than $14.5 million. Aircraft noise might affect even the quality of education. This is what one small-town Texas high school environment sounded like to a college professor of Health and Physical Education:

> In a single wing of the building, a half dozen classrooms are hammered with afternoon noises--Vocational Education classes. The efficiency and effectiveness of the lecture classes drop and the students strain to hear. Fatigue and irritability of students and teachers is great.
>
> (Quoted from Baron, 1970, p. 111)

On the whole, the effects of prolonged exposure to various types of noise are well known from the studies of psychologists, physiologists, and geographers, but the reaction and the

perception to noise is a variable which can only be anticipated. Therefore, it is necessary to concentrate on the impact of airport noise, its spatial characteristics, and people's perception of it.

Environmental Quality and Environmental Perception:

The literature in the field of environmental perception is growing rapidly and a sizeable amount of research has been done in this field by geographers and psychologists. Among the contributions made by geographers are those who worked with the perception of natural hazards. Norman T. Moline in his essay about perception research on floods on the Rock River, Illinois (1974) concluded that people on the flood plains were fully aware of the possibility of floods. Some specific characteristics were recognizable: (1) the extremely close attachment of the residents to their river location; (2) lack of knowledge about what they personally might be able to do in order to prevent damages and (3) the lack of awareness of those government agencies able to assist them with their flood problems. In another study about the adjustment to volcanic hazards in Hawaii by Brian J. Murton and Shinzo Shimabukura (1974), it was stated that the majority sampled did not worry but rather remained calm when they hear an erruption. A large group believe that nothing can be done to stop an erruption. Another group stated that because of their past experience, they know what to do and how they would

behave. In the study by Benjamin Wisner and Philip M. Mbithi about the perception of drought in Eastern Kenya (1974), it was concluded that people were aware of this hazard, but there were many ways for them to cope with drought including mixing crops and livestock and widely spacing fields.

Environmental quality is relatively new topic in geographical research; yet it has been the subject of several studies. Baron (1970) discussed in a chapter the price of noise in measuring environmental quality. He stated (p. 98) that

> we are all prisoners of noise. Democracy gives man the right to vote, but not the right to sleep, the right to dissent, but not the right to minimize the noises of social utility, the right to go to school, but not the right to be able to hear the teacher. A quality environment should, at the very least, have noise levels low enough to permit shouts and screams to be heard.

In the study of urbanization and environmental quality by T.R. Lakshmanan and Lata R. Chatterjee (1976), it was concluded that there are two types of environmental problems associated with the natural environment, one is discharge of pollutants into air, water, and land, and the other one discharge of energy forms such as noise around airports. Their table of common indicators of urban environmental quality is included as Appendix 1. These authors also made some recommendations for the improvement of the quality of environment due to noise pollution including the need for national aircraft noise abatement standards and urban land

use planning that minimizes the development of incompatible land uses such as residences and schools around airports.

Organization of Thesis:

With this brief introductory statement on noise and behavior completed, Chapter II will be devoted to a more detailed discussion of the previous studies which have been done in dealing with noise and especially airport noise. Major characteristics of the study area, the specific research hypothesis, methodology, sampling strategy, and discussion of the questionnaire are the materials included in Chapter III. The main discussion in Chapter IV is devoted to the analysis of data and major findings. The final chapter summarizes the results and offers suggestions for subsequent research.

CHAPTER II
REVIEW OF LITERATURE ON THE PERCEPTION OF NOISE

For the past decade, activity in the field of subjective response to aircraft noise has been intense. It is practically impossible, for example, to count the number of related publications which have appeared. People's behavior in the face of aircraft noise has been the subject of numerous controlled experiments and social surveys. The negative effects of noise can be considered from two perspectives. The first is the general interference with living habits; the second, which is more serious is the actual physiological consequences and the extent of devaluation of vicinal properties. There is little doubt that noise can frustrate one's desire for privacy, rest, relaxation and sleep, and interruption of the above are among the major causes of annoyance. Before the introduction of new turbojets, there were few instances where the public felt the noise level reached nuisance levels. But the introduction of these airlines brought a sharp increase in the number of people affected, and in the number of complaints. Thus, a great deal of research has been conducted to detect correlations between noise and hearing loss, sleeplessness, and physiological and psychological consequences. In the

conference about aircraft and environment sponsored by the Society of Automotive Engineers (1971) some factors which affect disturbance of sleep such as intensity and type of noise, stage of sleep, age of subjects, time of night, amount of prior deprivation, and the subject's past experience with noise stimulus were found to be important. In one of the publications of the National Aeronautics and Space Administration entitled "Community Reaction to Airport Noise" (1970), it is argued that the interruption of sleep or rest caused by an aircraft sound is more annoying than the interruption of other daily activities. Parrack, Eldridge, and Koster (1948) in their experiments exposed subjects to ten minute periods of jet engine noise (20-150 db*) and found the subjects showed a variety of symptoms such as heating of the skin, feelings of dizziness, muscular weakness and excessive fatigue. In a very short article in New York Times on March 13, 1966 (p. 66) it was stated that there is "the possibility that residents of communities afflicted by jet noise may develop psychotic symptoms because their dreams are interrupted at night." The Federal Aeronautics Administration (FAA) in its publication The Impact of Noise on People (May 1977, p. 34), declared that

---

*Decibels are numbers that represent large quantities of sound energy. Table showing the level of decibels for various sources are available in Appendix 2.

> the total amount of hearing loss produced by noise exposure depends on many variables. Hearing loss varies with the type of exposure and its degree of intermittency, the susceptibility of the individual exposed, the total duration of the exposure, and possible induced auditory of fatigue generated by the totality of exposure in terms of type, degree and duration.

Noise is measured in terms of decibels which are small numbers that represent large quantities of sound energy. Human beings can hear the range between 0 and 140 decibels. Baron (1970, p. 40) elaborated this concept and stated that "zero does not mean silence but it represents the threshold of audible sound for a healthy young set of ears." He further argued that the decibels progression increases logaritmically. A given sound at 10 decibels has ten times the intensity of sound at 0 decibels, at 20 decibels hundred times the intensity at 0 decibel and at 30 decibels are thousand times the intensity at 0 decibel. Human reaction to noise is very complex. Some individuals will evidence annoyance from sounds that others find acceptable. Many factors are involved in shaping the attitudes and perception of people regarding noise. Pietrasanta and Bolt (1955) pointed out some determining factors in evaluating the human's response to noise as follows: (1) the noise spectrum--those noises which are reasonably continuous in frequency are usually less annoying than a spectrum containing a single frequency; (2) the peak characteristics of noise--those reasonably continuous in time are less annoying than an impulsive one; (3) the repetitive character of noise; (4) the

level of background noise--people living in an area of low background noise are more likely to be annoyed than those living under high level of background noise; and (5) time of day--a subject can tolerate an intruding noise during the day much better than at night. In one of the National Aviation Facilities Experiment Center's publication by T.H. Green (1966) it has been stated that variation in flight path, altitude, temperature, relative humidity, wind direction, and wind velocity also might affect the noise responses. Hansen (1969, p. 6) argued that "aircraft noise is associated with aircraft gross weight, aircraft altitude, pilot technique, temperature, humidity, and wind." Individual differences account for different degrees of noise perception. Baron (1970, p. 49) put forward that "reaction to a given noise may be influenced by our attitude towards the noise source, our state of health and well-being, our personality, education, income, and previous exposure." Variables like time of day, season of year, and the interval between the exposure to jet noise might affect the human's tolerance.

Aside from factors of control, one may argue that individual differences play an important role in noise perception. It is in this area of study where geographers have made contributions. They have been concerned with the impact of aircraft noise on people's attitudes toward noise and corresponding factors such as socio-economic characteristics, age, and length of residency. Geographers have also

been concerned with the urban aspects of noise and its effects on property values. All of these studies have been conducted around huge airports such as Los Angeles International Airport, John F. Kennedy Airport, and Detroit Metropolitan Airport. Robert Allen Schwein (1971) came to the conclusion that variables like socioeconomic characteristics, age of exposed population, number of adults and children in each household, yearly family income, estimated home value and length of stay can affect people's attitude toward noise. Mary Werner Hans (1975) concluded that characteristics related to the property itself, location, and neighborhood might effect people's attitude and perception toward noise. She argued that property characteristics such as age of home, its appearance and number of rooms, locational characteristics including proximity to bus route and shopping center accessibility, number of persons per household, average family income, and the amount of open space can diminish the negative attitude toward noise. She identifies three ways of finding out people's attitude toward noise. One is by the number of complaints filed. The second way of obtaining people's attitudes is through an examination of government and zoning policies like central mortage and housing corporation policies regarding the financing of homes near flight paths. The third measurement of people's dissatisfaction with noise is through the devaluation of the single family house in comparison with similar but noise-free houses.

The direction and the relationship between noise levels and property values remain open to debate. Baron (1970, p. 91) reported that

> in Norway thirty-two home-owners sued the Ministry of Defence and Communications and won 185,000 Kroner, about $26,300, for the discomfort and property devaluation caused by jet noise.

However, in another study H.O. Walther (1960) arrived at the conclusion that airports do not cause serious devaluation in vicinal properties. He further argued that amenities coming forth from being near airports can offset any negative effects on the market value of real estate. De Neufville and Yajina generally confirmed this view in 1971 with the study of Detroit, Chicago, and Atlanta airports. They found that residential properties vicinal to runways initially gained faster in value than comparable houses away from airports, but less so during the 1960-1970 decade when the airports expanded rapidly. In effect, the changes cancelled out each other (quoted in Crowley, 1972). In another study Crowley (1972) examined Toronto's Malton Airport and concluded that the introduction of larger and noiser aircraft is responsible for possible devaluation in vicinal properties. The first account of an inverse relationship between noise and property values was established after 1972.

Physiologists have long been concerned with the effect of excessive noise on the performance and the physiological condition of the body. Jansen (1959) in his pioneering study

of a thousand steel workers found that the group working in noisy conditions (more than 90 db) had a higher incidence of physiological and psychological disturbances than a comparable group working under quiet conditions. Samuel Rosen (1966) stated that noises cause adrenal hormones to be released into the blood stream that intensify tension and arousal. William H. Stewart (1969) former Surgeon General of the U.S. Public Health Service said that stress has caused an increase in the amount of cholesterol and other fat levels which contribute to the thickening of the arterial walls. However, Finckle and Poppen (1948) reported no measurable physiological change resulting from one hour exposure periods over ten days of 120 db. Thus, one may argue that the differences in the physiological effects of noise are due to differences in the intensity or frequency spectrum of the sound used. In other words, the nature of noise is critical for understanding its consequent effects. Smith (1951, pp. 131-132) declared that

> intermittent noise has a greater tendency to impair performance than does steady noise. Also unpredictable sound has a more aversive impact on performance than predictable sound.

Psychologists have made some contributions to the study of noise as well. Personality variables account for a large portion of the total variance in relation to noise effects. Psychologists are concerned with the investigation of psychological attributes of sound and their relation to the characteristics of sound. In the Proceedings of the Symposium

on the Psychological Effects of Noise held by the University of Wales, Cardiff (1967) it was stated that introverts and extroverts have opposite reaction to an identical source of stimulation. Extroverts will experience it as being weak with the opposite applying to introverts. Similarly introverts perceive a given stimulus very pleasantly while extroverts would perceive it very unpleasantly. The quicker adaption by the extrovert is particularly important when work in noisy surroundings is considered. However, Ingham (1967) stated that there is no striking evidence so far that noisy jobs cause a larger number of adverse symptoms of psychological disorder than quieter jobs. He argued that we should bear in mind that some people are more suceptible to noise including older people who complain of noise symptoms when they work in a noisy environment.

Based on the above studies which were done by different professionals such as geographers, physiologists, and psychologists, noise has been found to have some possible negative physiological and psychological effects on humans and some devaluation of properties. A key point is that all studies concerned especially with airport noise and airport environs have been conducted around huge metropolitan airports. Thus it is the purpose of this study to find out whether these negative effects are applicable in the case of Lansing Capital City Airport which is much smaller than others investigated. Another objective of this research is to find

out how the perception of noise is related to people's income level, age, length of residency, and distance away from the airport.

The next chapter is devoted to the discussion of the study area, the procedures and method for sampling, and a discussion of the questionnaire.

CHAPTER III
RESEARCH DESIGN AND STUDY AREA

This chapter will provide discussion about the research design incorporated to carry out this study. The following are specifically dealt with: hypotheses, sampling strategy, the survey methods, and the development of a questionnaire.

Hypotheses:

A number of variables such as distance from the airport, income, age, and the length of residency were selected as possibly being related to people's perception of noise. These were shown to be important partly on the basis of previous literature and partly by logical inference. Six specific hypotheses are postulated.

Hypothesis I: People's perception of noise is inversely related to distance from the source of noise. In other words, as distance from the airport increases the level of negative perception of noise decreases.

Rationale: Robert M. Pierce in his field research problem entitled Open Space and Perception of Stress (1974) illustrates that the hypothesized inverse relationship between distance and perception of stress (in this case noise) was supported. He stated (p. 17) that

> those residents living closest to a noxious facility gave the highest negative meanings to the source of noise, while those residing at the greatest distance gave lower negative meanings to it.

It was concluded that perceptions of stress decline with distance from a source of irritation. He believed that the distance decay was not linear but curvilinear. Robert Allen Schwein in his thesis Airport Noise at LAX and Adjacent Urban Development (1971) treated the distance between aircraft and observer as the most important factor in the perception of noise. Schwein put forward the concept of Perceived Noise Levels* and argued that on the landing approach of any jet aircraft with about 1,500 feet the PNDB exceed 100. A PNDB of 100 is the acceptable limit of noise tolerance, beyond that noise will interrupt most daily activities.

Hypothesis II: The lower the income level, the less would be the likelihood of changing an address due to excessive noise.

Rationale: One might argue that for those people who have a relatively high yearly income, there exist some possibilities to move elsewhere since they could afford it. One should bear in mind that everything else being equal, noise-free houses are more expensive than noise-affected

---

*A subjective measure of noise which is intended to reflect the annoyance value of a given noise is called Perceived Noise Level in decibels or PNDB (quoted from Cohen and Ayer, 1964, p. 148).

houses. Lewis Goodfriend (1969) pointed out that

> in Miami, it is reported that because of jet runways being built near a housing development, people who could afford to moved away in spite of tax benefits. Whereas, previous residents of that development represented median annual income groups of $15,000-$20,000, six years later the median income range dropped to between $7,000-$8,000.

Hypothesis III: The older the individual, the less one will tolerate noise.

Rationale: Older people usually have a light and fragmented sleep. In a report in The Conference on Aircraft and the Environment which was sponsored by the Society of Automotive Engineers (1971), it was concluded that with aging, sleep tends to become light and increasingly fragmented, a condition which intensifies due to the presence of excessive noise.

Hypothesis IV: As the length of residency increases, the amount of adaptation to noise increases.

Rationale: One may argue that by living longer at the same residence people adjust to the stressful aspects of their environment and become accustomed to them. David C. Glass and Jerome E. Singer (1972, p. 11) stated that "man is highly adaptable and can therefore achieve adjustments to extremely undesirable conditions." Also Kryter (1970) argued that more important than adaptability itself is the pervasive phenomenon of adaptation to sound. Laboratory tests showed that automatic adaptation or habituation invariably occur with repeated situations of noise.

Hypothesis V: The higher the quality of house and neighborhood, the lower is the likelihood of changing an address due to noise itself.

Rationale: Mary Werner Hans in her thesis (1975) suggested a number of characteristics that relate specifically to property including age of home and average number of rooms. Also important are locational attributes such as shopping center accessibility and proximity to the bus route, neighborhood characteristics including the number of persons per household, average family income, and crime rate. These are the most influential factors for the house buyer.

Hypothesis VI: The noisier the environment in which the house is located, the more it is depressed in economic value. In other words, noise-affected houses are less expensive than comparable noise-free houses that are farther from airports.

Rationale: This hypothesis can be only supported if the sale price variation is only attributed to noise other than any determinant factors such as differences in social, economic, and locational composition. Hans (1975) argued that there is a considerable negative difference in house prices when compared to those very similar but noise-free homes. Residents perceive a reduced demand for homes near flight paths.

Graphic representation of the hypothesized relationships for all hypotheses is portrayed in Figure 1.

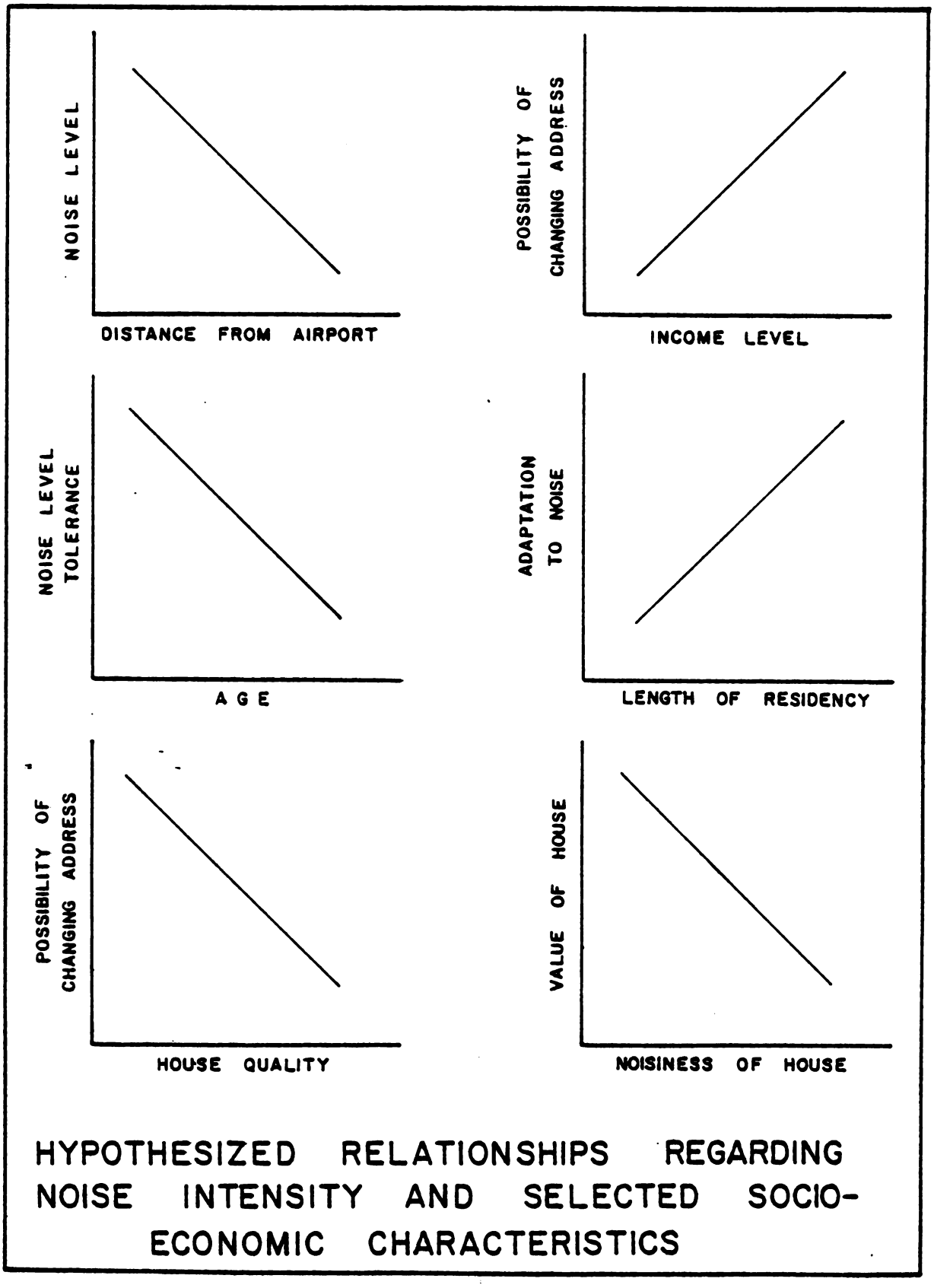

NOISE LEVEL
DISTANCE FROM AIRPORT
POSSIBILITY OF CHANGING ADDRESS
INCOME LEVEL
NOISE LEVEL TOLERANCE
A G E
ADAPTATION TO NOISE
LENGTH OF RESIDENCY
POSSIBILITY OF CHANGING ADDRESS
HOUSE QUALITY
VALUE OF HOUSE
NOISINESS OF HOUSE
HYPOTHESIZED RELATIONSHIPS REGARDING NOISE INTENSITY AND SELECTED SOCIO-ECONOMIC CHARACTERISTICS

Figure 1

Study Area:

Survey research on noise perception was conducted around the Lansing Capital City Airport. Capital City Airport covers an area of approximately 1430 acres in the Northwest part of Lansing (Figure 2). The runways and taxiways equal 40 miles of highway. The three runways, featuring the fully instrumented main runway (6,500 feet long), are capable of handling aircraft up to and including the DC8.

A brief history of Lansing Airport indicates that in the early 1900's on the present site was a sod strip flanked by a garage-like structure; this was the first Capital City Airport. Commercial aviation was in its infancy, and yet, because Lansing was a busy industrial center and the capital city of a large populated State, it was even then a focus for new and growing industries in the area. In response to the growing need for airport facilities and regulations within the State, the Michigan Legislature in 1929 established the Michigan Aeronautics Board. The Board planned to operate the Capital City Airport as a model facility for all future airfield operations in the State. In June 1931 the field was first licensed by the State to operate as a commercial airport. It continued to own and operate the airport until May 1971 when, as a result of enabling legislation and a public referendum, the Capital Region Airport Authority formally took over the operation. In 1975 the Capital Region

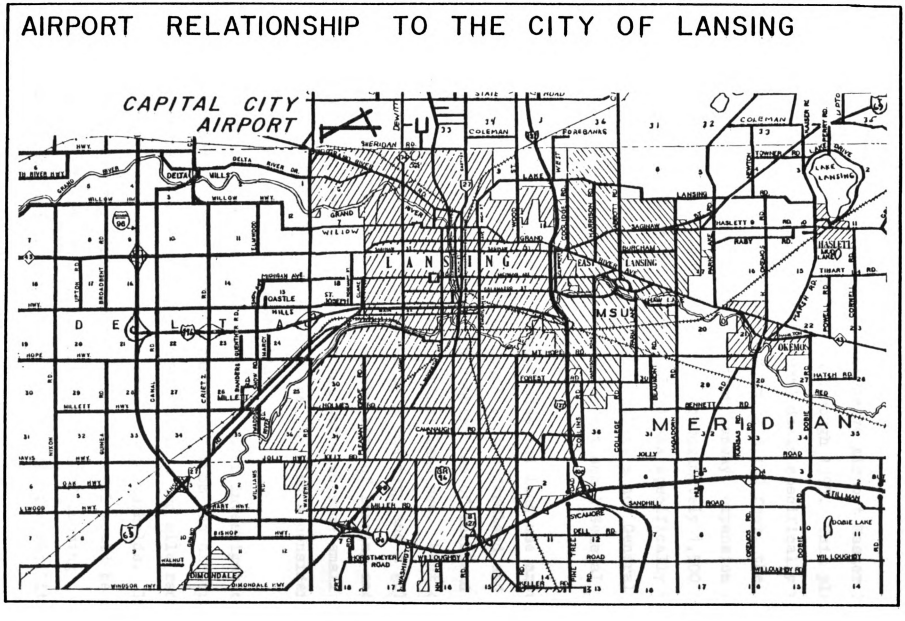

AIRPORT RELATIONSHIP TO THE CITY OF LANSING
CAPITAL CITY AIRPORT
LANSING
EAST LANSING
MSU
DELTA
MERIDIAN
OKEMOS
HASLETT
DIMONDALE

Figure 2

Airport Authority adopted a comprehensive Airport Master Plan for further development and growth through 1995. This plan has two phases, phase one (1975-1985) deals specifically with the expansion of current runway of up to 8,100 feet, the construction of a new General Aviation runway, expansion of the present terminal, and purchasing approximately 1,500 acres of land. Phase two (1985-1995) deals specifically with the construction of a new terminal complex, a new General Aviation runway, and extending the current small General runway to an air carrier cross wind.

In the case of economic activities and land use around Lansing Airport, north of it is found mostly farmland and woodland. To the east there is a combination of farmland and urban use, in particular residential land use. West of Capital City Airport is surrounded by a cemetery and a golf course and finally to the south is the city of Lansing and land uses that are mainly residential but also some small industry. Surrounding the airport one can find a considerable amount of open space and vacant land.

Inasmuch as one of the hypothesis under investigation was the relationship between distance away from the airport and the perception of noise, an area within a two mile radius was selected from which to draw a sample of households. It was felt that within this radius the noise level would be most critical. Furthermore, considering the size of Lansing Capital Airport and the type of aircraft using the facilities,

it was logically sound not to consider a distance greater than 2 miles. Since all of the area within the two mile radius is not settled in equal density, the study area selected was confined to a semicircle including the south-eastern and western parts of the Capital City Airport that were within two miles of the air-terminal building.

Sampling Design:

The intent of the sampling procedure was to draw a representative sample of the noise exposed population living within a two mile radius of the Capital City Airport. The clustering type of sampling was administered. Hurbert U. Blalock in his book Social Statistics (1960) argued that in this type of sampling we might use a random selection among the clusters. Thus every individual in the population has an equal chance of appearing in the sample. In fact the purpose of cluster sampling is to ensure that this situation occurs. The procedure for selecting the samples are as follows: four circles were drawn with radii of 0.5, 1.0, 1.5, and 2.0 miles away from the air terminal building. As previously mentioned only the southern part of the circles, those residential areas to the east, were included as part of the study area. Subsequently, each of the four circles was divided into 6 sectors with a 30 degree angle difference between them. In this process four zones were identified

within each sector for a total of twenty-four zones for the study area (Figure 3).

The next step was to assign numbers to all the street intersections within each zone. The first six zones, which encompass the first, also has two adjacent zones in Dewitt Township that were excluded since there were too few major intersections from which to draw a valid sample. A table of random numbers was used to select four separate intersections corresponding to four housing units in each zone. Sixty-four out of a possible 213 intersections were chosen. The first choice for a household interview at each intersection was given to the house at the Northwest corner, followed by Northeast, Southwest, and Southeast.

Method of Interviewing:

The research involved the acquisition of the field data from individual households concerning community characteristics and personal data such as age, income, and the degree of annoyance to aircraft noise. Social data were obtained by personal interviews based on a questionnaire administered by the researcher. The sixty-four interviews were secured on three consecutive days, August 21-23, 1977 at various times during evenings and mornings. On the basis of sixty-four interviews there were only nine refusals which meant other housing units at the corner of intersections than that on the Northwest corner were selected.

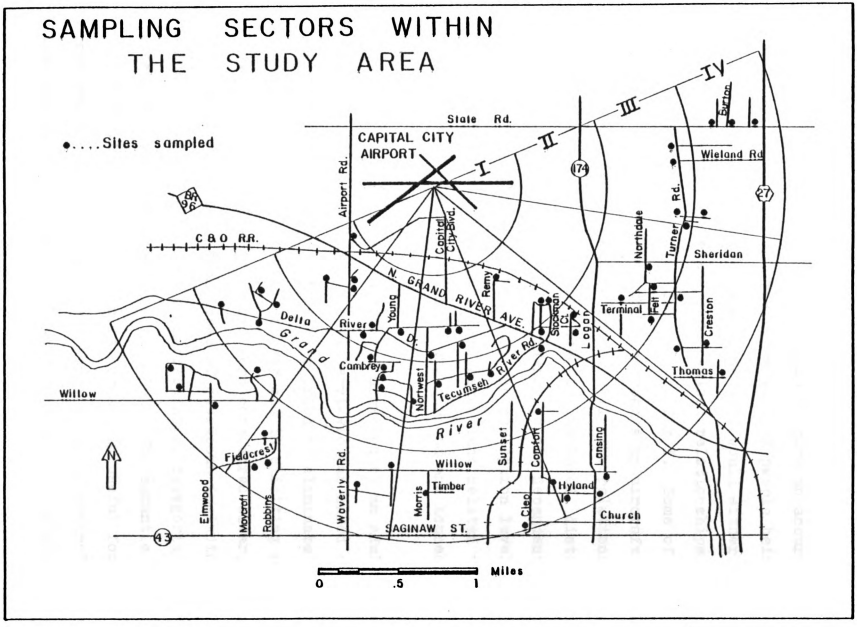

SAMPLING SECTORS WITHIN THE STUDY AREA
●....Sites sampled
I
II
III
IV
State Rd.
CAPITAL CITY AIRPORT
Airport Rd.
Capital City Blvd.
C & O RR.
N. GRAND RIVER AVE
Delta
Grand
River
Young
Cambrey
Northwest
Tecumseh
River Rd.
Remy
Shoppers City
Loop
Terminal
Northdale
Turners Rd.
Wieland Rd
Sheridan
Creston
Thomas
Burton
Willow
Fiddyment
Elmwood
Maverot
Robbins
Waverly Rd.
Morris
Timber
Willow
Sunset
Capitol
Lansing
Hyland
Church
Clio
SAGINAW ST.
Miles
0
.5
1

Figure 3

Discussion of the Questionnaire:

The questionnaire was designed to give an accurate measure of annoyance and the perception of people being interviewed. Information was asked that would either substantiate or refute the hypothesized relationships. The survey instrument is included as Appendix 3. Some of the questions were related to the disturbance by aircraft noise. Others attempted to measure specifically the relationship of independent variables such as age, income level, distance from airport, and length of residency to the dependent variable for this study, that is, the perception level of noise. Additional questions were asked that related to general characteristics of the neighborhood and household itself.

All questions were asked and answered by an adult member of the household. Each interviewee was asked only the twelve questions. The interviewer tried to eliminate sources of bias in administering the survey and in eliciting survey information. All the questions were considered clear, short, and easily answered. Four types of questions including the semantic differential, yes or no responses, categorized questions, and open ones were included. The semantic differential form of question is especially useful for this research as it is essentially a combination of controlled association and a scaling procedure (objective scale). It

has been used in other behavioral geography research concerned with environmental perception. For example, Robert M. Pierce in his dissertation (1974) relating to the perception of stress couched questions of this nature in order to measure whether some characteristics of stress related to home and degree of neighborhood noise and pleasantness in Detroit's inner city and suburban areas. The results of semantic differential data are convenient for usage in a quantitative testing of the hypotheses. In this survey it was found necessary and helpful to include some easily categorized questions, especially in the case of some highly touchy and personal questions that relate to age and income.

CHAPTER IV
ANALYSIS OF SURVEY DATA

As previously mentioned, the major objective of this study is to measure and determine the relationship between the perception of noise and variables such as distance away from airports and measures of income, age, and length of residency. In addition, it was hypothesized that houses near airports depress in value in comparison with the noise-free houses farther away. The analysis of the data collected and major findings are given below.

On the whole, there was a slight relationship between the perception of noise and all variables. The responses to questions relating the relationship between the perception of noise and length of residency is shown in Table 1. This table is important for it reveals that there is little strong and conclusive evidence that the perception of noise is positively or negatively related to length of residency. Most respondents did not perceive the noise level to be strong or weak; there were more who perceived it to be very high than very low. The number of years had little to do with the frequency of those regarding the noise levels as being high. For instance, the results given in column two (one year to ten years) and the next column (eleven to twenty years) are

Table 1: The Relationship Between the Perception of Noise and Length of Residency.

NOISE LEVEL	LENGTH OF RESIDENCY				
	Less Than 1 Year	1-10 Years	11-20 Years	21-30 Years	30 Years & Over
-3	--	2	--	--	2
-2	--	1	2	--	1
-1	1	6	--	--	--
0	3	7	10	2	--
+1	--	1	1	--	--
+2	2	--	1	--	--
+3	1	11	5	3	2

relatively identical even though it was hypothesized that as the length of residency increases, fewer people would perceive noise as nuisance. In a conference sponsored by the Society of Automotive Engineers (1971), it was argued that following the initial adjustment of people to the nature of the sound, they become less tolerant of exposure to sound, including aircraft noise.

It was hypothesized that as the age of subjects increases, the less they can tolerate noise. This inverse relationship is also not verified from the data. It should be mentioned in this connection that part of the reason for rejecting the

hypothesis was that most of the people interviewed were more than forty years old. The numbers of those people who perceive noise as neutral or even very little (+3) in both age categories of 22-30 years and over 60 years and above show the same result (Table 2).

Table 2: The Relationship Between the Noise Level and Variable Age.

	DIFFERENT AGE CATEGORIES						
NOISE LEVEL	8-15 Yrs.	16-21 Yrs.	22-30 Yrs.	31-40 Yrs.	41-50 Yrs.	51-60 Yrs.	60 Yrs. & Over
-3	--	--	1	--	--	--	2
-2	--	--	--	4	--	--	--
-1	--	2	3	1	--	1	--
0	--	3	6	4	3	1	5
+1	--	--	--	1	1	--	--
+2	--	--	1	1	1	--	--
+3	--	1	5	5	6	3	3

It was further hypothesized that noise affected people who are mainly in low income groups. This is postulated since they cannot afford to move away to comparable noise-free houses elsewhere and which may be relatively more expensive. The available data fail to support this hypothesis. The size and direction of the relationship between the perception of noise and different income groups is shown in Table 3.

Table 3: The Relationship Between Noise Level and Income Level.

		INCOME LEVELS			
		3,100-5,000	5,001-10,000	10,001-20,000	Over 20,000
NOISE LEVEL	-3	1	1	--	2
	-2	--	1	2	1
	-1	--	1	4	2
	0	1	6	8	7
	+1	--	1	--	1
	+2	--	--	1	2
	+3	3	5	8	6

By examining this table one can see that the perception of noise among three different income groups, $3,100-$5,000; $10,001-20,000; and more than $20,000 is nearly identical. This was not anticipated. It was somewhat surprising to discover that the majority of the people interviewed in the study area are classified as having relatively high income categories, that is, with the gross family incomes above $20,000. The analysis also shows only a very slight relationship between income and perception of noise level. Tracar Inc., in its study Community Reaction to Airport Noise (1971) came to the conclusion that residents who complain are those who live near the airport and are older, more highly educated, and more affluent.

We find that the available data analysis fail to support the hypothesis that those who live closer to the airport are more likely to perceive noise as a nuisance (Table 4). Most respondents no matter how far they live from the airport perceive noise as either neutral or very little. For those interviewed who live between a 0-1.0 mile radius of the airport, the survey results show that almost half of them perceive a very small amount of annoyance. The results further indicate this as a very slight positive association between the variable distance and level of noise perception.

Another noteworthy aspect of this study is that about 49 percent of the sample expressed the sentiment that their area had high neighborhood quality, a reason which could

Table 4: The Relationship Between Noise Level and Distance Away From Airport.

	DISTANCE AWAY FROM AIRPORT		
	0 to 1.0	1.0 to 1.5	1.5 to 2.0
-3	--	3	1
-2	2	1	1
-1	3	2	2
0	2	7	13
+1	1	1	--
+2	1	--	2
+3	6	10	6

outweigh the negative effect of noise. Mike A. Pearlman (1972) stated that it can generally be concluded that positive factors, or those elements that would influence people to stay in the area, outweigh the negative factors. A very small portion of the sample around the Lansing Airport stated that financial problems were a reason for their being unable to move away. Pearlman further mentioned that many residents state they are not interested in moving because they feel that they are not able to move into a comparable community.

Eighty-three percent of those interviewed around the Lansing Airport perceived no devaluation in property from

living where they do. Only two out of the sixty-four expressed the opposite view. The remaining expressed no opinion. Walther (1960) arrived at the conclusion that an airport does not affect the market value of vicinial real estate adversely. Any possible negative effect can be offset by amenities coming forth from airports.

In the study area 83 percent of households were homeowners with the remainder renters. The majority of single family dwellings belong to the homeowners, the majority of renters occupy multiple dwellings.

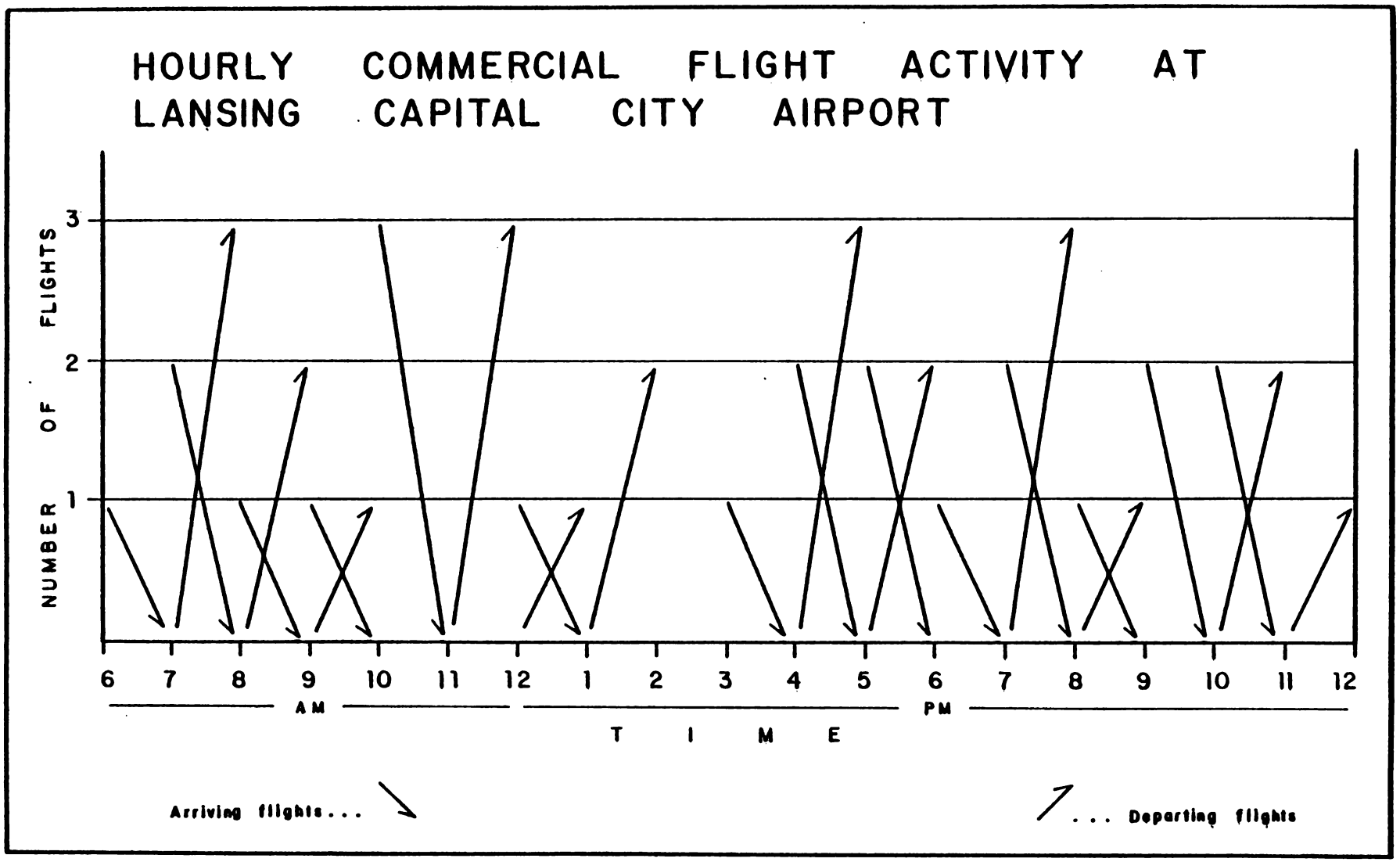
For that small portion of the sample who are annoyed by aircraft noise, disturbances like interference with sleep, watching television, talking by phone, and interfering with interpersonal communication are among the major ones.

From the results achieved, which basically are counter to previous findings, one may argue that the sample was not representative. This can partially be used to explain the unexpected results of this study and the rejection of the hypotheses. Furthermore, there are some characteristics specific to the nature of noise itself, characteristics of subjects who control response to sound, and people's perception to noise. The size of the Lansing Airport and especially the service which it provides, the type of aircraft utilizing it, and the frequency of flights can be determinant factors in the perception of noise. Based on interviews which the researcher had with airport personnel, it was learned that

Capital City Airport is mainly utilized by relatively small and two-engine type of aircrafts such as 727, 737 and DC 9. In the case of huge aircrafts, the 707, 747 and DC 9 are four engine, very large and noisy.

The frequency of flights play an important role in determining the level of perception in the surrounding area. Pearlman (1972) stated that frequency has a discernible effect on human perception of loudness which in turn affects varying degrees of perception. The daily frequency of flights for Capital City Airport is twenty-six. By way of contrast, there are over 500 regularly scheduled commercial aircraft flights coming in and leaving Los Angeles (LAX) daily. The altitude of aircraft in their ascent and descent is another important factor influencing noise perception. It was mentioned in one of the articles of Aviation Week and Space Technology (1967) called "Airport Area Housing Criticized" that an aircraft would be at an altitude of 600 feet on a normal approach when it passes over the buildings in the vicinity of an airport. However, it was found that at Capital City Airport, the Federal requirement for minimum altitude is 800 feet above the ground while flying over nearby residential units. State regulations are identical. Time of operations including landing and take off are also critical factors. In regard to time-of-day, it was found that only a few flights occur at Capital City Airport in the late evening; there are no flight operations after 11.09 pm (Figure 4). On the whole, one may

Figure 4



Source: Office of Airport Authority, Capital City Airport, Lansing, Michigan, 1978.

argue that there is a critical point regarding the intensity of sound in terms of decibels, beyond which people will start to complain. It was found that on a national level people can endure up to 85 decibels for five minutes period of time daily, after that people will perceive it as nuisance and start to complain about it (Lansing Capital City Airport, Personnel Communication).

The individual also plays an important role regarding the perception of noise. For instance, one may argue that the response to the sonic boom is dependent upon the development of an attitude toward this stimulus. Tracar, Inc. (1971), is in agreement with this argument when he states that the degree of disturbance felt by an individual is related to the intensity of a negative attitude developed concerning the sonic boom. It was further argued in that study that a negative attitude develops from hearing aircrafts which attitude in turn affects the degree of annoyance. It must be remembered that what some individuals will consider annoyance from sounds that others find acceptable. According to Jansen (1964) factors such as the personality of the listener, one's individual physiological and psychological make-up, and his life experience all can be determinants in the degree of adaptation to noise. Man is very complex in his thinking, behavior and decision-making processes, particularly where sight and hearing are concerned.

It can be argued that although Capital City Airport is relatively small in operation and the noise level is not critical, the adaptation to noise could be explained by different degrees of perception among residents living in the immediate area. Society of Automotive Engineers (1971) stated in Conference on Aircraft and the Environment that for persons continuously experiencing high levels of outdoor noise, there is a high degree of probability that one can get accustomed to it and may even have uninterrupted sleep.

In the researcher's opinion all of the foregoing discussion can be used to explain to a high degree the results and findings of this thesis.

In the next and final chapter, the major conclusions are given as well as some suggestions for further research.

CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

Conclusions:

With the passage of time, air commerce has become a vital factor in the nation's economy. However, vicinial communities have become exposed to enormous amounts of noise. A review of the literature by psychologists, physiologists, engineers, and geographers reveals that in addition to the interference with daily habits like sleep, watching television and communication, noise has some harmful effects such as adverse physiological reactions and psychological behavior, including hearing loss.

This study is related to previous studies in that it is concerned with the effect of noise on human behavior. It is different in that it attempts to measure in a geographic context the relationships between variables such as income level, age, length of residency, and distance away from airport. These variables are correlated with the level of noise perception of individuals living within a two mile radius of the airport.

It was hypothesized for 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 a 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. The results were unexpected as all hypotheses were rejected. There was almost no correlation between any of the independent variables, income, age, length of residency, and distance away from the airport and the dependent variable, perception of noise. The majority of the interviewees expressed no negative effect of airport noise, even with interruptions of daily activities at home. Most of them living in the study area had adjusted to the noise levels and did not have their activities disturbed by planes. Some even expressed the view that they enjoy seeing and hearing planes at very low altitude over their properties. The majority of those sampled stated they perceived no devaluation in their properties due to aircraft noise. For that minority of people interviewed who found the noise levels a nuisance, the desire for high neighborhood quality is the main and the only reason not to move elsewhere.

The discrepency between the results of this study and others is due in part to the fact that most of these studies on airport noise levels, the perception of residents, and impact on residential properties have been done around major airports like Los Angeles (LAX) and New York City (JFK). Thus, the type of aircrafts which utilize these airports, the frequency of incoming and outgoing flights, and possibly the

type of land use around airports are in sharp contrast to the Lansing situation. For instance, around the Kennedy International Airport, the predominant land use is residential; the area seriously affected covers eighteen square miles, 66,000 population, and 14,700 structures. The area around Edmonton's industrial airport is completely surrounded by residential properties which means numerous homes are subject to airport noise. In the case of Lansing Capital City Airport, in addition to some areas of single and multiple family residences, there is a sizeable amount of vacant land, farms, woodlands, and some small industrial developments. The combination of fewer flights, less noisy aircrafts, and a mixed land use pattern surrounding the airport is responsible for results that are divergent from previous studies on airport noise and noise perception, including those done by geographers.

Recommendation for Further Study:

This study suggests a number of ideas for further study by geographers interested in environmental quality, urban planning, and spatial behavior.

1. There is a need for further investigations about the effect of noise and the perception of noise around other small sized airports. Since all of the studies done so far are related to huge metropolitan airports, we need to determine whether the Lansing results are applicable to commercial

airports of similar size.

2. It would be worthwhile to attempt to test the perception of noise around airports of varying and different land use mixes.

3. It would be worthwhile to conduct further studies of the socioeconomic characteristics of people and their negative attitudes toward the noise. For instance, do the perceptions of people living in multiple dwellings differ from those living in single family dwellings near small and large airports.

4. It is argued in the literature that different types of aircrafts account for different degrees of annoyance and negative attitudes. Thus, there should be some studies related to the effect of different sizes of aircrafts, in particular the Concorde and people's perception of the noise they make.

APPENDICES

APPENDIX 1

TYPES OF URBAN ENVIRONMENTAL PROBLEMS

	Type of Problem	Pollutants and Source	Type of Service Quality Impairment	Nature of Damage
A.	Natural Environment			
1.	Air Pollution: SO_x, NO_x, CO, HC, Particulates	Oxides of sulfur, nitrogen and carbon (SO_x, NO_x, CO) and hydrocarbons (HC)		Danger to health in high concentrations; diseases; loss of amenity
2.	Water Pollution	Sewage, plant materials, sediments, organic and inorganic chemicals, industrial and household activity		Hazards to health, impairment of recreational uses, aesthetic insults
3.	Solid Wastes	Industry and household wastes; building rubble, hazardous industrial wastes		Fire and health hazards from organic garbage; aesthetic insults from auto junk yards and litter; disruption of wetland ecosystems; industry and household wastes; building rubble
4.	Noise and Heat	Noise near highways and airports		Physical, psychic, and economic damage, e.g., hearing loss, sleep loss, loss of property value
B.	Built Environment			
1.	Residential Environment		Privacy, personal safety, level of sanitation	Health and productivity adversely affected; social pathology
2.	Parks and Recreational Areas		Crowding; litter, noise from vehicles, etc.	Psychic disamenity
3.	Transportation Systems		Traffic congestion; time delays; safety, limited modal choices	Loss of productive time; accidents, pollution, annoyance

Source: T.R. Lakshmanan and Lata R. Chatterjee, Urbanization and Environmental Quality, Washington D.C.: Association of American Geographers, Resource Papers for College Geography, No. 77-1, p. 6.

APPENDIX 2

TYPICAL DECIBEL (dB(A)) VALUES ENCOUNTERED IN DAILY LIFE AND INDUSTRY

	dB(A)		dB(A)
Rustling Leaves	20	Loudly Reproduced Orchestral Music in Large Room	82
Room in a Quiet Dwelling at Midnight	32	(Beginning of Hearing Damage, if Prolonged)	85
Soft Whisper at Five Feet	34	Printing Press Plant (Medium Size Automatic)	86
Men's Clothing Dept. of Large Store	53	Heavy City Traffic	92
Window Air Conditioner	55	Heavy Diesel Propelled Vehicle (about 25 ft. away)	92
Conversational Speech	60	Air Grinder	95
Household Dept. of Large Store	62	Cut-off Saw	97
Busy Restaurant or Canteen	65	Home Lawn Mower	98
Typing Pool (9 typewriters in use)	65	Turbine Condenser	98
Vacuum Cleaner in Private Residence (at 10 ft.)	69	150 Cubic Foot Air Compressor	100
Ringing Alarm Clock (at 2 ft.)	80	Banging of Steel Plate	104
		Air Hammer	107
		Jet Airliner (500 ft. overhead)	115

Source: Robert A. Baron, The Tyranny of Noise, New York: St. Martin's Press, 1970, p. 42.

APPENDIX 3

QUESTIONS ON NOISE

1. How far are you from the Lansing Airport?
2. To what extent does aircraft noise bother you? (Circle the number below which most accurately represents your answer)

   very much — neutral — very little

   3 2 1 0 1 2 3
3. How many times a day does aircraft affect you?
4. How does it affect you and other members of your family in your daily life?
5. Have you ever complained to the airport authorities about excess noise?

   _____ yes _____ no
6. Have you ever complained to a public official?

   _____ yes _____ no
7. How long have you lived near the airport?
8. What is your age? (Please circle the age category that applies to you)

   a. 8-15 c. 22-30 e. 41-50 g. 60 and over

   b. 16-21 d. 31-40 f. 51-60
9. Are you a renter or homeowner?
10. Are you considering moving from your present residence?

    If YES, is it due to
    _____ high level of noise
    _____ low neighborhood quality
    _____ low house quality
    _____ all of them
    _____ other reasons

    If NO, is it due to
    _____ high level of your tolerancy
    _____ financial problem
    _____ high neighborhood and house quality
    _____ all of them
    _____ other reasons
11. What gross income category would you fall into? a. Under $3,000 b. 3,100-5,000 c. 5,100-10,000 d. 10,000-20,000 e. 20,000 & over
12. If you are inclined to move, how much farther away from the airport would it be?

BIBLIOGRAPHY

BIBLIOGRAPHY

Books

Anastasi, Ann. Field of Applied Psychology. New York: McGraw Hill, 1964.

Baron, Robert A. The Tyranny of Noise. New York: Colophen Books, Harper & Row, 1970.

Blalock, Hubert M. Social Statistics. New York: McGraw Hill Book Company (1960).

Bolt, Beranek and Newman, Inc. Noise Environment of Urban and Suburban Areas. Developed Under the Technical Studies Program of the Federal Housing Administration, Department of Housing and Urban Development, Washington: G.P.D., 1967.

Glass, David C., and Singer, Jerome E. Urban Stress Experiments on Noise and Social Stressors. New York and London: Academic Press, 1972.

Goodfriend, Lewis. Community Noise Problems: Origin and Control. Cedar Knolls, N.J., Goodfriend-Ostergaard Associates, 1969.

Kryster, K.D. The Effects of Noise on Man. New York: Academic Press, 1970.

Moline, Norman T. "Perception Research and Local Planning Floods on the Rock River, Illinois," in Natural Hazards, Edited by Gilbert F. White, New York: Oxford University Press, 1974, 52-60.

Murton, Brian J., and Shimbukuro, Shinzo. "Human Adjustment to Volcanic Hazard in Puna District, Hawaii," in Natural Hazards, Edited by Gilbert F. White, New York: Oxford University Press, 1974, 151-160.

Smith, Charles L. Noise Unwanted Sound: Bibliography. Berkeley, CA, 1969 and 1970.

Wisner, Benjamin, and Mbithi, Philip M. "Drought in Eastern Kenya: Nutritional Status and Farmer Activity," in Natural Hazards, Edited by Gilbert F. White, New York: Oxford University Press, 1974, 87-98.

Journals and Newspaper Articles

"Airport Area Housing Criticized," Aviation Week and Space Technology, LXXXVII (Oct-Dec. 1967).

Boville, R.E. "Effects of the Sonic Boom on Man," REV CORPS SANTE ARMEES, VII (October 1966), 659-688.

Cole, J.N., et al. "Evaluation of Noise Problems Anticipated With Future Vtol Aircraft, AMRL-TR-66-245," US Air Force AERO Space MED LAB (May 1967), 1-16.

Finkle and Poppen, Jr. "Clinical Effects of Noise and Mechanical Vibrations of a Turbojet Engine on Man," Journal of Applied Physiology, I (1948), 183-204.

Geber, W.F., et al. "Age Factor in the Response of the Albino Rat to Emotional and Muscular Stresses," Growth, XXX (March 1966), 87-97.

Glass, D.C., et al. "Psychic Cost of Adaptation to an Environmental Stressor," Journal of Personality Social Psychology, XII (July 1969), 200-210.

Haar, Charles M. "Airport Noise and the Urban Dweller--A Proposed Solution," The Real Estate Appraiser (Sept-Oct. 1968).

Jansen, G. "Effect of Noise on Health," German Medical Monthly, No. 9, 1959, 287-330.

_____ et al. "Reactions to Auditory Stimuli: Comparative Studies of Subjects in Dortmund, Germany and the Mabaan Tribe in the Sudan With Urban Populations," Archives of Otolaryngology, LXXIX (May-June 1964), 437-656.

Karagodina, I.L., et al. "The Effect of Aircraft Noise on the Population Living in the Vicinity of Airports," GIG SANIT, XXXIV (May 1969), 25-30.

Levin, S.M. "Aircraft Noise: Can it be Cut?" Space Aeronautics, XLVI (August 1966), 65-75.

Pietrasanta, Adone and Bolt, Richard H. "Basic Facts About Noise as Related to Aviation," Noise Control, Vol. LXIII (1955), 6-57.

Rosen, Samuel. "Hearing Studies in Selected Urban Rural Population," Transactions of New York Academy of Medicine, XXIX (Nov. 1966).

Smith, K.R. "Intermittent Loud Noise and Mental Performance," Science, CXIV (1951), 132-133.

Welch, B.L. "Physiological Effects of Audible Sound," AAAS Symposium, December 28-30, 1969, Space, CLXVI (Oct. 24, 1969).

Documents and Reports

Crowley, R.W. The Effect of Airport on Land Values. Ottawa: Ministry of State and Urban Affairs, 1972.

Green, T.H. Discussion of the Utility of Available Techniques for Measuring Aircraft Noise and Predicting Community Response. Atlantic City, N.J.: National Aviation Facilities, Experiment Center, SRD SRD 6631, 1966.

Hansen, Jerry. "Regional Airport Planning," Unpublished Research Paper, San Fernando Valley State College, Northridge, California, May 1969.

Lakshmanan, T.R., and Chatterjee, Lata R. Urbanization and Environmental Quality. Washington D.C., Association of American Geographers, Resource Paper, 77-1, 1977.

National Aeronautics and Space Administration. Community Reaction to Airport Noise. Washington D.C., NASA Contract, NASW 1549, Sept. 1970.

Parrack, Eldredge and Koster. Physiological Effects of Intensive Sound. Wright Pattern Airforce Base Aero Med. Lab. Rep. No. MC REXD-695-718, 1948.

Pierce, Robert M. "Open Space and Perceptions of Stress: Meanings of Noxious Facilities." Michigan State University, Deptartment of Geography, 1974.

Stevens, K.N. "Effects of Aircraft Noise in Communities," Report of Working Group 34, Armed Forces-National Research Council Committee on Hearing and Bio-Acoustic, Washington D.C., Oct. 1961.

Taylor, W., eds. "Symptoms of Psychological Disorder in Noisy Environments," Department of Social and Occupational Medicine, University of Dundee, Proceedings of the Symposium on the Psychological Effects of Noise. Cardiff: The University of Wales, Sept. 1967.

Stewart, W.H. "Noise as a Public Health Hazard." Keynote Address, Proceedings of the Conference, ASHA Reports 4, W.D. Ward, T.E. Frick (Eds.), Washington D.C.: The American Speech and Hearing Association, Feb. 1969.

Tractor, Inc. "Community Reactions to Airport Noise," Washington U.S. National Aeronautics and Space Administration, Vol. 1, 1971 (NASA Contractor Report CR: 1761), NAS 1.26.1761.

U.S. Department of Transportation, Federal Aviation Administration," Impact of Noise on People, Office of Environmental Quality, May 1977.

U.S. Department of Transportation, Sponsored by the Society of Automotive Engineers, Inc., Conference on Aircraft and the Environment, 1971.

Walther, H.O. "A Study of the Impact of Airports on Market Value of Real Estate in the Adjacent Areas," New York: Port of New York Authority, 1960.

Theses

Hans, Mary Werner. "The Influence of Aircraft Noise Annoyance on Single-Family House Prices: A Case Study of Edmonton's Industrial Airport," University of Alberta, Department of Geography, Master's Thesis, 1975.

Pearlman, Michael A. "Noise Field of the L.A. International Airport on Local Property Values," California State University, Los Angeles, Department of Geography, Master's Thesis, 1972.

Pierce, Robert M. "Behavioral Correlates of Perceived Stress in the Urban Environment: Spatial Restriction in Metropolitan Detroit," Ph.D. Dissertation, Michigan State University, 1974.

Schwein, Robert Allen. "Airport Noise at LAX and Adjacent Urban Development," Master's Thesis, San Fernando Valley State College, 1971.