

**THE STUDY OF
POPULATION-CONSUMPTION-ENVIRONMENT LINK:
THE CASE OF AIR POLLUTION IN BANGKOK**

**APHICHAT CHAMRATRITHIRONG
PRAMOTE PRASARTKUL
SUREEPORN PUNPUING
WATHINEE BOONCHALAKSI
THIRAPONG SANTIPHOP**

**INSTITUTE FOR POPULATION AND SOCIAL RESEARCH
MAHIDOL UNIVERSITY**

1999

**THIS RESEARCH PROJECT WAS SUPPORTED BY
POPULATION REFERENCE BUREAU, USA**

**The Study of
Population-Consumption-Environment Link:
The Case of Air Pollution in Bangkok**

by

Aphichat Chamrathirong
Pramote Prasartkul
Sureeporn Punpuing
Wathinee Boonchalaksi
Thirapong Santiphop

Institute for Population and Social Research
Mahidol University
1999

This research project was supported by
Population Reference Bureau, USA

The Study of Population-Consumption-Environment Link : The Case of Air Pollution in Bangkok

Researchers : Aphichat Chamrathirong
Pramote Prasartkul
Sureeporn Punpuing
Wathinee Boonchalaksi
Thirapong Santiphop

IPSR Publication No. 224
ISBN 974-661-342-1

Copyright 1999 by the Institute for Population and Social Research,
Mahidol University
All right Reserved
500 Copies

Cataloging in Publication Data

The study of population-consumption-environment link : the case of air pollution
in Bangkok / Aphichat Chamrathirong ... [et al.]

(Mahidol University. Institute for Population and Social Research
Publication; no.224)
ISBN 974-661-342-1

1. Air-Pollution-Bangkok-Research. 2. Air-Pollution-Demographic Aspects
Research. I. Aphichat Chamrathirong... [et al.] II. Mahidol University. Institute for
Population and Social Research. III. Title. IV. Series.

(TD 883.7T5 S933 1999)

Published by : The Institute for Population and Social Research
Mahidol University
Salaya, Phuthamonthon, Nakhon Pathom 73170
Tel. : (662) 441-9666, 441-0201-4 Ext. 115
Fax : (662) 441-9333
E-mail : directpr@mahidol.ac.th
WWW Homepage : <http://www.mahidol.ac.th/mahidol/pr/pr.html>

Preface

The relationship between population and environment has become an issue of public concern over this decade. It can be clearly observed that population dynamics, both in terms of the rapid growth and increasing concentration in urban areas, directly affect the natural environment. Forest, mountain, water, and air are being exploited by people. The crowded nature of life in urban areas, transportation and the industrial factories are the causes of air and water pollution in many large cities. The degraded environment and pollution, in turn, affect the quality of life of the population.

Bangkok Metropolis and periphery is home to not less than 10 million population. While we can clearly observe the crowdedness in this mega-city, Bangkok is still growing rapidly. Bangkok is “the never-finished city”. Since construction is continuing on without any sign of ending the city is perpetually covered with dust and particles. Bangkok has a reputation for her highly congested traffic. Many hundred thousands of vehicles running on the streets in this city are producing carbon monoxide which is hazardous to the health of the population. The pollution problem in Bangkok had become an issue in the last city governor election campaign. The successful candidate, Dr.Pijit Rattakul, labelled himself as “Mr.Green” during the campaign.

The solution to pollution problems in large cities certainly involves many factors. The determination of high-level administrators to solve the problems is a key to this issue. More importantly without the realization by the people of the negative impact to their health, the pollution problem would be overlooked. However, the most important factor to this problem is the people’s participation in solving it.

The research project on population, consumption and environment was initiated by the Population Reference Bureau of Washington D.C.. The research study has been conducted simultaneously in four countries, namely USA, Mexico, Mali and Thailand along the same study theme of the link between population, consumption and air-pollution. The results of the Thai study, which employed both quantitative and qualitative data to examine the hypothesised relationship, are reported here. It is hoped that the research results covered in this report will help increase awareness concerning the population, its behaviour and air-pollution among all parties and concerned people, and lead to the solution of the problems.

Acknowledgement

This study of the link between population, consumption and environment would be a difficult task, had we not received assistance and co-operation from various organization and persons.

The Thai research team would like to express its high appreciation to the Population Reference Bureau for its effective co-ordination of this research project. We thank Ms.Alene Gelbard, the project co-ordinator, who organized a series of useful workshops which helped in shaping our study. We are grateful to Roger-Mark De Souza who made several useful comments on our final draft. Throughout the project, we appreciate the friendly and warm hospitality of the PRB staffs, especially Ms.Rhonda Smith, Ms.Karen Semkew, and Dr.Peter Donaldson, the President.

We realize that the data collection for our research project took the valuable time of many participants. Mrs. Yupin Vorasiri-amon and Mrs. Nonglak Kalampabutara are greatly appreciated for their help in the data collection process, by acting as one of the focus group moderators and one of the interviewers respectively. We sincerely thank those who participated in our focus group discussion sessions. We thank all persons who spared their time for our rather lengthy in-depth interview. Their views and comments on the issue of population and environment are beneficial to our study and highly appreciated.

Last but most significant, we express our gratitude to the McArthur Foundation for the financial support that made the study on this important issue possible.

Contents

	Page
Chapter I An Overview of the Situation in Thailand	1
1.1 Demographic Overview	1
1.1.1 Population Trends and Prospects	1
1.1.2 Population Movement and Distribution	3
1.1.3 Population Composition	4
1.1.4 Socio-Economic Characteristics that Affect Consumption	5
1.2 Consumption Overview	7
1.2.1 Historical Trends and Projection of Household Consumption Variables	7
1.2.2 Data Sources for Household Consumption Activities	10
1.2.3 Assumption of Future Consumption	11
1.3 Environmental Overview	11
1.3.1 Global Warming	12
1.3.2 Land Resource	13
1.3.3 Forestry Resource	14
1.3.4 Urban Infrastructure and Industry	15
a. Air Pollution	15
b. Water Pollution	16
c. Hazardous Waste	17
d. Other Forms of Environmental Degradation	18
1.3.5 Energy	18
1.3.6 Outlook for the Future	19
Chapter II A Focus on Air Pollution in Bangkok	23
2.1 Statement of the Problem	23
2.2 Air Quality in Bangkok	24
2.3 Fuel Consumption in Transportation	26
2.4 Demographic and Socio-Economic	29
2.4.1 Population Size and Structure	29
2.4.2 Occupational Structure	32
2.4.3 Education Attendance	33
Chapter III Research Objective and Methodology	35
3.1 Research Objective	35
3.2 Conceptual Framework	36
3.3 Sources of Data at Macro and Household Level Analysis	37
3.3.1 Source of Data	37
3.3.2 Variables and Variable Measurement	39

	Page
3.4 Focus Group and In-depth Interviews	40
3.4.1 Constructing Interview Guidelines	40
3.4.2 The Selection of the Focus Group Participants and the Key Informants	41
3.4.3 Analysis of the Data	42
Chapter IV Research Results	43
4.1 Health Impact of Air Pollution	43
4.1.1 Breathing SPM	43
4.1.2 Carbon Monoxide (CO) : The Invisible Killer	46
4.1.3 The Fight against Dangerous Lead	48
4.2 Behavioral and Structural Causes of Urban Air Pollution	48
4.2.1 Demographic and Socio-Economic Factors	49
4.2.2 Poor Public Transportation Mode	51
4.2.3 Unplanned Land Use Haphazard Land Prices	53
4.2.4 Confused and Delayed Transportation Policy due to Political Interest	55
4.3 The Dynamics of the Link between Consumption Behaviour of the Population and Air Pollution	57
4.3.1 Rapid Urbanization and the Extremely Congested City	57
4.3.2 Air Pollution from across All Income Levels : the Poor and the Affluent	59
4.3.3 Individualism plus Consumerism	61
4.3.4 Urbanization without Urbanism	62
4.4 Solutions to the Problems	64
4.4.1 Decentralization : Keep Bangkok Relatively Small	64
4.4.2 City Planning and the Green Zone	64
4.4.3 Legal Measures Must begin with Awareness Campaign	65
4.4.4 Raising of Awareness : The Leading Roles of Mass Media	67
Chapter V Summary and Recommendations	71
5.1 Summary	71
5.2 Recommendations	75
Reference	77
Appendix	87

List of Tables

		Page
Table 1.1	Consumer Expenditure per Household by Region, 1994 (Baht)	10
Table 1.2	Share of National Warming Effect via Green-house Gas Emission (in CO ₂ equivalent) from Various Sub-sectors in 1990, Thailand	13
Table 1.3	Ambient Air Concentration in 18 Curbside Stations in Bangkok	16
Table 1.4	Summarized Major Environmental Problems in Thailand	21
Table 2.1	Bangkok-Morbidity and Mortality Associated with SPM Estimated Impacts of 20% Reduction in Ambient Concentrations	24
Table 2.2	Concentration of SPM (less than 10 micron) in Bangkok During 5.5 Months Period (July 1996-February 1997)	25
Table 2.3	Fuel Consumption in Transportation, M litres	26
Table 2.4	Air Pollution from Transportation, K ton	27
Table 2.5	Population: Thailand, Bangkok and Peripheral Provinces, 1960, 1970, 1980, 1990, 2000, 2010	29
Table 2.6	Population Growth: Thailand, Bangkok and Peripheral Provinces, 1960-1970, 1970-1980, 1980-1990, 1990-2000 and 2000-2010	30
Table 2.7	Changing Age Structure of the Bangkok Metropolitan Area (BMA), 1960-1970	30
Table 2.8	Occupational Structure of Population Aged 15 and Over, Bangkok 1960-1990	32
Table 3.1	Percentage Distribution and Number of Selected Variables	38
Table 3.2	Total Pollution Emission (tons/year) in Bangkok, 1994	39
Table 4.1	Morbidity Rate for Respiratory Disease for Bangkok Residents, Year 1986-1993	46
Table 4.2	Ordinary Least Squares Regression Model of Pollution Emission (Kilogram/year)	50

List of Figures

		Page
Figure 1.1	Average Monthly Income per Household and Per Capita Income (Baht), in 1994	9
Figure 1.2	Comparison of Per Capita Monthly Income (Baht), 1992 to 1994	9
Figure 1.3	Household Monthly Expenditure in 1994 (Baht).	9
Figure 2.1	Motor Vehicles Registered in the BMR and in Bangkok, 1980-1993	28
Figure 2.2	Bangkok's Population Pyramid : 1970-1990	31
Figure 3.1	Current Conceptual Perspectives on Population-Environment Relationships	37

CHAPTER I

An Overview of the Situation in Thailand

1.1 Demographic Overview

1.1.1 Population Trends and Prospects

1.1.1.1 Historical Population Size and Projections

Like many other developing countries, Thailand experienced rapid population growth after the Second World War. Its population was approximately 26 million in 1961 and doubled within a quarter of a century, growing to more than 52 million in 1986, the end of the Fifth National Economic and Social Development Plan, 1982-1986 (National Economic and Social Development Board, 1994). Population growth between 1961 and 1986 was almost entirely determined by trends in mortality and fertility, since international migration played an insignificant role. Mortality decline preceded that of fertility by more than two decades, culminating in a 3.5 percent rate of population increase during the period 1961-1966. After fertility started to decline, the average annual rate of growth for five-year time intervals was almost halved from 3.5 percent in 1961-1966 to 1.8 percent during 1981-1986 (National Economic and Social Development Board, 1994).

The population of Thailand is estimated to have reached 60 million in 1996. The growth rate has dropped to a very low level, of only 1.1 percent annually. The Crude Birth Rate (CBR) is 17 per 1,000 population and Crude Death Rate (CDR) is 6 per 1,000 population. However, by the year 2019, the population of Thailand is officially estimated to reach 70 million.

1.1.1.2 Total Fertility Rate

The onset of fertility decline in Thailand probably occurred around the mid-1960s, even before the government launched its anti-natalist population policy. The reduction in the total fertility rate (TFR) from a level of over six children per woman was initially slow. Following the introduction of the national family planning program in 1970, fertility decline gained momentum, bringing the TFR down to 3.1 children in 1984 (Kamnuansilpa and Chamrathirong, 1985). This TFR decline was to a large extent made possible by a rapid spread of family planning practices. By 1981, 60 percent of married women of reproductive age were using contraceptives, up from about 15 percent

in 1969/70^{1/} (Institute of Population Studies, 1981). However, contraceptive use, which is highest in Bangkok, the North and the Central region, has not yet spread evenly over all regions. Fertility in the Northeast and South, and especially among certain population groups, such as people in remote areas, hill tribes and Thai Muslims, remains higher than the national average. Religious values, culture and traditions of those groups have made it difficult for the government to introduce modern contraceptive methods to limit family size.

The report of the Survey of Population Change in 1995-1996 (National Statistical Office, 1996a) indicates that the total fertility rate (TFR) dropped from about 2.2 in 1991 to 2.0 in 1996, and the National Fertility Survey in Thailand in 1996 conducted by IPSR estimated that the TFR in Thailand was below the replacement level at 1.9 (Chamratrithirong et al., 1997).

1.1.1.3 Mortality and Morbidity

It has been estimated that the expectation of life at birth has increased from almost 54 years for males and 59 years for females in 1959-1961 to more than 60.3 years for males and 66 years for females in 1980-1985 (Institute for Population and Social Research, 1998). During roughly the same time period, the crude death rate was nearly cut in half, from 13.5 (deaths per 1,000 population) in 1960 to 7.8 by 1980-1985 (Economic Commission for Asia and Far East, 1973; NESDB, 1985). In part, this reflected a sharp drop in the infant mortality rate, from 84 (infant deaths per 1,000 births) in 1964-1965 to 45 in 1983 and around 26 in 1996 (National Statistical Office, 1965; Prasithratsint and Charoenkul, 1986). The estimates of infant mortality for the time period from the mid-1960s to the mid-1980s suggest that much greater gains in infant survivorship had been achieved in the various regions before the mid-1970s than thereafter.

In addition, mortality levels are quite low due to vast improvements in public health and education. By 1998, the crude death rate was at 6.5 per 1,000 population, while the infant mortality rate was 25.0 per 1,000 live births. A decrease in the mortality rate was reflected in an increase in life expectancy: 69.9 years for males and 74.9 years for females by 1998 (Institute for Population and Social Research, 1998).

Several surveys conducted since 1970 have examined morbidity patterns of the Thai population. The urban population, especially those living in Bangkok, generally has a lower incidence of illness than the rural population. Morbidity levels are highest in the North and Northeast, while morbidity levels are similar for the populations of the other three regions:

^{1/} The rural survey was taken in 1969; the urban survey in 1970.

Bangkok the South, and Central regions (Prasartkul et al; 1988; National Statistical Office, 1991b).

Age differences of illness are also observed, with those aged 5 or less and those aged 60 or over displaying the highest levels of morbidity. Females tend to have lower incidence than males at younger ages, but higher levels at ages 40 and over (National Statistical Office, 1991b).

There have been significant changes in the leading causes of deaths and illnesses in Thailand since the 1970s (Ministry of Public Health, 1970, 1980 and 1990). During the present decade, non-infectious diseases and accidents are increasingly important causes of death, and they have become one of the nation's unsolved health problems. Infectious diseases, namely, pneumonia, diarrhea, diseases of the digestive system and viral diseases, remain as major health problems among under-one and under-five year old population groups. Regional differences among the general population are correlated with the degree of social and health development of each region. A new factor in health in Thailand is the growth in the AIDs epidemic. To solve such public health problems and to improve the health status of the Thai population, health development policies have been included in the National Five Year Development Plans.

1.1.2 Population Movement and Distribution

1.1.2.1 Rural-to-Urban Migration Trends

During the past decade, rural-to-urban migration increased as a proportion of all migration. Whereas rural-to-urban migration constituted only 12 percent of all moves during the five-year period preceding the 1970 census, it constituted more than 15 percent for the five-year period preceding the 1980 census. Although there were no significant changes in the regional distribution of the population as a result of this, the proportion of the population that was urban, which had increased only marginally between 1960 and 1971 (from 12.5 percent to 13.2 percent), jumped to an estimated 25 percent by 1984 (National Economic and Social Development Board, 1994). During that period, Bangkok increased its share to above 10 percent. The 1990 census found that over 18 percent of all recent migrants in 1985-1990 moved from rural to urban areas while 12.6 percent moved from urban to rural areas. Bangkok is the urban center that has gained the most from the rural-to-urban population transfers. In the period 1985-1990, Bangkok had 638,000 in migrants aged 5 years and over (National Statistical Office, 1990a). This represents an increase from 366,000 recorded during the previous 10 years. The latest data from 1992 National Survey of Migration shows that Bangkok was involved in 56 percent of all the movements of migrants within the last 2 years (Chamrathirong et al., 1995).

1.1.2.2 Trends in Urban and Rural Population

The urban population grew at about 3.5 percent annually during 1975-1984. This was due mainly to internal migration from rural areas to the Bangkok Metropolitan Region (BMR)^{2/} where residents suffer severe shortages of public utilities, facilities and housing, and increases in unemployment, crime, environmental deterioration and pollution. The urban population was estimated to be about 18 million or 32 percent of the population in 1990, and is expected to increase to about 25 million or 39 percent in 2000. One half of this number was living in the BMA (National Economic and Social Development Board, 1994). Consequently, the BMA has become the primate city of the country.

1.1.2.3 Population Density and Population Distribution

Thailand's population is not evenly distributed. The Central region, excluding Bangkok, is the most densely populated of the five regions (Bangkok, North, Northeast, Central, South), while the Northeast has the largest number of people, and the South has the least population. Bangkok is the largest city and it is the most populated area in Thailand. It can be classified a mega-city with a population that is 22 times larger than the second largest city of Nonthaburi, which is part of the same conurbation (Ministry of Interior, 1997).

1.1.3 Population Composition

1.1.3.1 Age/Sex Distribution

Mortality and fertility declines during the past few decades caused substantial shifts in the population age structure. Declines in infant and child mortality and continuing high fertility between 1960 and 1970 caused a small increase in the proportion of the population under age 15, making the age distribution of the population younger. After 1970, the level of fertility declined and the Thai population grew progressively older. This is indicated by a rapid drop in the proportion of the population below age 15, from about 45 per cent in 1970 to about 29 per cent in 1990. At the same time, the proportion within the age group 15-59 grew from 50 per cent in 1970 to more than 63 per cent in 1990 (National Statistical Office, 1970 and 1990a).

Due to a reduction in fertility during the last 20 years, significant changes in the population age structure have emerged. The percentage of the population over 60 years of age has increased slightly from about 5 per cent in 1970 to 7.4 per cent in 1990, while the population below age 15 has decreased.

^{2/} BMR includes the Bangkok Metropolitan Administration (BMA) and the five peripheral provinces : Nonthaburi, Pathum Thani, Samut Prakan, Nakhon Pathom, and Samut Sakhon.

It is estimated by the year 2000, those at what are considered dependent ages (less than 15 and over 60) will account for about 27 and 8 percent of total population respectively.

Regional fertility differentials will continue to exist with the highest fertility being in the South.

1.1.3.2 Family and Household Size

Due to declines in population growth, as well as the independent choices of parents and their economic responsibilities, Thai family structure has undergone a drastic change in only a single generation. The traditional Thai family was an extended one with several generations of family members living together. This family structure type was advantageous because it provided a secure base from which all members could tap necessary resources and provide for their own and others' need. In contemporary Thai society, however, low fertility has led to small family size, a reduction in the role and importance of kinship groups, and an increase in the number of nuclear families such as those in which the household head (male or female) must migrate to cities leaving behind their children in the care of elderly parents, or single-headed households where one spouse is either deceased or more likely separated. The traditional way of life, guided by the values, beliefs and cultural systems of the past, is giving way to economic rationality, resulting in problems such as lack of family closeness, an inadequate sense of family sharing, and of equal caring for children and the elderly.

1.1.4 Socio-Economic Characteristics that Affect Consumption

1.1.4.1 Labor Force Participation

Although the share of output from non-agricultural sectors in Thailand has exceeded that of agriculture since 1985, the majority of Thailand's labor force are employed in the agricultural sector. In 1992, the share of output in agriculture, manufacturing and service sectors were 0.13, 0.37 and 0.50, respectively, but labor employment shares by sector were 0.61, 0.15 and 0.24 respectively (Government of Thailand, 1995). These figures alone reflect problems of inequality in income and labor productivity between agricultural and non-agricultural sectors. Approximately two-thirds of laborers are self-employed or unpaid family workers in small enterprises, while one-third work as employers or employees in either private or public establishments. Educational attainment of the work force is low. In 1992, approximately 82 percent of the work force had a primary education or lower; 13 percent and 5 percent respectively had secondary and tertiary education (Government of Thailand, 1995).

In the past, Thailand shared a characteristic with many developing countries, in that it was a country of cheap unskilled labor. Despite the economic problems which accounted in 1997, the nation has experienced rapid economic development and decline in the population growth rate, and can be expected to resume this path. Due to internal and external economic and political changes, Thailand is now facing a more competitive world market. Consequently, Thailand must change the development strategy from that based on labor intensive industry to more value added types of production. Manpower requirements will no longer center on cheap unskilled labor, but on a skilled and better educated work force. Under current circumstances, therefore, it is expected that there will be shortage of skilled and semi-skilled labor in the future. Simultaneously, the demand for unskilled labor will increase slowly or even decline, causing a surplus of unskilled labor. How the labor market adjusts to the changing demand pattern is crucial to the success of future economic development and the welfare of workers.

1.1.4.2 Household Income

Per capita income gaps among regions have widened, with the income of people living in the Bangkok Metropolitan Region (BMR) having grown at a much higher rate than that of people in other regions. With respect to rural-urban income inequalities, the 1975/1976 average per capita income of rural people was about 3,252 baht (U.S.\$130.1) while that of the BMR residents was 7,908 baht (U.S.\$313.3), or 2.4 times the income of people living in rural areas. By 1988 rural income per head rose to 8,916 baht (U.S. \$356.6) while that of urban dwellers rose to 26,970 (U.S.\$ 1,078.8) baht per annum, representing a three-fold difference. The income of all Thais rose from 20,483 baht (U.S. \$819.3) in 1985 to 38,906 baht (U.S.\$1,556.2) in 1990. By contrast, income levels in the Northeastern Region which is the most isolated were 8,193 baht (US \$327.7) and 13,152 baht (U.S. \$526.1) in 1985 and 1990, respectively (Government of Thailand, 1995).

Widening income disparities among these various group are mainly due to the transformation of urban production structures, which are becoming increasingly industry and service oriented, especially within the BMR. However, the government emphasized concrete income distribution policies in the recent Seventh Plan (1992-1996) to enable the under-privileged to live in society with an adequate basic means of livelihood; to improve the relative income better other target groups (poor agricultural workers, hired laborers in agricultural sector, small self-employed workers, low income employees in private sector, government official and state employees, and those who can not help themselves); and effectively to reduce income disparities among various other target population groups.

1.1.4.3 Education

Since the 1960s, Thailand has made considerable progress in developing its educational system and enhancing the educational status of the Thai people. The various measures adopted, especially the education reforms introduced in 1978, have been successful in bringing about very significant improvements in the educational system. Thailand has today achieved universal primary education. But the nation's efforts are not stopping there. While 97 per cent of children in relevant age groups attend primary schools, attendance rates at secondary and higher levels of education are substantially lower at 33 per cent for the lower secondary, 23 per cent in upper secondary, and 7 per cent in higher or tertiary education (Government of Thailand, 1995). The government is now focusing on raising these rates, by making junior secondary school compulsory, and improving access to other types of training and skill development programs.

1.2 Consumption Overview

1.2.1 Historical Trends and Projection of Household Consumption Variables

Household consumption variables considered here are household size, income, expenditure items, and consumer behavior. These variables have been shown to be involved in the process of change in consumption trends in Thailand. The household size of both urban and rural areas has fallen from an average of 3.9 persons in 1992 to 3.8 persons in 1994, but the increasing household and per capita income is resulting in household expenditure also increasing. The historical trends of household consumption depend largely on income; if household income increases then household expenditure increases.

1.2.1.1 Distribution of Income

Income is unevenly distributed among urban and rural areas in Thailand (see 1.1.4.2). Per capita income in all regions has been increasing. National income depends on agricultural products especially rice, cassava, corn, rubber latex and increasingly on industrial products. Despite Thailand's high economic growth rates before 1997, income disparities between agriculture and other economic sectors and between regions remain. Disparities include differences among groups of people in the cities, and between Bangkok and other regions (National Economic and Social Development Board, 1994).

Household monthly income and per capita monthly income in Thailand varies among regions. In 1994, households in the Bangkok Metropolitan Region (BMR) received the highest average annual income of

16,543 baht per household. This was followed by households in the Central Region, the Southern Region, and the Northern Region, (see Figure 1.1). The lowest average annual income was reported by the Northeastern households, an area where a high level of poverty remains.

When comparing average per capita monthly income for 1992 to 1994, (see Figure 1.2) it can be seen that over the two years the average per capita monthly income increased from 1,811 baht in 1992 to 2,191 baht in 1994, an increase of 21.0 percent. The highest rate of increase, 31.8 percent, was found in the Northeastern Region, followed by the Central, the South and the Northern Region. The lowest rate of increase 6.9 percent, was found for the Bangkok Metropolitan Region.

1.2.1.2 Breakdown of Consumer Expenditures

In 1994, average monthly expenditure was 8,034 baht per household or 2,114 baht per capita. About 7,246 baht (90.2 percent) or 1,903 baht per capita was for consumption, including 32.1 per cent for food and beverages and 58.1 percent for other goods and services (see Figure 1.3). Households also spent 788 baht or 9.8 percent on non-consumption items, which include taxes, gifts and contribution, insurance, premiums, and other items.

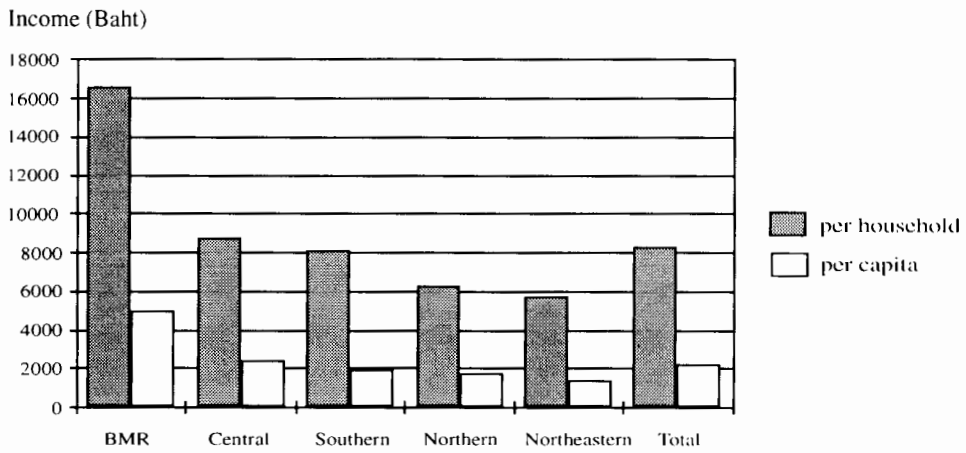
The highest average monthly household expenditure of 12,486 baht was by households in the Bangkok Metropolitan Region followed by Central Region households, Southern households, and Northern households where expenditure per household was 7,716 baht, 7,201 baht, and 5,633 baht respectively. The lowest monthly expenditure of 5,596 baht per household was found in the Northeastern Region.

Expenditure type for the five regions is shown in Table 1.1. The main items of household expenditure were food and non - alcoholic beverages, housing, transportation and communications.

The patterns of expenditures among regions differ. Food and non-alcoholic beverage had lower expenditure (29.5 percent) for households in the Bangkok Metropolitan Region, while in the other regions these items constituted 32 - 34 per cent of total expenditures.

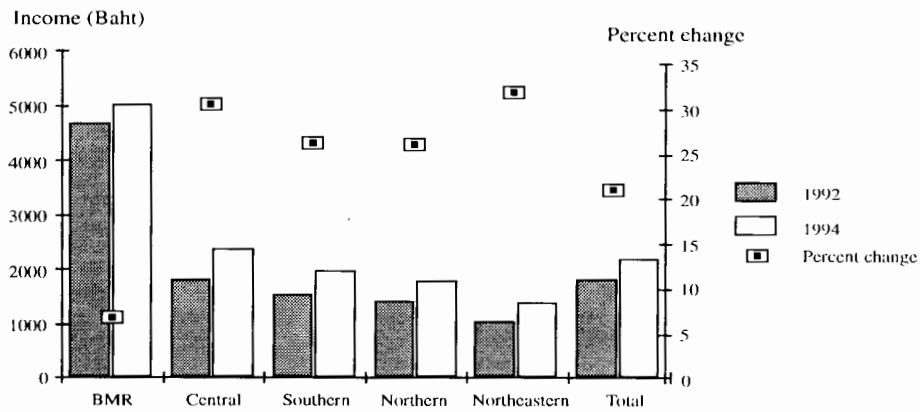
The relative amount spent on housing did not vary significantly among regions. It was estimated to be 22.9 per cent in the Bangkok Metropolitan Region and around 22 - 25 per cent in all other regions except for the South, where housing expenditure comprised 20.3 per cent of total expenditure. Transportation and communication expenditures of the households in the Bangkok Metropolitan Region were higher than for other regions.

Figure 1.1 Average Monthly Income per Household and Per Capita Income(Baht), in 1994



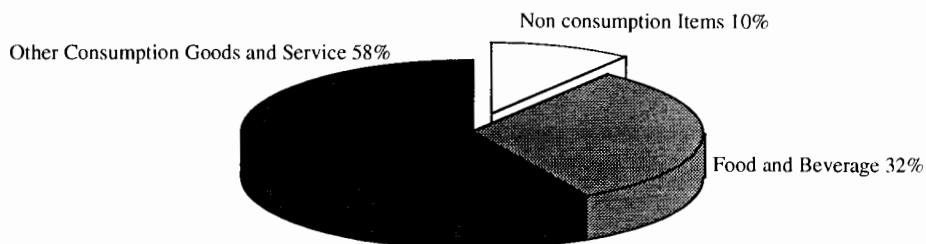
Source : National Statistical Office (NSO), 1996b.
 Note : 25 baht approximately equal \$1 in 1994.

Figure 1.2 Comparison of Per Capita Monthly Income(Baht), 1992 to 1994



Source : Same as figure 1.1

Figure 1.3 Household Monthly Expenditure in 1994



Source : Same as figure 1.1

Table 1.1 Consumer Expenditure per Household by Region, 1994 (Baht).

Expenditure Group	BMR	Central	South	North	Northeast
Food and Beverage	4,127 (29.5%)	2,738 (32.1%)	2,650 (33.1%)	2,033 (32.6%)	2,101 (34.3%)
Alcoholic Beverage	246 (1.7%)	146 (1.7%)	101 (1.2%)	99 (1.6%)	76 (1.2%)
Housing	3,207 (22.9%)	2,165 (25.3%)	1,626 (20.3%)	1,402 (22.5%)	1,431 (23.3%)
Transportation and Communication	2,433 (17.4%)	1,166 (13.7%)	1,368 (17.1%)	916 (14.7%)	871 (14.2%)
Other	2,373 (17.7%)	1,501 (17.5%)	1,456 (18.1%)	1,183 (13.0%)	1,017 (18.2%)
Non-Consumer Expenditure	1,509 (10.8%)	829 (9.7%)	814 (10.2%)	600 (9.6%)	538 (8.8%)

Note : 25 baht approximately equal \$1, in 1994

Source : National Statistical Office (NSO), 1996b

1.2.1.3 Estimates of Non-cash Expenditures

For non - cash expenditures, there is greater expenditure in urban areas than in rural areas. The cities in Thailand have many traffic problems, especially in Bangkok. The expenditures in terms of the cost of lost energy, time, and tension in the congestion are enormous. Estimates are that more than four hours per capita is lost in transportation per day for Bangkok residents. Although other cities have lower non-cash expenditure than Bangkok, this cost still exists. In rural areas most non-cash expenditure is for gathering natural food, energy, and time. Rural households can obtain natural food from the forest. For energy and time, there is the cost involved in slow transportation between the village and municipality.

1.2.2. Data Sources for Household Consumption Activities

The data for analysis of household consumption activities are drawn from the National Statistical Office (NSO) for 1992 and 1994 socio - economic survey data and the National Economic and Social Development

Board of (NESBD) for national income data. The NSO survey occurs every two years, while the NESBD has data for each year. These data sources are important for assessing development of the country, especially rural areas and other regions which have wide gaps between household and per capita income and consumption when compared to Bangkok.

1.2.3. Assumption of Future Consumption

Thailand's population and development situation contains many paradoxes between consumer behavior and household size. For example household size is small and the pattern of consumer behavior has changed due to rapid increase of per capital income. People have access to money, cash, credit cards, infrastructure modernization, and can pay by installments. Households are likely to buy luxury goods especially televisions, telephones, microwave ovens, air conditioners, electric fans and cars. Therefore, consumer behavior related to payment for manufactured goods both affects and is affected by household size. Growth in consumption expenditure is due to an increase in government expenditure in the public sector, and to increased liquidity in the economy. An assumption is that large - scale consumption began prior to rapid population growth and is related to the degradation of the natural environment (Monopimoke, 1992). The population growth rate has declined over time due to an effective national family planning program but the household consumption continues to increase.

To project future consumption, a consumption-based poverty line is used. It consists of two elements: the expenditure necessary to reach a minimum standard of nutrition and buy other necessities; and a further amount that varies from country to country. Estimation of such a poverty line for each country is still somewhat subjective and arbitrary (Kirananda, 1993). In the year 2000, it is estimated that the proportion of household monthly income used in expenditure on consumer expenditure items will increase. Between 90 and 95 per cent of total expenditure will be for the cost of consumer goods.

1.3 Environmental Overview

There are many links between the use of natural resources and environmental degradation. For example, in Thailand the loss of 60 per cent of the nation's forests over the past thirty-five years has partially led to a crisis in water resource allocation, particularly in the lower Chao Phraya basin. During the dry season, agriculture, industry, municipalities, and transportation are increasingly competing for surface water resources. Ground water is available, but extraction causes an increasing land subsidence, which is associated with

floods, drought and soil salinity. Landlessness, rural poverty, marginal farmland, forest encroachment, and low levels of education are dynamically inter-related in Thailand, especially in the Northeast region (Development Alternative Inc., 1994).

The population of Thailand increased from 28 million in 1961 to 56 million in 1990, and 60 million in 1996. The increasing population has been accompanied by economic growth and improved standards of living, which has caused an increasing exploitation of natural resources. This also causes land use pattern change and increased energy consumption, which play a major role in the emission of green-house gases in Thailand (detail discussed in Boonpragob, 1996).

During the period 1960-1995, the number of people in the agriculture sector increased from 21 million to 35 million, and is expected to increase further to 35 million in 2000, and then decline to 31 million in 2010. The proportion of population participating in the agriculture sector had declined steadily before 1997 (Boonpragob, 1996). This trend reflects the changing economic structure of the country and will have consequential impacts on changes of people's occupations, land use and forestry, energy consumption, waste and industry, which in turn will affect the emission of green-house gases in the future.

1.3.1 Global Warming

In 1990, Thailand was the world's 18th largest producer of green-house gases, contributing 1.2 per cent of net global green-house emission. Thailand produces 0.7 per cent of global carbon dioxide emissions and 2.2 per cent of methane emissions. The three most significant green-house gases in Thailand are Carbon dioxide (CO₂), Methane(CH₄) and Nitrous oxide (N₂O), of which CO₂ shares the largest proportion of total warming effect (55 per cent and CH₄ shares 41 per cent of the total emissions. Data for warming effects of emissions in 1990 by sector (agriculture, land use change and forestry, energy, industrial processes, waste, and wetland) are available for Thailand^{3/}. Table 1.2 indicates share of national warming effect via green-house gas emission (in CO₂ equivalent) from various sub-sectors in 1990^{4/} (Boonpragob, 1996).

^{3/} Some of sectors related to Global Warming have been described above.

^{4/} Global Warming Potential (GWPs) defined the warming effects caused by a unit mass (1 kilogram) of a given gas relative to that of carbon dioxide. For example, it is estimated that in a hundred year time frame, the GWP of methane (CH₄) and nitrous oxide (N₂O) are 24.5 and 320 respectively.

Table 1.2 Share of National Warming Effect via Green-house Gas Emission (in CO₂ equivalent) from Various Sub-sectors in 1990, Thailand.

Sub-Sector	Mass (Million tonnes)	% of Global Warming Potential (GWPs)
Rice	108	33
Woody Biomass	90	27
Transport	35	11
Forest Clearing	33	10
Power	28	9
Industry	12	4
Livestock	12	4
Other activities *	11	2

Source: Boonpragob, 1996.

* Other activities include Oil and Natural Gas, Industry Process, Small Combustion, Agriculture Soils, Waste, Wetland, Field Burning, and Solid Fuel.

1.3.2 Land Resource

The robust growth of agriculture during the 1960s and the 1980s was accomplished not through land reform and productivity improvements but through the expansion of agricultural land into national reserve forests. Between 1950 and 1988, 18 million hectares of forest land were cleared, 90 per cent being converted to agriculture. Moreover, a shift from subsistence cropping to cash crop farming resulted in a dramatic deterioration in land quality and forest land. Generally crop yields from newly cleared land are high during the first two or three years because of the nutrients released from the burning of forest, therefore, farmers often seek to open new lands for cultivation.

Limitations on land availability began to slow down the growth of agricultural productivity in the early 1980s. As forest reserves have declined from 60 per cent in 1950 to less than 30 per cent today, little land was left for agricultural expansion. The deforestation and rapid expansion of agricultural land have been linked to problems of soil erosion and the run-off of surface water. An estimated 50 million tons of topsoil erode into the Gulf of Thailand annually. Loss of topsoil, soil nutrient depletion resulting from intensive cultivation of cash crops, and poor land and water management have become major problems. Farmers responded to the situation by increasing use of chemical fertilizers and biocides on their fields, which in turn increase emission of green-house gases (Jesdapipat, 1996).

Declining agricultural productivity in Thailand is likely to increase rural poverty and forest encroachment. However, the continued severity of land resource degradation is also likely to be offset by three factors: 1) the

dramatic reduction in the country's population growth, 2) continued growth in the manufacturing and industrial sectors, which results in increased migration from rural areas to towns and cities, and 3) the increased availability of non-agriculture employment.

1.3.3 Forestry Resource

Major causes of Thailand's deforestation in the last three decades are the uncontrolled logging and land clearance for farming. The most rapid destruction of forest took place in the mid 1970s when an estimated 10,000 square kilometers of forest were lost each year. During the period 1960 to 1985, the population of Thailand doubled from 26 to 52 million, while the country's forest area was reduced by nearly half, and cultivated land was doubled from 20 per cent to 40 per cent of total land area.

The high rate of deforestation has effects on Thailand's biodiversity, and extensive stretches of coastline including mangrove forests, sandy beaches and coral reefs have been damaged. In response to growing national and international concern, the government imposed a ban on all logging activities in 1988^{5/}

At the national level, government and non-government organizations such as the Royal Forest Department, Forest Industry Organization Farm-Forestry Programs, The United Nations Development Program (UNDP), Food and Agriculture Organization (FAO), the Isan Khiaw Project, and research institutions from various universities in Thailand have emphasised that solutions to the problem of deforestation are not only reversing the trend of forest degradation and loss of biodiversity but also encouraging more consultation with local communities.

The government has promoted the role of the private sector in reforestation through tax concessions and the leasing of public lands at relatively low rates. However, the plantation forestry program has failed to address key issues such as watershed protection and the restoration of natural forest habitat. Community forestry programs, particularly in the North and Northeast regions have been implemented. The Thailand Development Research Institute (TDRI) has conducted case studies of NGO-supported community forestry projects, and noted that:

- Communities are not likely to engage in forest protection until the level of resource decline threatens their survival
- Traditional community institutions do not have the power to enforce forest conservation measures in the face of external

^{5/} However, it does not mean there is no logging in Thailand, because illegal logging continues.

- threats (for example, logging concessions and the other commercial development) without government support;
- The failure of many community forestry projects lies in the inability of planners to understand the heterogeneity of the “community” and the dynamic relationship between the community and the forest that is determined by the community’s changing dependence on forest resources (Development Alternative Inc., 1994).

It seems likely that the government and other supported programs address the fundamental issues of land tenure inadequately. There is little incentive for settlers to manage their lands in a sustainable way and for them not to encroach further on the remaining forest reserves unless they have secure tenure.

1.3.4 Urban Infrastructure and Industry

Thailand’s most critical urban infrastructure and industry environmental problems are concentrated in Bangkok. These problems have affected public health, damaged the physical environment, and contributed to downstream ecological system degradation. These urban infrastructure and industry environmental problems also exist in Thailand’s secondary cities, where there is one-third of the urban population. Although the environmental problems are less severe than in Bangkok and perhaps affect only a small number of people, they are more tractable and they possibly lead to more cost-effective solutions (Development Alternative Inc., 1994).

a. Air Pollution

The level of air pollution in Bangkok frequently exceeds national air quality standards, which are lenient by international comparison. Levels of Carbon Monoxide (CO) and Suspended Particulate Matter (SPM) in some areas are far above the standard (see Table 1.3).

The most serious health problems in terms of deaths and days of work lost are associated with SPM and lead. In 1990, one million city residents received treatment for respiratory infections. Levels of lead in blood are among the highest in the world, causing hypertension, heart attacks, strokes, and intellectual incapacitation among children. A reduction of 20 per cent in the concentration of these two pollutants would result in improved health with, annual benefits valued at \$440-\$1,620 million and \$300-\$1,480 million respectively (World Bank, 1994 cited in Development Alternative Inc., 1994). During the period 1980 to 1987, there was a ten-fold increase in occupational diseases caused by toxic substance exposure in Thailand. This partly results from many Thai

workers suffering from indoor air pollution at the workplace (IIEC, 1994 cited in Development Alternative Inc., 1994).

Transport, industry and power sectors are the main sources of air pollution. Vehicular air pollution is accelerated by the severe congestion and particular mix of vehicle types in Bangkok. Air pollution from industry has been worsening in recent years because of changes in industrial structure with high growth rates of polluting industries such as fabricated metal products, machinery and transportation equipment.

Table 1.3 Ambient Air Concentration in 18 Curbside Stations in Bangkok.

Station	Max. SPM (24 hr)(mg/m ³)	Max. CO (8 hr)(mg/m ³)	Max. Lead (24 hr) (µg/m ³)
Khom Phrasusat	0.48	10.45	0.49
Bangyekhun Power Station	0.53	6.65	0.47
Phratunam	0.81	11.09	0.73
Yaovaraj	0.56	6.36	0.63
National Statistical Office	0.50	11.02	0.30
Mean Sri	0.49	12.81	0.52
Sri Phraya	0.37	10.17	0.41
Banglumpoo	0.33	6.31	0.29
Ban Somdej Police Booth	0.51	11.53	0.41
Phra Pin Klao Hospital	0.24	8.14	0.16
Sapankwai	0.43	27.12	0.40
Khugthep Christian Hospital	0.65	29.52	0.38
Police Department	0.40	11.07	0.20
Hua Mak Post Office	1.13	11.58	0.47
Khom Pattana Thi-din	0.25	13.14	0.23
Ministry of Science, Technology and Environment	-	13.44	-
Khom Kan Khon Song	-	16.56	-
O dian	-	9.34	-
Standard	0.33	20.00	1.25

Source: Department of Pollution Control, Ministry of Sciences, Technology and Environment, 1994.

b. Water Pollution

About 24 per cent of urban residents of Thailand live without access to safe drinking water, and 26 per cent lack access to sanitation (UNDP, 1994). There is serious contamination of river and canal water from household and industrial waste. Although the level of water pollution does not have obvious effects on public health, there are considerable economic costs, including the

impact on the fishing industry, the consequences to tourism, and the cost of supply and treatment of piped and bottled water. The polluted water in the Chao Phraya River may move upstream to the main intake for Bangkok's piped water supply, which may result in increased treatment costs or, in the worst case, render the water supply untreatable. The excessive amount of freshwater extraction from tube wells, resulting in an intrusion of salt water, will become a serious problem.

c. Hazardous Waste

It has been reported that 17,056 factories were producing large and moderate quantities of hazardous waste in 1989. Thai industry produces two million tons of hazardous waste each year, an amount which is expected to triple by the end of the decade (Phantumvanit, 1994). It was estimated that 47 per cent of hazardous waste in Thailand was produced in the BMR during 1991. Two million tons/year of hazardous waste were produced during 1996, while the 1996 treatment capacity was estimated to be 0.2 million tons/year. The treatment site is located in Bankhuentien, a district of Bangkok Metropolitan Administrative. Currently, four hazardous waste sites have been planned and budgeted in Ratchaburi, Chon Buri, Sara Buri, and Rayong, but all are facing construction opposition. The country needs to invest in larger facilities for hazardous waste treatment.

One incident at Khlong Toey port indicated a significant risk associated with uncontrolled dumping of toxic wastes, which could lead to widespread and possibly permanent health problems and to death (Development Alternative, Inc., 1994).

d. Other Forms of Environmental Degradation

As Bangkok's demand for water has grown, the depletion of groundwater resources has led to land subsidence, which, in turn, causes saltwater intrusion, decreased storm water drainage capacity and increased flooding, damage to infrastructure and increased costs of pumping groundwater from deeper wells.

Bangkok suffers from severe traffic congestion, which has tremendous effects on the economy as well as on health and well-being. It has been estimated that a 10 per cent reduction in trips would lead to operating and time savings of \$156 million a year. The average traffic speed in Bangkok is about 10 kilometers per hour, resulting in a notable amount of unnecessary emission.

Bangkok also suffers from noise pollution from road and water traffic, and construction machinery. A 1987 study conducted by NESDB found

that 21 per cent of motor cycles, 18 per cent of trucks and 15 per cent of *tuktuks*^{6/} exceeded the Thai noise level standard of 100 dBA (the international accepted level is 70 dBA) (NESDB, 1987).

Half of the solid waste generated is not collected in Bangkok due to inefficient management. The waste blocks drains and leads to flooding, and creates breeding grounds for rats and mosquitoes (Development Alternative Inc., 1994).

Many policies have been implemented to address environmental issues. For example, a policy to accelerate and intensify the introduction of unleaded gasoline was implemented in May 1991. It was planned that all gasoline in Thailand will be unleaded by January 1996^{7/}. A waste minimization program in polluted industrial districts was implemented, and the development of electric tuk - tuks is seen as a partial solution to the city's air pollution. A concentration of industries in estates allows for more efficient treatment of wastes, encouraging an involvement of private companies in waste treatment. Bangkok Metropolitan Administration accelerated provision of environmental services by offering a Build-Operate-Transfer contract for the installation of a sewer system to collect and treat the wastewater from about 3-4 million people (Development Alternative Inc., 1994).

1.3.5 Energy

The rapid economic growth of Thailand has resulted in increasing energy consumption during the last few decade. Total energy consumption increased from 15,000 kilograms of oil equivalent (koe) in 1980 to 44,000 koe in 1994, at an annual rate of growth of about 7.4 per cent (Boonpragob, 1996). Woody biomass, widely used by industry, and fuelwood by households is projected to decline from the present 24 per cent of total consumption to 11 per cent by 2010 (Development Alternative Inc., 1994).

Thailand increasingly uses modern energy sources such as coal and coke, petroleum products, natural gas and hydro electricity. The share of modern hydro-electricity energy supply sources increased from 59 per cent in 1981 to 74 per cent in 1994, while the share of non-renewable energy decreased constantly during the same period. In the future, the share of modern energy sources will continue to dominate because of the lack of non-renewable energy sources and conversion technology (Department of Energy Development and Promotion, Ministry of Sciences, Technology and Environment, 1994 cited in Boonpragob, 1996).

^{6/} Tuk-tuks are three-wheeled motorized rickshaws, which are unique to in Bangkok.

^{7/} As of February 1998, there remains leaded gasoline in Thailand, but new vehicles are required to use unleaded gasoline.

Since 1980, commercial energy demand has grown at 10 per cent per year, and 14 per cent annually during 1991-1995 for electricity. Demand for electricity will have grown threefold between 1994 and 2006. The need will be met by developing new domestic sources and by importing coal, oil, gas and hydroelectricity, particularly from neighboring countries. Most of the national supply in the next decade is likely to be dependent on gas- and coal-fueled power plants, while the reserves of natural gas and oil are limited.

Sulphurdioxide (SO₂) and Nitrogendioxides (NO₂) emissions from lignite-fired power plants, especially from Mae Moh (a major electricity power plant in the Northern region), contribute to much of the country's atmospheric pollution. Because of the high level of public concern arising from a significant number of local residents who have suffered from the emission, the Electricity Generation Authority of Thailand (EGAT) has reduced production at Mae Moh to 60 per cent of capacity. EGAT also attempts to control SO₂ emissions through the fitting of high-efficiency fuel gas desulphurization units on new lignite-powered plants, and retrofitting existing plants. Thailand is engaging in a Demand-Side Management (DSM) project, which focuses on reducing energy use through efficiency improvement in end use (Jesdapipat, 1996).

1.3.6 Outlook for the Future

Economic development in combination with decreasing population growth in Thailand, particularly during the last two decades have both negative and positive effects on environment as well as consumption patterns. On one hand, the increasing size of the middle class, particularly in Bangkok, has influenced people's attitudes toward more luxury goods, energy consumption and environment degradation. Highly materialistic attitudes are predominant in Thai society. On the other hand, increasing educational levels result in increasing awareness of sustainable development. For instance, while there are also increasing numbers of people who use cars or woody furniture, there are increasing numbers people who work toward sustainable development projects or campaigns. Both the government and non-government organisations have implemented many environment- friendly programs, such as the magic eyes project^{8/}, and the community forestry programs.

Natural resource conservation and rehabilitation of the environment was first introduced in the fourth National Economic and Social Development Plan (NESDP) (1976-1981), and the fifth NESDP also recommended an integration of natural resource and socio-economic approaches, while the sixth NESDP recognized that the country's natural resources were limited. The seventh NESDP (1992-1996) included major environmental

^{8/} The magic eyes project's campaign message is 'do not litter, the magic eyes are watching'.

objectives: to reduce solid waste and wastewater pollution and to control water quality in the Chao Phraya River (central Thailand's principal river), coastal areas, and tourist destinations; to enforce the polluters-pay principle for pollution control; to mobilize investment to control pollution, through subsidies, joint venture programs, and concessions to the private sector; and to set up tripartite commissions (government, private sector, and community) to supervise and control environmental quality.

The eighth NESDP (1997-2001) places emphasis on solutions of environmental problems associated with economic strategies. The major aims are: to maintain the country's forest area at about 25 per cent, and mangrove forests to at least 1 million rai^{9/} by the end of the plan; to promote roles of communities in looking after their forests; to control water quality in the rivers, oceans, coastlines and other natural resources; to control pollution from air, noise and toxic wastes especially in urban areas to the level that does not affect people's health; to increase capacity for garbage collections and proper hazardous waste treatments; and to encourage both public and private hospitals to operate a complete infections waste and garbage treatment.

The government approach has been to treat environmental problems as symptoms rather than the root causes of problems, which involve the dynamics of population and consumption pattern changes. It could be expected that Thais may react to the environmental problems in the near future based on the facts that people always act when problems threaten their survival.

^{9/} 1 Rai = 0.40 Acre

Table 1.4 : Summarized Major Environmental Problems in Thailand.

Environmental Problems	Stressors	Variable Measured	Sources	HH Level Data Needs
Atmosphere: Global Warming Air Pollution Energy	Direct: Greenhouse Gases Air Pollution Indirect: Population growth/ size/structure/ distribution and density	Emissions of: CO ₂ , CH ₄ , and N ₂ O Annual emission of: particulates, CO, lead, SO _x , NO ₂ , lead Emissions of: particulates, NO ₂ , SO ₂	By economic sector: Agriculture, land use change and forestry, energy, industrial processes, waste, and wetland By category of HH consumption: Biomass burning Transportation	Per capita energy usage Per HH CO ₂ emissions from vehicles and energy consumption: Average HH size, Age structure, Age-specific HH headship rate, Total tons oil consumption, Per capita (Kg oil equivalent), Per capita GNP
Land Soil Erosion and degradation Deforestation	Direct: Farming practices Forest logging Fuel practices Indirect: Land tenure Population growth	Forest loss/ degradation Loss of topsoil/ soil nutrient depletion	By economic sector: Agriculture Manufacturing By category of HH consumption: Heating/cooking practices Shelter (construction materials, land requirement)	Forest land area, Reforested land area, Population projections, Food consumption model: Per capita GNP, Family structure and size, Life style

(continued)

Table 1.4 (continued)

Environmental Problems	Stressors	Variable Measured	Sources	HH Level Data Needs
Water Water scarcity Contaminated water Poor water quality	Direct: Deforestation Household and industrial waste Indirect: Population growth/size/ age structure/ distribution and density Rural-urban migration and marginal land	Loading of: toxic chemicals, pesticides, other Over use of underground water	By economic sector: Agriculture Manufacturing Service Tourism By category of HH consumption: Water requirement	Per capita consumption of water
Wastes: Toxic Waste Hazardous Waste	Direct: Industrial/ domestic/ hospital waste disposal Indirect: Population growth/size/age structure/ distribution and density	Not applicable	By economic sector: Manufacturing process Agriculture production By category of HH consumption: Heating/cooking practices Waste disposal/biomass burning	Not applicable

CHAPTER II

A Focus on Air Pollution in Bangkok

2.1 Statement of the Problem

Bangkok is one of the most polluted cities in the world. Air pollution has significantly affected the health of people in Bangkok (Department of Toxic Control, 1990). About 500,000 of Bangkok's residents suffer from respiratory problems, and the number is increasing at 5-7 per cent per year (Webster, 1995). Excessive levels of lead cause approximately 200,000-400,000 cases of hypertension and some 400 deaths a year in Bangkok (World Bank, 1992). About 19 per cent of Bangkok residents have breathing problems (Bangkok Post, February 7, 1995), which would imply 1.2 million or more residents affected. Among 3,801 street sweepers in Bangkok, 209 suffer from respiratory diseases and 32 have hearing loss (Bangkok Post, February 7, 1995). In 1993, about 800 traffic policemen in Bangkok had developed work-related illness (Bangkok Post, June 30, 1995). An example of mental stress can be seen from the following case: in late 1993, a 25 year-old traffic policeman was hauled out of a traffic jam and off to a psychiatric hospital where he was diagnosed as suffering from an unspecified "mental" illness. He switched all traffic lights to green and danced in the chaos (Canberra Times, October 23, 1993). A 52 year-old traffic policeman died of lung cancer in 1994, after 25 years directing traffic in Pratunam, one of the most polluted areas in Bangkok. Doctors said his work was the main cause of his death (Bangkok Post, June 30, 1995).

The United States Agency for International Development (USAID) (1990) indicates that annual health benefits from less sickness and lower mortality from reducing ambient concentrations by 20 per cent from current levels in the Bangkok Metropolitan Region (BMR) would be between \$400 million and \$1.6 billion for Suspended Particulate Matter (SPM) and between \$300 million and \$1.5 billion for lead (World Bank, 1994). Table 2.1 provides the range and best estimates of the physical impacts associated with the scenario for low, middle and high health impact. For example, if health impact from SPM is low, about three million fewer restricted activity days will be lost in a year.

**Table 2.1. Bangkok-Morbidity and Mortality Associated with SPM
Estimated Impacts of 20% Reduction in Ambient
Concentrations.**

<i>Health Impact</i>	<i>Reduction in Number of Cases/year</i>		
	<i>Low</i>	<i>Middle</i>	<i>High</i>
Restricted Activity Days	3,300,000	5,330,000	8,370,000
Emergency Room Visits	3,120	34,600	66,100
Asthma Attack	322,000	25,800,000	51,300,000
Chronic Bronchitis in Children	863	78,600	156,000
Chronic Cough in Children	537	90,700	181,000
Respiratory Hospital Admissions	3,450	14,900	26,400
Respiratory Symptom Days	159,000,000	200,000,000	251,000,000

Source: World Bank, 1994

2.2 Air quality in Bangkok

The concentration of air pollution in Bangkok has already exceeded the safe standard, especially during the last decade. It is also expected to worsen in the future. The major air pollutants that affect people's health in Bangkok are:

Suspended Particulate Matter (SPM)

During the period 1990-1994^{10/} the SPM level ranged from 0.04 to 3.14 gram per cubic metre (g/m^3), which on average exceeded the Thai standard of $0.10 \text{ g}/\text{m}^3$. SPM was projected to generate 1.07 million tons by the year 2010, an increase from 0.35 million tons of SPM in 1991 (International Institute for Energy Conservation (IIEC), 1994 cited in Gakenheimer and Gelfand, 1995).

Recent data indicates that no monitoring stations meet safe air quality standards for SPM (see Table 2.2). The percentage of days that exceed the daily standard varies from the inner to outer zones of the city^{11/}. Monitoring

^{10/} Based on maximum and minimum daily concentrations per month for each month of the years 1989-1994 at Rajburana, Soawap, NEB, Chankaseam, Bansomdej, Sukumvit and Bangna monitoring stations. 1994 measurements include only the months January-April.

^{11/} Bangkok is divided by the Bangkok Metropolitan Administration into three administrative zones, based on land-use patterns and population density. The inner zone is the area of Bangkok's early settlement. It has been developed for a variety of social and economic activities and has the highest population density. The middle zone is an area of houses and government offices and is targeted to support further urban expansion. The outer zone is the periphery of Bangkok, in which most of the area is used for agricultural purposes and manufacturing. It still retains rural characteristics but is rapidly being re-developed for housing (Department of Policy and Planning, 1987).

stations in the inner zone (i.e. Din Daeng and Nonsree Withaya) of Bangkok are more likely to return a higher percentage of days over the standard than those in the middle or outer zone of Bangkok (i.e. Khlong Jan, Ram Khamhaeng and Bangkhuntien). This may be because of the concentration of traffic and activities in areas surrounding the monitoring station.

Table 2.2 Concentration of SPM (less than 10 micron) in Bangkok During 5.5 Months Period (July 1996-February 1997).

Station	Concentration of SPM, $\mu\text{g}/\text{m}^3$				Percent of day over std.
	Mean	SD	Minimum	Maximum	
Ram Khamhaeng	93	70	11	915	18
Khlong Jan	72	44	11	814	6
Huay Kwang	122	74	11	928	29
Nonsree Withaya	121	63	15	885	42
Bangkhuntien	114	72	11	566	28
Thonburi Substation	134	64	19	745	54
Chockchai 4	126	59	18	705	34
Din Daeng	189	89	15	953	68

Source: Panich et al., 1998, Table 6.

Note: Daily Standard of Thailand is $120 \mu\text{g}/\text{m}^3$: Safe Air Quality Standard is $50 \mu\text{g}/\text{m}^3$

Carbon Monoxide (CO)

The concentration of CO in Bangkok has increased over time. The most recent data, 1990, indicated a range of 0.11-53.11 milligram per cubic metre (mg/m^3) per hour, which was below the Thai standard of $20 \text{mg}/\text{m}^3$ (Ministry of Science, Technology and Environment, 1990). It was estimated that the average 1990 level of CO concentration would cause 20,000 people with heart disease to be at moderate risk of angina pain, and 900,000 people to be at risk of headaches, inability to concentrate, drowsiness and inhibited development in young children (Gakenheimer and Gelfand, 1995). Emitted CO is expected to total 8.4 million tons in 2010, of which 87 per cent will originate in the transportation sector (Gakenheimer and Gelfand, 1995).^{12/}

Lead

During the period 1982-1986, levels of lead concentration ranged from 0.1 to 1.0 micrograms per cubic metre ($\mu\text{g}/\text{m}^3$), and limited data from 1994 indicates a high of $0.52 \mu\text{g}/\text{m}^3$ with an average of $0.15 \mu\text{g}/\text{m}^3$. This level is

^{12/} The estimate was made by International Institute for Energy Conservation (IIEC) and the United States Agency for International development (USAID) (Gakenheimer and Gelfand, 1995).

above the Thai standard of 0.01 mcg/m³ (IIEC, 1994 cited in Gakenheimer and Gelfand, 1995).

Although the lead content in gasoline has been reduced from 0.85 to 0.45 and then to 0.15 grams per litre, the average lead concentration in Bangkok remains higher than the Thai standard. This is due to the increased number of automobiles and traffic congestion. Lead emissions are expected to reach 2,000 tons in 2011, which is double the 1991 emissions (Gakenheimer and Gelfand, 1995).

Nitrogen dioxide (NO₂)

During the period 1987-1990 the level of NO₂ had been increased over time. It ranged from 0.01 to 0.49 at the five monitoring stations in Bangkok. Four of the five monitoring stations showed the concentration of NO₂ to be above the Thai ambient standard, which is 0.32 mg/m³ daily one-hour maximum (World Bank, 1994).

2.3 Fuel Consumption in Transportation

The level of fuel consumption is positively related with the level of air pollution (see Tables 2.3 and 2.4). The consumption of various petroleum products in transportation from 1990-1995 has increased at an average rate of approximately 12 per cent per year, although the consumption of LPG slightly decreased. The total use of petroleum for transportation is almost 20,000 M litres, which accounts for about 60 per cent of the country's petroleum consumption (see Table 2.3). From 1990-1995, the amount of SPM increased about 10.7 per cent per year, CO increased at an average of 6.1 per cent per year and NO_x increased by 12.2 per cent per year (Wibulswas, 1997).

Table 2.3 Fuel Consumption in Transportation, M litres.

Type of Fuel	Fuel Consumption (in M litres)		
	1990	1992	1995
LPG	205	318	242
Premium Gasoline	1,734	2,207	4,018
Regular Gasoline	1,856	2,046	2,120
High Speed Diesel	7,080	7,457	12,181
Low Speed Diesel	88	122	172
Fuel Oil	481	604	842
Total	11,444	12,754	19,575
% of Country Petroleum Consumption	60.0	57.2	59.7

Source: Wibulswas, 1997.

Table 2.4 Air Pollution from Transportation, K ton.

Year	SPM	CO	NOx	CO ₂	HC
1990	14	1,016	202	14,622	10
1992	15	1,186	230	38,489	12
1995	23	1,387	350	57,189	14

Source: Wibulswas, 1997.

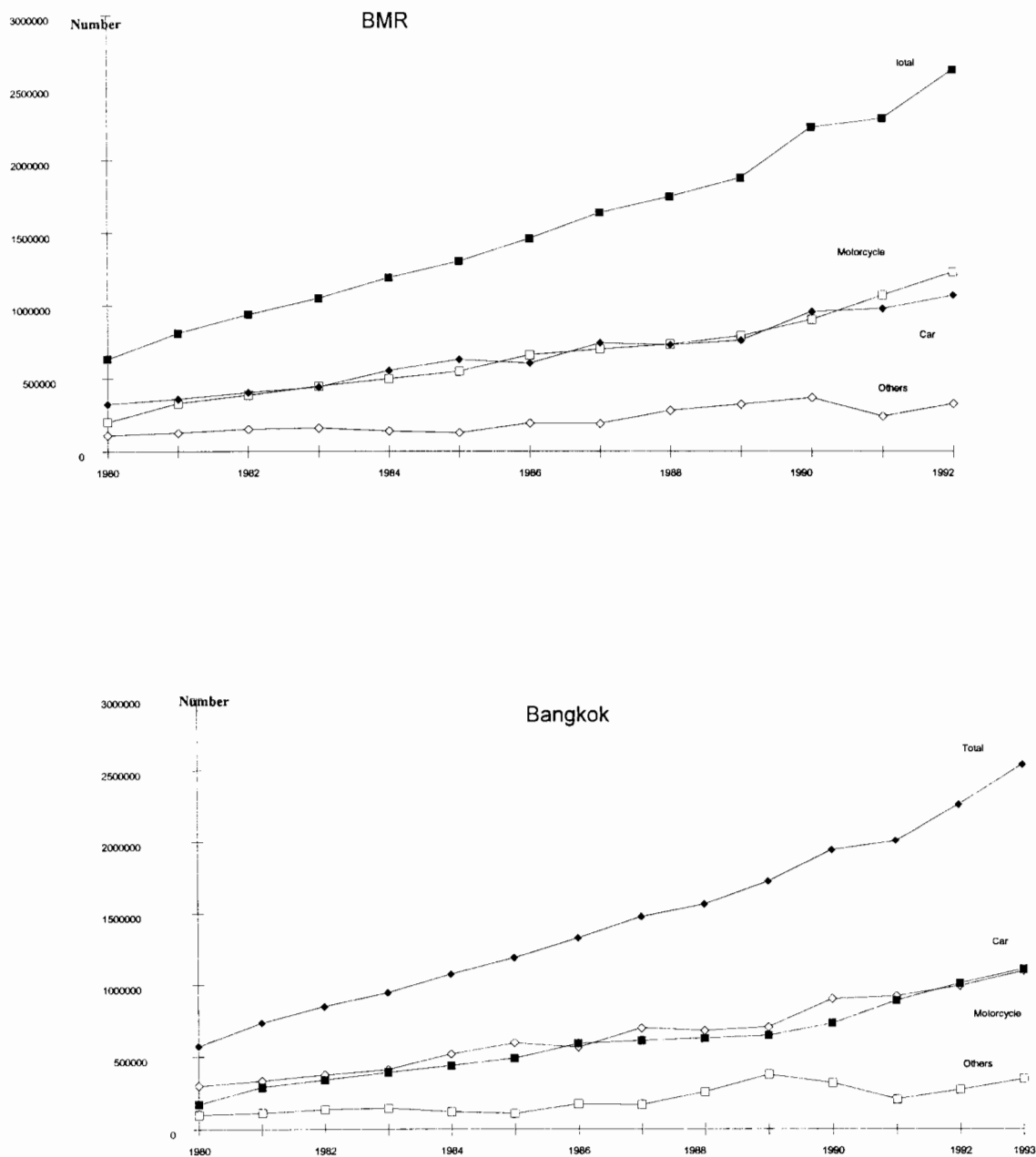
In the Bangkok Metropolitan Region (BMR) vehicles contribute about 60-70 per cent of air pollution (Webster, 1995), while the rest is contributed by industry and domestic sources (World Health Organisation (WHO), 1976). Traffic congestion results in incomplete combustion because of slow vehicle speeds, frequent starts and stops, and “gunning” of diesel-fuelled engines of overloaded buses and trucks. This in turn results in the emission of all sorts of pollutants. It is projected that air pollution will continue to deteriorate in Bangkok if there is no emission control policy, and no limit to the number of vehicles on the road (BMA, 1991; Webster, 1995).

Motorcycles were the largest proportion of all vehicles registered in Bangkok in 1990. Most motorcycles (82 per cent) have two-stroke engines,^{13/} which emit considerably more unburnt hydrocarbons, in both visible and invisible form, than the four-stroke engines of pickups, buses and private cars (IIEC, 1992 cited in Gakenheimer and Gelfand, 1995:24).

Cars and motorcycles comprise the main private transport modes in Bangkok. Trips by private transport account for 51 per cent of all daily trips, the highest in any Asian city; in Tokyo and Hong Kong, private transport accounts for only a third of all daily trips (Poboorn and Kenworthy, 1995). Domestic production of cars and commercial vehicles has risen from less than 80,000 units in 1986 to more than 300,000 units in 1992 (Stickland, 1993). There were 610,404 registered vehicles in Bangkok in 1979 and more than 2.7 million in 1993, somewhat more than half being private cars and 42 per cent motorcycles. During the period 1991-93, vehicle ownership grew by 7.5 per cent per year (TEI et al., 1993) and the numbers of car and motorcycle owners have increased steadily since 1982 (see Figure 2.1). However, high growth rates of private-vehicle ownership would have slowed down, especially after the economic downturn since July 1997.

^{13/} A two-stroke engine has a single cylinder and operates on a mixture of gasoline and lubricating oil. There are two strokes of the piston during each rotation of the engine, compared with four in larger internal combustion engines.

Figure 2.1 Motor Vehicles Registered in the BMR and in Bangkok, 1980-1993*.



Sources: NSO (1990c, 1992 and 1994); data for 1980-1981 and 1987-1988 from Department of LandTransport, Ministry of Transport and Communications (1992).

* Prior to 1989, data for the BMR do not include province Samut Sakhon.

The increasing amount of air pollution is positively associated with the amount of fuel consumption and the number of vehicles in Bangkok. This association is expected to be related with demographic and socio-economic factors. If population increases, the demand for vehicles increases. The demand for vehicles increases because of changes in population size and structure, occupational types, and educational attainment. The following section explores situations of the population in terms of its size and age-sex structure, occupational types, and educational attendance in Bangkok.

2.4 Demographic and Socio-Economic

2.4.1 Population Size and Structure

Economic development in Thailand has led Bangkok and its peripheral provinces to develop more rapidly than other part of the country. This has caused rapid growth in the population of Bangkok and the peripheral provinces (see Table 2.5). It is estimated that the proportion of in-migrants in Bangkok's population increased from approximately 30 per cent in 1990 to 32 and 35 per cent in 1995 and 2000 respectively. In fact, the rate of growth in the peripheral provinces was greater than that of Bangkok during the period 1980-1990, and it is expected to remain higher, though declining, in the current decade and in future (see Table 2.6). In addition, the Bangkok population has spilled to the peripheral provinces during recent times. The attraction of employment and amenities in Bangkok increases the mobility of Bangkok and the peripheral provinces' residents (Browder et al., 1992).

Table 2.5 Population: Thailand, Bangkok and Peripheral Provinces, 1960, 1970, 1980, 1990, 2000, 2010.

Year	Numbers in Millions		
	Thailand	Bangkok	Peripheral Provinces
1960	26.3	2.2	1.1
1970	34.4	3.1	1.4
1980	44.8	4.7	1.9
1990	54.5	5.9	2.7
2000	64.1	7.1	3.7
2010	71.1	8.0	4.6

Sources: Data for 1960-1990 from NSO (1960, 1970, 1980 and 1990a) and for 2000-2010 from NESDB (1991).

Note: Population figures for 2000 and 2010 are projected.

Table 2.6 Population Growth: Thailand, Bangkok and Peripheral Provinces, 1960-1970, 1970-1980, 1980-1990, 1990-2000 and 2000-2010.

Period	Average Annual Population Growth Rate (%)		
	Thailand	Bangkok	Peripheral Provinces
1960-1970	2.70	3.46	2.27
1970-1980	2.65	4.22	2.93
1980-1990	1.96	2.26	3.29
1990-2000	1.62	1.95	3.00
2000-2010	1.04	1.10	2.25

Source: Based on data in Table 2.5.

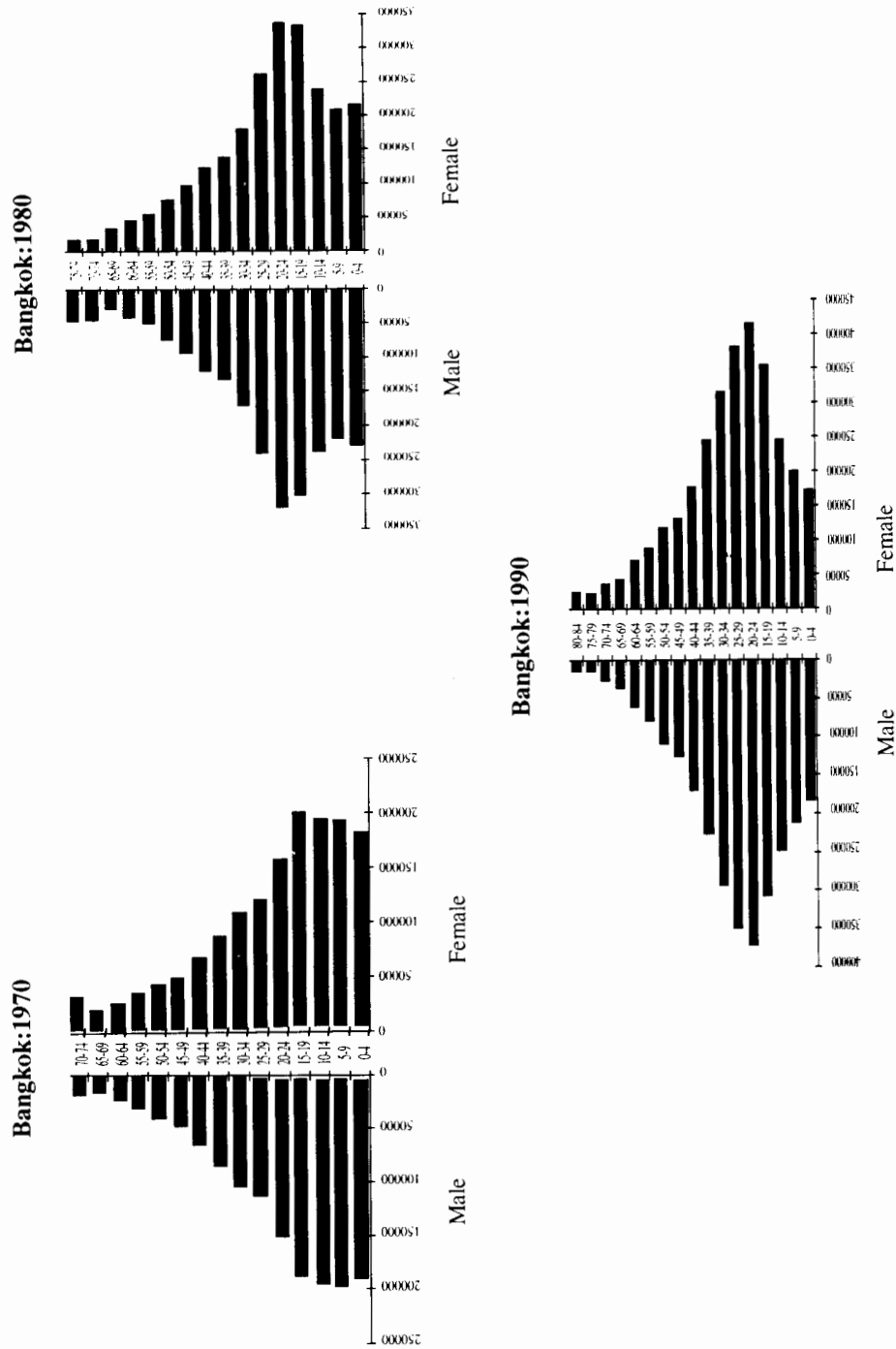
The growth and redistribution of the population between Bangkok and the peripheral provinces, is accompanied by changes in the age structure in Bangkok. The remarkable change in the population age structure during the period 1960-1990 has resulted from a dramatic decline in fertility abetted by an increasingly age-specific migration of young adults, and especially of females aged 15 to 25 (Sternstein, 1995). During 1960, 1970, 1980 and 1990 respectively, the proportion of population aged lower than 15 years decreased from 41 to 39 to 29 to 21 per cent; the proportion of population aged 15-59 increased, 54 to 57 to 66 to 73 per cent; and also the proportion of population older than age 59 ranged from 5 to 4 to 5 to 6 per cent (see Table 2.7 and Figure 2.2). Therefore, there would be fewer children, but a higher proportion of those in the labor force and slightly more elderly in a household. This, of course, affects the household's dependency ratio. It is expected that transportation demand for households with a higher number of children and/or elderly will be higher than for households with lower numbers of children and/or elderly.

Table 2.7 Changing Age Structure of the Bangkok Metropolitan Area (BMA), 1960-1970.

Age	1960		1970		1980		1990	
	'000	%	'000	%	'000	%	'000	%
Less Than 15	874	41	1,185	39	1,351	29	1,267	21
15-59	1,158	54	1,748	57	3,108	66	4,265	73
60+	99	5	141	4	238	5	351	6

Sources: NSO (1960); NSO (1970); NSO (1980); NSO (1990a).

Figure 2.2 Bangkok's Population Pyramid : 1970-1990



Source : National Statistical Office (NSO), 1970, 1980 and 1990a.

2.4.2 Occupational Structure

Thailand has experienced high growth of Gross Domestic Product (GDP) for almost three decades, averaging almost 8 per cent per annum in the 1960s and almost 9 per cent per annum during the period 1975-1979 (The Economist Intelligence Unit (EIU), 1992 and 1993). After 1979 there was some slowing in the rate of growth partly because of an "oil crisis" (Ayal, 1992), but GDP rose markedly during the second half of the 1980s, and the Seventh Plan (1992-1996) of the National Economic and Social Development Board (NESDB) set a target of more than 8 per cent per annum in GDP growth (NESDB et al., 1991). The economy retreated into negative growth after the economic recession beginning in 1997.

The results of economic development partly led to a decreasing proportion of the population of Bangkok in the agricultural sector and an increasing proportion in the non-agricultural sector and especially white-collar occupations (professional and administrative) in Bangkok (See Table 2.8). This change in the occupational structure implies an increase in commuting as employment is separated from the place of residence. These changes caused a marked increase in commuting in recent decades, even considering only the large number of agriculturists who have turned to other occupations and the substantial increase in professional and administrative personnel who are likely not to reside close to their places of work.

Table 2.8 Occupational Structure of Population Aged 15 and Over, Bangkok 1960-1990.

Occupation	1960	1970	1980	1990
Agricultural	19	10	5	3
Professional/ Administrative	6	14	16	21
Clerical/Sales/ Service	43	42	45	41
Transport/Craftsmen				
Production/Labourers	32	34	34	35

Sources: NSO (1960: Table 16); NSO (1970: Table 19); NSO (1980: Table 24); NSO (1990a: Table 22).

Note: Percentages add vertically, so that each column adds up to 100.

The increasing number and proportion of the population in the labour force age group implies a heightening level of commuting to work and also to school because of the need for higher education in order to meet the growing demand for white-collar and skilled workers. A heightened level of commuting also implies longer distances and times of commuting to work and to school, which is linked to increasing vehicle use and, certainly, to the level of air pollution.

2.4.3 Educational Attendance

The changes in occupation and relative age structure of population in Bangkok during the period 1960-1990 suggest a much increased demand for schooling and also commuting. The number of people aged under 15 years increased until 1980 but then fell (see Table 2.7). However, there is an increasing school participation rate of population aged under 15 year. This may be partly because of the reducing number of children, improvement of the family's economy and the extension of compulsory education from level 6 to level 9. At secondary level, a large number of students commute long distances to school and contribute to traffic congestion because there is no effective mass transportation system (Tanaboriboon, and Jin, 1995). The general standard of education in the provinces is markedly lower than that in Bangkok, and only a relatively few specialised schools are located there. Approximately half the university students in Thailand are concentrated in Bangkok (NSO 1990a; Table 19). Students who migrate to Bangkok from the provinces are unlikely to find housing near their places of education and must commute over long distances. The effect of school commuting on traffic congestion generally is revealed dramatically when schools are closed during holiday periods; at these times commuting to work is shortened considerably, even halved (Tanaboriboon and Jin, 1995).

There are positive relationships among levels of air pollution, fuel consumption, the number of vehicles, (which reflects demand for vehicles), and impact of air pollution on people's health. Although the population growth rate of Bangkok started to decline during the period 1980-90 and is even lower than those of the peripheral provinces, the population is still increasing. On the other hand, economic growth has also led to changes in occupational structure towards increasing numbers of people participating in white-collar employment. This precipitates a shift in lifestyle in which people demand more space for housing of a higher quality. This is partly associated with an increasing demand for vehicles for commuting, which, of course, links to increased fuel consumption in transportation and an increasing level of air pollution.

CHAPTER III

Research Objective and Methodology

3.1 Research Objective

The main objective of this research is to study the links between population, consumption and environment. We intend to scrutinize the influences of population dynamics on consumption behaviors, and consequently on environment. The consumption behavior in this study will be studied at the household and individual levels. The wide ranging definition of environment will be limited to atmospheric pollution. More specifically speaking, this research aims to study the impacts of household consumption patterns on the air quality in Bangkok Metropolis, the capital city of Thailand. The case study of Bangkok will be compared with research studies using the same design in other three countries, namely United States, Mexico, and Mali.

Theoretically speaking, there are several factors responsible for air pollution in an area. Natural factors such as geographical and meteorological conditions can play an important role in determining the air quality. Human behaviors, both in the use of machines and technologies in their productive processes and consumption patterns in their daily lives, may be responsible more for air pollution nowadays. In this research study, we will focus on transportation or more specifically the use of vehicles by the population in Bangkok, as a representative form of household consumption behaviors. Thus, we will analyze the relationships between socio-economic and demographic variables of households and transportation and travel consumption behaviors, including their impacts on air quality of Bangkok.

We also have an hypothesis that the independent variables such as socio-economic and demographic factors are influencing attitudes and perceptions which further shape the daily consumption behavioral patterns of population. Thus in this study, we will scrutinize individual perceptions about the population-consumption-environment links. We aim to study qualitatively people's perception of air quality, individual behaviors and household characteristics that pertain to air pollution, and their opinion of how to solve the problem. We expect that the knowledge and understanding from this research study will help in improving the environment in the capital city for the sake of better quality of life of the population.

3.2 Conceptual Framework

To access the objectives of the study of air pollution in Bangkok three main perspectives of population and environment relationships are used; Malthusian and Boserupian perspectives, Multiplicative perspective and Mediating perspectives (Figure 3.1)

Malthusian and Boserupian perspectives imply direct relationships between population and the environment, or between population, technological change and the environment. The Malthusian viewpoint has had a direct influence on the development of the concept of carrying capacity and the Boserupian perspective examines the relationship between population growth, technological change in agriculture and environmental impacts. **Multiplicative perspectives** present the view that population (size, growth, density and distribution) interacts in a multiplicative way with other factors, such as levels of consumption and technology, to have impacts on the environment. One of the most frequently used multiplier approaches is the “I = PAT” equation. Total environmental impacts (I) are seen as a product of population size (P), the level of affluence or per capita consumption (A), and the level of technology (T). The IPAT equation implies that although population, consumption or technology might be considered as independent causes of environmental impact, it is their combined effect which is of most interest. In the study of macro and household level analysis we try to develop an empirical model linking population growth, energy consumption pattern and air quality by using a simple causal model to incorporate and control for the effect of other causal factors such as socio-economic change and changes in technology. The IPAT model used is expressed as follows:-

$$I = P \times A \times T$$

when;

I	=	A pollutant or environmental impact
P	=	Population
A	=	Affluence activity or consumption per capita
T	=	Technology

Mediating perspectives emphasize that social, cultural and institutional factors play a mediating role in determining population-environment relationships. The influence of those factors on population-environment relationships is viewed as multilevel so that layers of mediating variables at the household, community, national and international levels must be considered (Marquette and Bilsborrow, 1994).

Figure 3.1 : Current Conceptual Perspectives on Population-Environment Relationships.

(A)

Malthusian : Population ----- > Environment
 Boserupian: Population ----- > Technology ----- > Environment

(B)

Multiplicative: $I = P \times A \times T$

(C)

Mediating: Social,
 Institutional,
 Cultural factors

Population ----- Environment

Source : Marquette C.M. and Bilsborrow R. 1994. *Population and Environment in Developing Countries : Literature Survey and Research Bibliography*. Preliminary unedited version prepared for the Population Division of the Department of Economic and Social Information and Policy Analysis, United Nations, Secretariat. pp.3-6

3.3 Sources of Data at Macro and Household Level Analysis

3.3.1 Source of Data

This study is based on two sources of data:

1. The first source is the Household Socio-economic Survey, 1994 conducted by the National Statistical Office. The survey is conducted every two years. It is a nationally as well as regionally representative survey.

Table 3.1 Percentage Distribution and Number of Selected Variables.

Variables	Percent	Number
Age		
15-29	28.0	534
30-44	37.8	720
45+	34.2	651
Gender		
Male	72.2	1,376
Female	27.8	529
Education		
No education	4.9	94
Primary	54.0	1,027
Secondary	19.6	372
Tertiary	21.5	409
Occupation		
Professional/Admin.	9.3	177
Clerical	8.6	163
Sales/Service	27.7	525
Production	37.7	714
Other	16.6	315
Migration status		
Yes	53.2	1,014
No	46.8	891
Income (Baht/Month)		
Less than 7,000	26.4	503
7,001-20,000	48.7	927
More than 20,000	24.9	475
Family structure		
Extended	28.3	539
Nuclear	52.9	1,008
Single	18.8	358
Dependency ratio		
0	48.2	903
0.1-0.5	26.4	495
More than 0.5	25.4	475
Presence of car		
1 +	76.6	1,459
None	23.4	446
Presence of motorcycle		
1 +	79.8	1,520
None	20.2	385

Source: Household Socio Economic Survey, 1994.

Table 3.1 provides information on the percentage distribution and number of cases of selected variables employed in this analysis.

2. The second source is the Report on Thailand's Pollution Situation by Department of Toxic Control, Ministry of Sciences, Technology and Environment. The amount of air pollution emission by mode of transportation measured in terms of ton/year are taken from the second source of data. The data on the air pollutant SPM is employed for this analysis, (see Table 3.2)

Table 3.2 Total Pollution Emission (tons/year) in Bangkok, 1994.

Mode of Transport	SPM
Small and Medium car	3,465
Motorcycle	15,187
Total	18,652

Source : Department of Toxic Control, 1996.

3.3.2 Variables and Variable Measurement

The level of air pollution emission per household is calculated through household expenditure on gasoline, which is assumed to have a positive relationship with emission of pollutants. The level of pollution emission is assumed to be a proxy variable of gasoline expenditure. Therefore, explanations for the level of pollution emission are related to the use of car or motorcycle by the heads of households with different demographic, socio-economic and household characteristics. The household gasoline expenditure is employed from households that have a car or a motorcycle or have both.

Expenditure on gasoline is taken from households that own cars or motorcycles or both. The gasoline expenditure data was not separated into gasoline expenditure on cars or motorcycles. This is no problem for a household having either a car or a motorcycle, but it is a problem for households that have both car and motorcycle. So, in the later case, we create a predicted gasoline expenditure on car and on motorcycle by using household compositions and head of household characteristics as predictors, and then we calculate real expenditure spent on car and motorcycle from the proportion of predicted expenditures. Finally, we get total gasoline expenditure spend on car and motorcycle. The sum of gasoline expenditure from 1,905 households is

extrapolated to be come the sum of gasoline expenditure for about three million households in Bangkok.^{14/}

3.4 Focus Group and In-depth Interviews

In order to meet the research objectives, qualitative research methodologies, namely focus group discussion and supporting in-depth interview were used. The strength of these qualitative techniques is their ability to supplement the quantitative overview of the situations effectively, and to uncover the unanticipated links among population, environment and consumption variables. The methods help in gaining understanding about the reasons for trends and factors affecting individuals' attitudes. The qualitative data are collected in the areas of perceptions, attitudes and views about the future related to the direct and indirect causes and consequences of pollution. Information collected also includes people's consumption behaviour linked to the generation of air pollution and people's commitment to solve the problem.

3.4.1 Constructing Interview Guidelines

In preparation for the focus group and in-depth interview studies, interview guidelines were carefully constructed. There were two steps involved in this process.

The first step was to draft the guidelines, both for the focus group study and the in-depth interview. The first drafting was done by the researchers, following the objectives of the study and having the targeted interviewee in mind. The researchers met to discuss the total picture and the detail of the guidelines. It was agreed to use seventeen main questions for the focus group study and nine questions for the in-depth interview guidelines. The content of the questions and guidelines consists mainly of the people's perceptions and attitudes on the link of population and air pollution, its relation to the individual's behaviour, technological change, and aspects of social organization that are connected to solving the problem.

The second step was to pretest these questions and guidelines. The first pretest was made at the Institute for Population and Social Research

^{14/} It is important to note that, there are two sources of possible error in this study. First, sampling error may occur when the total gasoline expenditure of 1,905 households is expanded to represent the gasoline expenditure of about 3 million households in Bangkok. Second, non-sampling error may occur when we measure the amount of air pollution emission in Bangkok only. Actually, cars and motorcycles from peripheral provinces coming in and out of Bangkok have also emitted air pollution. Conversely, some pollution caused by Bangkok-based vehicles occurs outside the city.

itself. A research staff member was the moderator of the focus group session with five participants (three males and two females) invited from different departments of the University.

The session was conducted with all project researchers observing the process. The validity and reliability of the questions was later discussed among the researchers and the participants. The results were used to improve question design and the moderator's technique.

A similar process was followed for the pretest of the in-depth interview guidelines. The pretest lasted about forty minutes. The improvement of the guidelines and the process of interview was made in the same manner as the focus group session pretest. This also included the discussion of the guideline substances, flow of conversation and interview time.

These questions and guidelines were later modified further as the actual fieldwork started. The modifications were only on minor issues. The emphasis of different questions, however, varied as the fieldwork went on. The flexibility of the instruments was kept on the principle that unanticipated issues could be investigated.

3.4.2 The Selection of the Focus Group Participants and the Key Informants

The selection of the focus group participants and the key informants was purposive. For the focus group study, a total of six groups were included. All of the participants were from Bangkok Metropolitan areas. The six groups were classified into three income levels (high, medium and low) and two age brackets (18-29 and 30-59). In each group, there were eight participants, four males and four females. The three income levels were operationally defined as follows. The low income group were residents of a slum area in Bangkok. The medium income group were office workers and some young professionals whose salary ranged from about 15,000 to 25,000 baht per month. The high income participants were recruited with salaries of more than 25,000 baht per month.

A total of 20 key informants were included. Fifteen key informants were from government offices and state enterprises, four from the private sector, and one from a non-government organisation. The position of these key informants was generally high in the administrative structure. They were at the level of director or manager or chief of departments that are involved with the environment and related issues under study.

3.4.3 Analysis of the Data

The focus group sessions and the interviews of key informants were tape recorded with permission from the participants and the interviewees. The tapes were transcribed into texts. Content analysis was carried out. The researchers met to discuss issues under question. The topics and sub-topics were then identified. The writing up of reports on each of these topics was done with coding from the transcriptions to highlight the issues under investigation. Names of all respondents were removed. Strong generalisation of the situation was avoided but broad assessment was possible. Linkage to the quantitative study was made as much as possible. Comparison across socio-economic groups and different administrative offices was made carefully. While the analysis was mainly qualitative, the results were meant to identify the different possible phenomena rather than to test the hypotheses on the causal link of population, environment and the consumption behaviour. However, the results of qualitative and quantitative analysis are mingled. We did not put them in two different chapters as the merging of the two methodologies should constitute our best resource.

CHAPTER IV

Research Results

4.1 Health Impact of Air Pollution

Air pollution in Bangkok is caused partially by the rapid increase of population in Bangkok due to transformation of the nation's economic structure switching from agriculture to industry. Migration of workers from rural areas to Bangkok results in more scattered residential areas around Bangkok causing transportation problem as workers commute to the center of the city where business areas are located. Incomplete road networks which depend mostly on main roads without adequate supporting roads in combination with the ineffective mass transportation system, lead to unavoidable traffic congestion. The outcome of this traffic problem is the decline of air quality in Bangkok which gradually affects the quality of health for all residents of Bangkok.

Air quality is worsened by transportation and traffic. This health-threatening problem can be measured mainly by three components, namely Suspended Particulate Matter (SPM) Carbon Monoxide (CO) and Lead (Thai Environment Institute, 1994). Previous studies found that different vehicles emitted toxic pollutants in different amounts. The Department of Toxic Control (1994) revealed that small vehicles such as cars, taxis, local motor tri-cycles, pick-up trucks, small pick-up trucks and motorcycles were the main sources of carbon monoxide and hydrocarbon production. Heavy vehicles produced a large amount of oxides of nitrogen. SPM was emitted the most by big vehicles and motorcycles.

4.1.1 Breathing SPM

SPM consists of molecules suspended in the air. SPM of large size is less dangerous than small SPM because the small SPM can enter the respiratory system. These small SPMs include black smoke from diesel engines, smoke from cigarettes, smoke from burning and from some kinds of industry. The Japanese International Cooperation Agency (JICA) (1990) found that 40 per cent of SPM in Bangkok was black smoke while the rest was dust from the road, soil and salt from the sea. Therefore, SPM has black color and a salty taste. The danger of inhaling SPM is to cause allergic response and respiratory diseases. It is well recognized that SPM in big cities contains

cancer-related component such as PAH (Polycyclic Aromatic Hydrocarbons). It was also concluded in a document of the Institute of Public Health Research that air pollution certainly affected health. This conclusion was confirmed in many studies done in Thailand and other countries. Death rates of urban populations with serious air pollution are higher than death rates of urban populations with less air pollution, at a statistically significant level. Studies in the United States (Vena, 1982 and Henderson, 1975) found that lung cancer and cardiopulmonary diseases were related to the level of small SPM in the air. In Thailand, a previous study (cited in Punyaratabandhu et al., 1997) found that bus drivers in Bangkok have higher CO in their blood after work. They indicate signs of chronic headache, muscle pain and eye irritation during work. This qualitative study also confirms that dispersion of SPM in the air is dangerous for health. The increase of SPM and smoke from public vehicles, buses, motorcycles and dust from construction turns air pollution into a critical point for Bangkok residents. As dispersion of SPM is scattered throughout the city, a large number of the sampled population living in Bangkok feel that they develop illness related to breathing and respiratory diseases.

Air pollution is more serious in areas with heavy traffic congestion. At present, almost every part of Bangkok has a traffic problem. The more severe the traffic problem is, the more polluted the air is, and this substantially affects the health of the population. Quality of life is lost through more hours in bus travel. Air pollution in Bangkok is now much higher than the standard safety level. The current study found that commuting in heavy traffic areas even on occasional basis can cause illness such as throat pain, frequent sickness and mental stress.

"The serious problem is SPM, there is a lot and the amount of toxic smoke is very high, so high that I feel it will become critical and is dangerous for children. Even though we are adult we are also affected. When we breathe, we feel the air is no good. Some people are allergic to dust. When they get home, they itch and they have quite serious rashes. Now, many areas are having construction work. Traffic jam areas are more serious than other places, but overall it is disseminated, it is not stable"

(In-depth interview. Female. Department of Planning, Public Facilities and Environments)

"When I first came from up country (to live here), I never had allergy. Now going to work every day, I have to use a handkerchief to cover (my mouth and nose) every day no matter whether I travel by boat or vehicle. When I return

home, and I looking at the handkerchief it is totally black ! If the handkerchief is this much (black), what about what I can't see, inside me. Now my nose, it is like catching cold but it is not a cold."

(Focus group. Low income group. Age 18-29)

"If we go outside, commuting regularly, we have to use (cloth to protect nose and mouth). For example, if we pass through Silom (road), there will be the ceiling up there where they are constructing the sky train. I think that will be the end of it. The toxic smoke will just having around up there. It won't disappear easily. It will be smoky and smelly.

(Focus group. High income group. Age 18-29)

"I suffer from bronchitis infections all the time. If I go to Yellow Bridge near Chinatown, for a number of days in a row, then I feel sick. My throat hurts, and I cough all the time. At first I did not recognize the cause. (Then noticed that) if I did not go there for a while, I had no problem. If I go outside the city for several days, I feel very fresh, but when I get back into the area for 2 to 3 days, I feel ill again. I have a lot of phlegm. I have it all the time."

(In-depth interview, Male, Petroleum Research Center)

"Toxic smoke such as smoke, dust, smoke from buses, taxis, motorcycles, dust from roads, construction and smoke from engines, industry, they are very problematic. When we go to areas where they are building highways, we feel uneasy, we cannot breathe, we are ill. When we pass Pratunum (a famous clothes market in Thailand), dust from construction gets through our nose. The car is also damaged by paint, and cement."

(In-depth interview. Male. Bangkok Mass Transportation Organization)

In addition, illness from respiratory system disease ranks as one of the ten leading causes of illness for people of Bangkok for many consecutive years. In the latest information for 1993, this illness became the first leading cause of illness in Bangkok (table 4.1)

Table 4.1 Morbidity Rate for Respiratory Disease for Bangkok Residents, Year 1986 - 1993.

Year	Leading cause	Rate per 100,000
1986	Rank # 2	166.54
1987	Rank # 2	182.80
1988	Rank # 2	193.45
1989	Rank # 2	226.85
1990	Rank # 3	176.34
1991	Rank # 2	201.76
1992	Rank # 5	189.60
1993	Rank # 1	223.73

Source : Punyaratabandhu, et al., 1997.

At present, SPM is still a serious problem in Bangkok and apparently its severity is increasing, partly because the traffic is more congested. Vehicles have to speed up and to restart the engine more frequently. Smoke emitted while speeding up the engine is more than when running at a normal speed. At the same time, there are more high buildings to block the natural dispersion of air and smoke. Therefore, SPM is accumulated. The government, in 1992, tried to improve the quality of fuel oil, especially diesel oil, by reducing the temperature during refinement from 370° C to 357° C, thus allowing the oil to be burnt more easily to reduce black smoke. However, the problem has not been lessened.

4.1.2 Carbon Monoxide (CO) : The Invisible Killer

Carbon Monoxide is a gas without color, smell and taste, and is produced from incomplete combustion in every kind of vehicle using gasoline, if the ratio of air to fuel is less than 14 : 1, or if there is a clogged filter or incomplete combustion. When inhaled, CO will cause hemoglobin to be temporarily ineffective. The combined carboxyhaemoglobin causes dizziness and is dangerous for patients with ischaemic heart disease.

Participants from focus groups felt that black smoke and toxic smoke in Bangkok was at a dangerous level, threatening health for all people regardless of their income. The lower income group is directly affected by toxic fumes and black smoke, especially toxic pollutants which are invisible but very dangerous to health causing them to experience faintness and

giddiness. While participants who commuted by bus were the most affected, participants with medium and high income think that people in general are also affected from these toxic pollutants. In-depth interviews point out that everyone is at risk for respiratory diseases and abnormal blood circulation as carbon monoxide is dispersed throughout Bangkok.

“Toxic smoke we cannot see but dust we can feel it periodically. When I sit in a bus for a long time, when I get home, I am very tired. I don’t want to do anything. I think when I watch T.V. that I did not do anything hard. I did not drive, why am I so exhausted? It is nothing else. It is the air that I breathe, that makes me drowsy. Some day I don’t notice. I don’t know what happens to me but I feel tired.”
(Focus group. High income group. Age 29-59)

The amount of highly condensed carbon monoxide, when being burnt is very dangerous to health. CO resulting from incomplete combustion of diesel engines and other vehicles is three times higher than the standard limit, causing 900,000 people to suffer from respiratory diseases, and another 1.3 million people to have headaches and faintness, 300-900 people per year to develop heart disease, and the I.Q. of 7-year-old children to decrease 3-5 points because of the deterioration of the brain (Daily News 1994, December 22). This study also found that CO has serious effects on health and on quality of life especially for vendors on streets and traffic policemen who work in the areas congested with traffic.

“Vendors on streets who have to earn their daily living have to face these outdoor pollutants. School students have to face toxic smoke and dust. I feel sympathy for passengers who have to use these roads, and I feel most sympathy for traffic policemen who work in the field. They become ill, first with bronchitis and then with lung complaints. Some developed cancer and died.”
(In-depth interview. Male. Consultant of Bangkok Metropolitan Mayor)

As CO occurs only in areas with highly congested traffic, from incomplete combustion and where high buildings disrupt the natural dispersion of air, the problem is serious in areas with high buildings such as Bumroongmuang, Silom and Saphan Kwai.

CO pollution has tended to decrease in severity since 1992, when the government launched the policy of catalytic converters to be installed in every new car using gasoline. Its benefit is to change CO to CO₂ which is not harmful to health although it is a greenhouse gas. Methyl Tertiary Butyl Ether

(MTBE) was also introduced to substitute for lead in fuel oil. These substances have oxygenating components which increase complete combustion and decrease CO emission.

The technology of engines has also been improved, such as by the use of injection systems controlled by computer. These facilitate appropriate burning of fuel in different stages of driving. Changing the engines of old vehicles is also well utilized in Thailand, because used engines with higher technology are still cheap.

4.1.3 The Fight against Dangerous Lead

Lead, as a toxic substance in the form of small molecules less than 1 micron (1 per million cm^2), is emitted from the smoke of cars using gasoline with lead impurity. Lead is an 'anti-knock' substance that improves engine performance. When it is inhaled or consumed into the body, it will attack the haemoglobin creation system causing anemia, nervous disorder and nervous deterioration especially in children. Some industries such as manufacturing lead fuses, ceramics, batteries, and paint also produce lead,. Presently, there are new technologies reducing the use of lead. Unleaded gasoline uses MTBE or alcohol instead of lead. There is also unleaded paint. Since 1991, emission of lead has tended to decrease because of reduction of lead quantity. On January 1, 1997, use of lead in gasoline was prohibited. The level of lead found is now lower than the standard limit of 1.5 microgram per cubic metre.

Given the threat to human health posed by suspended particulate matter and carbon monoxide, and their prevalence in Bangkok, it is clear that the emission of these substances beyond safe standards needs to be curbed. Fortunately, the threat posed by lead has been effectively reduced.

4.2 Behavioral and Structural Causes of Urban Air Pollution

Following from the background information of air pollution in Bangkok discussed in Chapter II, this section explores causes of air pollution. Firstly, population and socio-economic variables are investigated to describe their relationships with fuel consumption and the level of pollution emissions (using Suspended Particulate Matter (SPM) as an example). The population factors consist of the demographic, socio-economic and household characteristics of the head of household. Secondly, other causes of pollution are examined. These are : transportation modes, pattern of land use and land

prices, and government policy. Data from both quantitative and qualitative approaches are analysed.

4.2.1 Demographic and Socio-Economic Factors

Chapter II has examined various demographic and socio-economic factors as well as the extent of urban air pollution at the macro level. This section investigates these situations at the micro level by analysing the amount of pollution emission per household (dependent variable) in relationship with head of household's demographic, socio-economic and household characteristics (independent variables). However, these variables are related to each other, for example, those with high income almost always have a high level of education and occupational status. Therefore, a multivariate technique, multiple regression, is employed to examine the net effect of each independent variable on the dependent variable.

Table 4.2 indicates that about 29 percent of the variability in the level of SPM could be explained by the independent variables. Among independent variables, only gender, occupational status and income of household head, and family structure significantly affect the amount of pollution emission with other things being equal.

Male heads of household are likely to emit about 2.7 kilograms more SPM per year than female household heads. Household heads who do sales/service work, and production occupations produce about 3.7 and 4.6 kilograms less SPM per year than those of professional or administrative occupations. Each 1,000 Baht per month increase in income causes an emission of pollution increase at about 0.1 kilogram per year. Extended and nuclear families are likely to produce approximately 5.3 and 3.5 kilograms more SPM per year than single individual. People from single households may not need to use cars or motorcycles as much because they usually move close to their workplace, which is due the fact that they are not tied to a family (DaVanzo, 1981).

Surprisingly, education does not have a significant relationship to the use of a car or motorcycle for commuting after all variables are taken into account. It is likely that occupation and income are both highly related to education, and are the major processes operating in this case. In other words, education leads to high status jobs and higher income rather than changing attitudes toward the use of cars or motorcycles (Punpuing, 1996).

Table 4.2 Ordinary Least Squares Regression Model of Pollution Emission (Kilogram/year).

Characteristics	PM-10
Age (In Year)	0.0365
Gender	
Male	2.7167 *
Female ^{a)}	-
Education	
No education	-1.3905
Primary	-0.7023
Secondary	0.6254
Tertiary ^{a)}	-
Occupation	
Clerk	-0.6305
Sales/Service	-3.7430 *
Other	-2.8808
Production	-4.5690 **
Professional/Admin. ^{a)}	-
Migrant	
Yes	-0.9616
No ^{a)}	-
Income (Baht/Month)	0.0001 **
Family Structure	
Extended	5.3228**
Nuclear	3.4517**
Single ^{a)}	-
Dependency Ratio	-1.1144
Intercept	1.8218
R ²	0.2936

Source: Household-Socio Economic Survey, 1994.

Note: * = Significant at level 0.05

** = Significant at level 0.01

^{a)} = Reference category

The definition of “migration status”, which uses 10 years as a cut off point, would affect the lack of relationship between “migration status” and level of SPM emission. It seems that these migrants behave more or less the same as local people, especially in terms of where to live and work. Therefore, there is no difference in the decision to use cars or motorcycles between “migrant” and “non-migrant” heads of household.

Overall, this analysis indicates compatibility between variables at the macro and micro level. For example, the positive relationships between “population size” and “affluence”, and environmental impacts in the IPAT model, are compatible with the positive relationships between “family structure”, “income or occupational status” and amount of SPM emission.

Findings from the quantitative data give rise to broad conclusions on the relationship between selected population factors and the level of air pollution. It is essential to understand further the people’s perception and attitudes toward air pollution problems. This is accomplished through the qualitative approach.

The process of development in Bangkok has been associated with an increase in non-agricultural occupations, especially in professional/administrative occupations. At the same time the government plans to extend the compulsory education level from 6 to 9. This could lead to more people participating in higher occupational status and earning higher income than in the past. Those with high educations and incomes are likely to live far from the workplace, and this requires private modes of transportation in order to save the time of commuting by bus. Therefore, those with high incomes are likely to consume more, and are expected to produce more pollution. This conclusion is supported by this study. However, it is argued that those with high incomes may consume more, but produce less pollution because they can afford high technology, which is always designed to reduce pollution. Findings from the qualitative study exploring this argument are in section 4.3.2.

4.2.2 Poor Public Transportation Mode

It has been reported that about 80 to 90 per cent of commuters using vehicles in Bangkok travel by ordinary public bus (Daniere, 1993; Thai Rath, January 24, 1995). Though the service is slow, overcrowded and unreliable, it is inexpensive (NESDB et al., 1991). During the period 1984-92, as the population of Bangkok increased by some 20 per cent, the number of ordinary public buses actually decreased by 5 per cent, while the number cars and motorcycles increased 92 and 137 per cent respectively (Pianuan

et.al., 1994). The government has been accused of not even trying to improve bus transport in Bangkok but, in fact, there were attempts to increase the numbers of buses, especially air-conditioned buses, to encourage the provision of company buses and school buses, to modernise bus depots, to designate bus ways and bus lanes, and to rearrange bus routes. Some of these attempts have had a measure of success - there are increased numbers of air-conditioned buses and school buses - but some have failed. For example, the BMA's school-bus programme evoked the remarkable criticism that the government did not understand Thai culture; that the majority of Thai parents are very much concerned with the safety of their children, and prefer to drop them off and then pick them up at school themselves (Daily News, December 22, 1994; Siam Post, December 13, 1994). The school-bus fare was relatively high, so where there were several students in a family it was more expensive than taking them to school by car. In addition, the number of ordinary public buses decreased because the government concentrated on improving other modes of transportation within a limited budget.

It is not only the population, demographic, socio-economic characteristics of an individual, and household composition, but also household fuel consumption behaviour which is associated with the level of air pollution. It is expected that high use of private vehicles will be related to high fuel consumption and households with more children or elderly, or in other words, a high dependency ratio, are more likely to use cars or motorcycles for the comfort of their family members. In Bangkok, households with school-age children are more likely to use cars because parents are very concerned about their children's safety and prefer to drop off or pick up school children along the way from home to workplace. The parents' use of private transportation modes are not only for children's school, but also for recreational purposes and other social activities (Heggie, 1978).

Findings from the qualitative approach shows that people use private vehicles because of poor public transportation, occupational needs, and for convenience. People also stated that choice of transportation mode may be linked to their preference and satisfaction.

"Because we have to spend a lot of time on the road, we look to our convenience. So, we bought a car. We knew that when our car was added, the traffic would increase... but the traffic is already congested if our car wasn't added (therefore, it doesn't matter to add one more car on the road)..."

(Focus group. Middle income group. Age 18-29).

The maintenance and selection of type of vehicle, especially the two-stroke motorcycle are recognised as the causes of air pollution.

“The people who use cars are connected to air pollution. Two-stroke motorcycles produce white smoke, and the buses which do not get good care or maintenance produce black smoke. People are both the vehicle users and produce pollution. The important causes of air pollution are no protection, no care and no concern about the environment. They cause pollution”

(Indepth interview. Male, A key informant. Bangkok Mass Transit Authority)

However, there is some doubt whether people will use mass transportation or not. A key informant from our study pointed out that

“People’s consumption behaviour is that they love convenience and comfort. But sometimes, it’s necessary. Take air-conditioners for example. In the future the temperature of our world will get higher, and we cannot live without air-conditioner. Now if the temperature is 41,42 (celcius) or what not, it is rising, this is necessary. But for the car, it’s both necessary and unnecessary, it’s difficult to say. It’s necessary because our public transportation is not good...They don’t believe that the electric train under construction will absorb the poor because of the high fare. The rich or those who have some money and already own cars they will not use the electric train. Therefore, the electric train may become a monument hanging in the sky for the people, but will there be anybody to use it?”

(Indepth Interview. Male. A key informant, Division for Environmental Technology).

The poor service of public transportation modes stimulates the use of private transportation modes. Together with people’s preference and satisfaction, this leads to the high level of car use in Bangkok.

4.2.3 Unplanned Land Use Haphazard Land Prices

The need for space to accommodate population and economic activities in Bangkok causes expansion outward because land available around the city centre is for enterprises which need and can afford a central location, and for relatively wealthy residents (NESDB et al., 1991; Peerapun and Silapacharanan, 1992). This is because high land prices are related to the best public facilities being located in these areas. Expansion is occurring in all directions from the city centre without any land use plan.

During 1958-1988, the built-up area of Bangkok had expanded from 96 to 637 square kilometre (Punpuing, 1996). This has spilled over the boundary of the Bangkok into adjacent peripheral provinces and particularly provinces Nonthaburi and Samut Prakan. During the period 1974-1984 about 45 per cent of land converted to urban use was developed within a band 11 to 20 km from the city centre (the Central Railway Station, CRS), but during the period 1984-1988 about 45 per cent of land converted to urban use was developed beyond a distance of 30 km from the city centre (Dowall, 1992). The most important process of expansion is ribbon development, in which the built-up area expands along the routes of the major roads extending from Bangkok. The expansion of built-up areas has changed patterns of land use, particularly from land for agriculture to residences and workplaces. The distribution of residences and workplaces is shaped by land prices, which reflect land ownership patterns (NESDB et al., 1991).

In Thailand, housing estate development has started since the 1970s, and at present comprehensive housing developers account for approximately half of all the land converted to urban use in Bangkok (Changrien and Stimson, 1992). Since the predominant aim of private-housing developers in Bangkok is to provide relatively spacious residences for high- and middle-income families, housing estates are often located in the outer areas of Bangkok and the peripheral provinces, where land prices are relatively low (Koanantakool and Askew, 1993). High land prices in the inner city not only encourage relatively well-off residents to sell and relocate in newer, less central areas of the BMR, but also force inner-city slum dwellers to peripheral locations. In short, the residential and workplace developments just lead to increasing and increasingly lengthy commuting in the BMR.

Currently, in 1997-1998, the economic crisis in Thailand has affected the real estate business, and the land price has dropped dramatically by about half, although, rapidly rising land prices, and expanses of “unused” land within the built-up area in the past suggests that vehicle demand as well as fuel consumption for commuting have increased. This is because residential areas have spread to the outer area, but workplaces remain concentrated in the inner area of Bangkok.

Findings from the qualitative study point out that mixed land use between residential areas and workplaces causes people to move out. It also indicates that people who own land in the inner area are more likely to sell their land to investors. People are aware of land use planning, however, they are not clear about how it works.

“ I think where there is the residential area, they shouldn't allow for high rise buildings with 15, 16 or 20 storeys.. People who own the land are not the ones who permit that construction, only the investors. Therefore, they have to determine where is the residential area, and the businessmen

cannot build a high rise building there. "Soi Aree" used to be a residential area, but now it is probably not a place to live any more"

(Indepth interview. Male. A key informant. Division of Health Promotion and Environment).

"Land use planning: I used to think about it. The Ministry of Interior should know the size of the area before starting to build something. It appears that there should be a land use plan, but the government didn't have one... They have it but there is no continuity".

(Focus group. Middle income group. Age 30-59).

"It's a city planning matter because Bangkok is the centre of everything, centre of government, centre of economics. There are important pull factors ... Bangkok keeps on expanding, they try to develop until the 8th Plan, they started thinking during the 5th Plan, try but not succeed. So, they let Bangkok grow without nothing to accommodate appears until the 6th, 7th, 8th, Plans, they implement mass transit ..."

(Focus group. High income group. Age 30-59).

4.2.4 Confused and Delayed Transportation Policy due to Political Interest

Many of the solutions to transportation problems in the BMR which have been proposed by different consultant groups over the years have not been implemented, though planners and engineers agreed these proposals were appropriate (Penner, 1992; Daniere, 1993). The formulation of a comprehensive transportation policy was also long delayed because of the absence of any authoritative organisation with clear responsibility for the co-ordination of various transportation projects (Stickland, 1993; Gakenheimer and Gelfand, 1995). Ten government organisations have responsibility for land transportation, each with its own objectives.

Four separate organisations are involved in providing and regulating public transportation. And at least three organisations are responsible for traffic management. These organisations promote their own projects based on their own policies and priorities: the organisation responsible for road construction wants to build as many roads as possible, whereas the organisation charged with building expressways wants to build as many expressways as possible. The best example is that two political parties within the government coalition, in power from July 1995 until late 1996, had responsibility for traffic solutions. One political party was responsible for traffic in Bangkok, and the other for traffic in the nearby provinces. The "solutions" that they implemented in their respective areas led to complaints

by the His Majesty the King that they were just passing the congestion between them, and this resulted in a promise by the Prime Minister of better co-ordination (The Nation, August 18, 1995). At present, only one political party takes care of traffic problem in Bangkok and the nearby provinces.

Participants from focus group discussion and indepth interview perceived that the political interest was one cause of the problem. The government does not have good management and honesty.

R.: "People do not have enough knowledge. So (we) need to bring people with knowledge to do the administration. (But) those who have knowledge may not do the right (righteous) thing. There is quite a lot like this. The more they have knowledge, the more they can zig - zag (go around the rules)."

Y.: "We must have a system of checking."

R.: "Things that are better might get worse."

C.: "This is because political parties cannot combine (collaborate). This party has one policy. Another party has other policy. They take turns (switching back and forth) being the government. The policy keeps changing. It never continues unchanged. For instance, today cars turning left can have four passengers (a car with four passengers has the right to take a left turn into the bus lane), uh..., tomorrow no, it is not like that anymore. There is no continuity. It stops then it starts again. This does not lead us anywhere. We got stuck here."

(Focus group. Middle income group. Age 18-29)

T.: "During the period of the good Governor Chamlong, we tried to solve the traffic problem. The vision of those days was far sighted, I don't know. But now we took out the fly-over bridge. Another story is the bridge at Bangkhaen and Kaset. By this time, he (government) who signed the contract to hit (take out) the high-way bridge, is not pure (honest). Such a person like acted dishonestly. He signed the contract with company without knowledge to the people to hit (take out) the high-way bridge. Between vision and honesty, which you prefer."

C.: "Let me tell a story why we have to build a fly-over bridge. According to engineering principles the main road bridge should not have the entrance sloping up. The speed will be down. But the (engineering) principles were in conflict with the contract signed by the one person. The policy point of view ... not transparent."

(Focus group. High income group. Age 18-29)

V.: "Like the road. Usually for building the road we use (the steel) of 8 quarterinches. When they actually come (to build

the road), it is only 5 quarterinches. After 3 or 7 years they quickly ask for budget to rebuild it again. This is because they got some corrupt payment.. That's why they accepted. Certainly, dust pollution results."

P.: "Contractors received a sub-contract from the telephone authority.....They dug up the concrete (road).....When they finished, then they just patched the surface. They come to create pollution,they come to dig, then patch it up again. When they have projects they come to dig again."

P.: "There is no coordination (among telephone, electricity and waterwork authorities). They did lousy jobs. Telephone, waterwork, electricity authorities okay, I will dig. I will lay waterpipe, you do the electricity. But here, the waterwork contractor comes to dig first, then the electricity people come, after the electricity is finished then oh oh the telephone comes again."

(Focus Group. Low income group. Age 30-59)

The causes of air pollution seem to be complicated, involving the behaviour of individuals in households and families right up to the government policies on transportation and communication, including other apparently irrelevant factors such as land use patterns and land prices. Any measure designed to solve the air pollution problem should take these various factors into consideration. It is clear that a better mass transportation system is urgently needed for this capital city. Concerning the mass transportation in Bangkok, despite its slowness in starting the project, the system of fly-over and underground electricity trains is under construction at present and part of the project is scheduled to be completed in the year 2000.

4.3 The Dynamics of the Link between Consumption Behaviour of the Population and Air Pollution

4.3.1 Rapid Urbanization and the Extremely Congested City

Results from the qualitative study focus on the root of the problem that Bangkok Metropolis is the only main center of business and development. The economic pull of Bangkok together with the rapid transition from agricultural to industrial economy induces an influx of labor migration even more than in the past. The rapid urbanization of Bangkok has been mainly due to in-migration. Both temporary and permanent migrants now reside in crowded areas of Bangkok. The daily commuting patterns

become numerous. The objectives as well as the routes of communication are also more complicated.

Findings support the relationship between population density and air pollution. They show that migration is one of the important but indirect factors that worsen the air pollution problem. Migration is linked to an increase in population and rising demand for commuting and transportation.

“There is no migration that causes air pollution directly. Only the problems of population density. The urban areas couldn’t expand to accommodate the rapid increase of population. Population density increased, the need to commute increased. But if we said air pollution isn’t produced by individuals, indirectly they do need more buses, more commuting. The air pollution will increase too”.

(In-depth interview. Male, A key informant Toxic Control Department).

“People who migrate are another cause that worsens the problem. It brings about more traffic because Bangkok is a centre of everything. Bangkok looks like a dream city, if you come to Bangkok, it seems that you go abroad.”

(In-depth interview. Male. A key informant, Bangkok Metropolitan Administration)

“Everybody produces pollution, each individual produces pollution. The increasing population increases pollution, it’s normal. People migrate to Bangkok, less or more, depending on the growth of the economy. They migrate because of the pull factor, income. It pulls not only migrants from rural area but also migrants from Burma, and Cambodia.....”

(Focus group. High income group. Age 29-59).

The result is the crisis of traffic jam in Bangkok, which becomes more and more serious. The traffic jam forces the cars to run slowly, stop and take off all the time. More gasoline is wasted. The combustion process is not completed. The polluted elements are released in a higher proportion. This is especially true for the diesel engines used in the pickup trucks, which are cheaper and popular.

“The behaviour of people, you know, is also involved. Firstly, the traffic and the air pollution are very much related. The more the traffic jam, the more slowly the cars go, the more we have air pollution. The pollution also increases with the traffic. One of the consumption

behaviour that happens is that the pickup trucks are popular. In other countries we don't see many of the pickup trucks."

(In-depth-interview. Male. Department of Pollution Control)

4.3.2 Air Pollution from across All Income Levels : the Poor and the Affluent

The behaviour of commuting and communication among the low, medium and high income populations is different as far as the choice of methods of travelling is concerned. However, it is not at all different in generating pollution. The majority of the low income people who do not own cars, use the mass transit of the government or the bus services of the private companies who receive concessions from the government. They also ride their own motorcycles or use the hired ones (motorcycle taxis). The bus services are not convenient or fast enough. The traffic surface areas are just not enough for the daily increasing number of motor vehicles. The heavy use of the diesel engines and motorcycles of two stroke engines add to the problem. In general, the buses release much of black smoke because of overload of the passengers. The trucks increase the pollution by producing the dust from their own loads of soil they carry for the construction industry. The demand to use these services increases at the time of the rush hours. The pollution is at its peak at these hours too.

"Talking about the two cycle engine and the diesel engine. People like the fast stuff. As for the diesel engine, most of them will be the transportation vehicles. The bus has to have high power. Nowadays people use diesel engines because it is cheaper and has more power. The gasoline engines, they are more likely to be broken down quicker. If we are talking about big buses, they use more gas. The diesel engines, even though they are big, they do not consume a lot of gas. The cycle is shorter. People of high status, they need to use the car. It is the need according to their occupations. Also the need according to the circumstances. They earn good money. They find their ways. Like people who use the motorcycles, they are certainly not going to take the bus. They can check the time more exactly, even though they may get exposed to the polluted air (in the street). As for those who are much better off, they go more slowly (by the car), but they close down the windows, turn on the air conditioner, listen to the radio. Raining is no problem. They have more choices, better choices. They should use the cars somewhat less. Like me, I

use the car because of my occupation. I have to load the merchandise, tools and so on. The motorcycle cannot take them all. I think people who don't have options, have to be patient."

(Focus group among adolescents. Medium income group. Age 18-29)

Because of the shortage of good bus services especially at the rush hours, the higher income groups find their ways to commute other than taking the bus. From in-depth interviews, the medium income group makes great effort to have their own cars to travel. This is just to get to their office in time. To be late all the time is to take risk of losing the job. At the same time, the search for convenience also exists naturally. The consumption values of having choices, such as choices of school for children even though the school may be quite a distance away, are still there. Regardless of income level, the households tend to try their best to send the children to the most prestigious schools. Use of schools close to the house is not the norm. Private cars are therefore very popular. Safety and time concern are the key elements of this choice.

"The situations of tremendous difficulties of travelling by bus. Well. Even though they don't have enough income, they will struggle hard. It doesn't mean just for themselves. It means also their families, their young children. You understand, would you let your young children hang in the bus, swinging around like that. I think this is what they cannot bear."

(In-depth interview. Female. Division of Public Utility and Environment)

"If anyone ever takes the bus during the rush hours. I am not talking about just waiting for the bus and never be able to get on one. I mean you can get on the bus finally, but squeeze yourself in. The bus misses the bus stop. That is to say, before it arrives at the bus stop, it gets stuck in the traffic on the street. Once it arrives at the bus stop, it cannot take passengers. Then it becomes so late. People then try to have a car for the sake of convenience. Because working (on a job) has its limit too. Hanging in the bus to work? If the services are on time, they would not mind that much. Therefore everybody struggles to get themselves to their committed responsibility. Not like...starting office work at 8.30 but arriving at 10.00. The boss will certainly fire you."

(In-depth interview; male, a key informant, Environment Committee, the Parliament)

In addition, the population's lack of education is also very important in the way the pollution is generated. It was mentioned that

“Part of the story is that the, majority of migrants are not well educated. They want to find jobs in Bangkok. Some have no education, only want to work... If they work in a community and are told to do things, they can get correct knowledge. But the uneducated who come to work, and nobody told them what to do and should not do, they will behave as they were in the up-country provinces. In the up-country provinces, they can throw garbage and there is no pollution as there are not as many people as in Bangkok. In Bangkok, they cannot do that.”

(Focus group. Low income group. Age 18-29).

Although, the quantitative analysis shows that the rich are more likely to emit air pollution than the poor, some of our participants in the focus group discussion point to the controversy of this issue with different views.

“The poor produce pollution more than the rich. The poor commute by bus, the bus is the major source of pollution in Bangkok. The trucks too...they produce black smoke and dust. But cars do not emit black smoke”

(Focus group. Low income group. Age 18-29).

4.3.3 Individualism plus Consumerism

Bangkok Metropolis is the primate city. Its growth is much greater than any other cities and not under any kind of control. The economic sub-centers spread around in all directions. The construction projects are multiplied in response to the urban population's consumption behaviour and demand. It is said that Bangkok is the never-ending city. Modernisation and urbanisation per se bring about a growing variety and complexity of cultures and subcultures. At the same time, the deep rooted focus of individualism is even more intensified. A way of life tied to long hours of commuting in the city interacting with the values of materialism and consumerism, spending money over the limit of current income, often leads to ownership of more than one car per household.

The focus group study also reveals the existing irresponsibility concerning the environment among the consumers. Dropping the cigarette butts on the streets, and dumping garbage into the canals or rivers are behaviour still seen among so many people in Bangkok. The lack of social responsibility and consciousness about the environment prevail in spite of the legal actions. Many repeat their irresponsible acts even though they are fined. The social sanction or the condemnation by society are not strong. The

practice of sanctions or treating people as outcasts by the community is not evident for polluters in Thai society. As a consequence, lack of social awareness for the community is usually seen among the Thais. Examples are the black smoke from the trucks or vans or buses beyond the higher limit allowed by law, and the many evidences of repeated illegal actions.

The law in our country is very loose. In case of black smoke (emission), you may get caught, you may get fined. (But then) you keep on doing the same thing. Like garbage littering, you are fined 2000 baht. Then you litter again. There should be something more strict. Our home (in our country) we have freedom for a long time. We can do anything we want. We have fun, not being under any kind of regulations. For example, we litter into the canals. We consider it is all right. Because the garbage flows away along the canal. It takes only a short while to pass our house. That's it. But we never thought that those Baygon tin cans or foams, it takes 10 or 20 years to dissolve in the water. These things will pack and get rotten and spoiled. It is only later now that there is a policy of putting rubbish into garbage can. These cans belong to the Bangkok-Noi district office. Some people never put rubbish in the can, littering into the canal still".

(Focus group. Low income group. Age 18-29)

4.3.4 Urbanization without Urbanism

The consumption does not vary positively according to household size. The emerging smaller families get into consumerism. The values among the young urban population are to compete with each other in consumption. Urbanism becomes only a culture of urban competition, not the "true and constructive" urban way of life. The waste of resources is due to the demand for convenient items and the hastily defined "quality of life" out of consumerism. Ownership of a private car becomes an important indicator of socio-economic status rather than just having a vehicle. The struggle for everyday life at home, office and school and the risks related to the use of public buses finally call for "a car".

"We taught everyone to stand alone. We taught them to make out for themselves. We taught them to compete (to be the best). Therefore we are here, we are going to have a lot of social problems. Because our base is not good. We all are self fulfilling, all of us. Nobody wants to take the disadvantaged (position). I would rather take my own car instead. Everybody does it his way, (all alike). Me, I drive

my kids (to school). Why? Because I am worried. If I let my kids go by bus, (god knows) when will they arrive.”
(In-depth-interview, Female, NGO lobbyist).

Lack of socialization about community good and lack of empowerment towards the community participation among individuals make it almost impossible for a self reassessment of development objectives and long term definition of life status. Concretely speaking, life is going too fast and no community activities can be promoted. The stage of early urbanism still characterizes the rapidly growing city of Bangkok. The development of civil society is still at an early stage. The process towards the mature urban way of life will include raising awareness about the protection of the environment at the end. But so far, Bangkok is at a stage of urbanization without urbanism.

“The consumption behavior of those people is not appropriate and not corresponding ...And we are currently interested in these people, the high economic status group. I believe these people exist. They are the major source of pollution. I say this in a total way. I understand that we do not have to separate the problems one by one, not to separately talk about the dust or the black smoke from the total (picture) all of the pollution. When we try to understand people and their behavior, (we will do it) in the positive and negative aspects, won't we? We look at people as people, and people as groups. And we have to give weight to the “ process” of how the groups of people will emerge and grow, along the basis of their strong belief in their own participation. This (process), we have to be able to relate it to the “system”... including the legal (system) and the educating and the educational (system) as well as mutual learning.”

(In-depth interview, University Professor and NGO Representative and Lobbyist)

The over urbanization of Bangkok combining with the unavoidable urban ways of life are determining the present means of traveling of Bangkok residents with very little alternatives. To solve the air pollution problem of this big city may need macro planning and a policy on urbanization of the whole country. There might need to be some changes of people's attitudes and ways of life for a better environment in this city.

4.4 Solutions to the Problems

4.4.1 Decentralization : Keep Bangkok Relatively Smaller

The focus group study results point out clearly that the Thai government should seriously implement the decentralization of industries and development to rural areas and other provincial towns to reduce the rural-urban disparity. At present, most of the economic activities, such as employment, business investment, educational and welfare infra-structure, are concentrated in Bangkok Metropolis. Bangkok has been growing very fast and has become the primate city of the country. The study results illustrate that the distribution of development and industries to rural areas should be a measure to prevent the rural-to-Bangkok stream of migration. The reduction of in-migration to Bangkok will certainly be able to reduce the air pollution-relevant consumption. As we have discussed, the air pollution problem in Bangkok is caused significantly by too many people in this megacity.

“Bangkok is really the main place of living. Most of the factories, companies, shops are here. Few are in other provinces. Now there is some distribution of income to up-country and some factories have moved out . This partly makes a lot of rural people stay away from Bangkok”

(Focus group, Low income , Age group 18-29)

“We must distribute income, and distribute development to prevent in-migration to Bangkok and to push those who are working in Bangkok to move out. I have to say that nowadays Bangkok is Thailand, everything is in Bangkok. I myself don't want to live in Bangkok but I have to be here. Because of what? Because there is no job in any other place. Every business is in this city. No one feels good living here, but we have no choice.”

(In-depth interview, Male, A key informant, Department of Pollution Control)

4.4.2 City Planning and the Green Zone

The study results show that concerning the growth of Bangkok, it is unfortunate that appropriate city planning and land use have not been implemented effectively. A good city plan that determines proper zoning of

commercial and business, residential and green areas would help the flow of traffic. The resource consumption and the pollution problem would be reduced. From the focus group discussions, we have heard many complaints about unplanned work and poor co-ordination among organizations working for public utilities. Due to the lack of good city planning and effective co-ordination, we can see the repeated digging and filling-up of roads for water pipes, telephone lines, and road-repair many times in a year on the same road. This reduces the traffic surface which further causes “black smoke” from low speed vehicles. We also found from some in-depth interviews that the expansion of the green area zone, the project of planting trees on the footpaths, and the “dust-free road” programme were believed to significantly reduce the air pollution.

“A city plan is necessary for any country, and not just for this year only, in the next 5 - 10 years it will still be necessary. There should be co-ordination among organizations of what each one is going to do. But it may be impossible since it is a matter of project bidding. There is a hidden benefit from the bid. Like if I am in the Telephone Authority, why should I work with the City Planning Department if the Department is responsible for the bidding? I think that the Ministry of Interior should have a city plan before any construction.”

(Focus group. Middle income group. Age 30-59.)

“We must plant trees in the city. Can you see, Singapore, very green all over the city. There are a lot of cars also, but we can see less smoke and feel less pungent in our noses than here. The trees help absorb toxic smokes and produce oxygen”

(In-depth interview. Male. A key informant, Petroleum Authority of Thailand.)

4.4.3 Legal Measures Must Begin with Awareness Campaign

From our qualitative study, the participants of the focus group discussion and key informants of the in-depth interviews expressed their opinions which can be summarized in the conclusion that everyone in a community must be responsible for the solution to the air pollution problem. At the macro level, the government must be careful about possible negative

impacts on the environment, from social and economic policy and planning. Many NGOs are playing active roles in fighting pollution. At the micro level of individual and household, people must realize the mal-impacts of air pollution on their surroundings so that they want to correct it.

In fact, Thailand has already had a law prohibiting an emission of black smoke over a safe standard. The problem is that sometimes this law is abused to be a tool for corruption by some involved parties.

The measures to reduce air pollution such as fines addressed to black smoke producers must be continuously and fairly enforced. Punishment by unpredictable example and discrimination is useless. What we have to take into consideration is that the laws and regulations should be in line with people's ways of life, otherwise they will hardly work. For example, any measure to limit the number of personal vehicles on the streets would be difficult to be implemented since cars have become necessities for people in Bangkok and mass transportation has not yet been fully implemented. People would try to avoid those measures which affect their ways of life, as we found in our qualitative data.

“The use of vehicles in our country is due mainly to two reasons. One is the use because of necessity, and another is because of the status value. We have to take into consideration these two causes of the problem. In some countries, there is no problem of using cars for status. They use cars because of the real necessities in their lives. So their problem can be easily solved. But in our country, it is the problem of values and not only the matter of necessity in life. As long as those values still remain, any measures that affect them will hardly be implemented”.

(In-depth interview, Male, An MP).

Hence, the most feasible approach to change people's behavior is a campaign parallel with the law enforcement. Campaigns such as “a car pool” and “use of bicycles” should be undertaken continuously. Government officials must be rigid to those who intentionally violate the law, and have a warning process for first time violators. It is found in our study that when the fine is actively implemented, the streets in Bangkok look cleaner with much less dust and SPM.

“I think that consciousness of people is quite difficult to create. Sometimes we have to use laws. If there are fines and it is done seriously, I’m sure we can reduce air pollution. Like here in Bangkok, they put signs of dust free roads and they fine those violators. At first, they just gave warning but later they seriously fined. Can you see now in Bangkok, it’s much cleaner. Sometimes, if people are not forced, they won’t do it.”

(In-depth interview. Male. A Key Informant. Department of Health and Environment Promotion.)

An individual who is using a car or truck can help reducing air pollution by assuming his responsibility to follow the law about pollution emission and have his vehicle checked regularly. It is found that regular engine checks make vehicles produce less black smoke and carbon monoxide. The campaign for this awareness is needed.

“People like us can help reducing air pollution. We know well what’s the cause of dust and what is the cause of carbon monoxide. We should have our car engine checked, if the burning is incomplete, have it fixed. There are 5 to 6 millions cars in Bangkok, if the owners of 2-3 millions cars help together in this matter, air pollution will be reduced a lot.”

(In-depth interview, Male, A key informant, Department of Health and Environment Promotion):

4.4.4 Raising of Awareness : The Leading Roles of Mass Media

It is clear from the study results that not less important than the distribution of income is the need for education for people to learn how to solve the environmental problem together. Community participation seems to be a key factor to cope with the pollution problem. The strength of a community derives from the willingness of all members to solve their common problems. An organization set up by community members themselves would be a mechanism to increase their skill and experience in solving an environmental problem. We found from the qualitative study that the campaigns for better environment should be implemented stepwise. The campaigns, as factors arousing people’s learning and realization of the dangers of pollution, would lead to positive consumption behavioral change. There should be a public relations effort by both government and private

sectors for the campaigns to create people's consciousness to realize the environmental problem through various forms of mass media, i.e. newspaper, radio, television and publications. These campaigns should aim to promote people's senses of mutual responsibility, such as self discipline, respect for rights of others, including knowing how to fight for protection of community interest.

"I'd like to see more people helping in public relations. That is to make people realize that the dangers are very close to us. People in our country seem to have a problem of lack of knowledge. In our country, people don't love education....I don't know why,.... they don't like reading. We have to use other approaches to push them. A campaign is one method to make people alert in realizing what rights they have and what duties they have to perform. If we want to have good quality of life, we have to do some duties for the public as well."

(In-depth Interview, Female, A Radio Programmer)

V.: "The young people, they stay around (they don't go anywhere). The (radio) programmers should collect the data and information in detail, saying which are good, which are bad things that cause pollution. What are good (ways to protect the environment), they should spell them out (on the TV and Radio). Young people nowadays like and get addicted to television programs and radio."

S.: "Maybe it doesn't have to be the full (environment) program. Maybe rotating (with other things). Like inserting in other programs like talk shows or beautiful music programs. Young people listen (to these programs) in great number."

(Focus group. Low income groups. Age 18-29)

"A good cutout with (movie or television) stars. With a lot of bright light. Keep repeating the message all the time. Quite often. Then people will remember. Not just round up (the polluters) and fine them only once and disappear."

(Focus group. Low income group. Age 18-29)

"We must have periodical campaigns. Newspaper, T.V., and other mass media are good stimulants. T.V. time is very

expensive, they calculate the rate per second! But the campaign on T.V. is very effective. Like the campaign against smoking, they show the symptoms, how death is caused, and how one suffers from smoking by pictures. It works well. But the effect of pollution is not immediate death and torture like smoking. It gradually absorbs and cumulates in one's body. So I think that there should be steps of telling people about the negative impacts of pollution to their health."

(In-depth Interview. Male. A Senator.)

CHAPTER V

Summary and Recommendations

5.1 Summary

The rapid increase in the population of Thailand to 60 millions in 1996 accompanied by the fast economic growth and rising standard of living has caused increasing exploitation of the natural resources. Lacking timely management of the resources and the appropriate regulations to protect the environment, the country is faced with at least five major environment problems, all linked to changes in consumption behavior. These include global warming, land resource deterioration, deforestation, rapid urbanization and unsustainable industrialization, and energy consumption increase. As a result, air, water and noise pollution and hazardous waste negatively affect the quality of life of Thai people. These phenomena are accompanied by the highly materialistic attitudes increasingly predominant in the urban as well as rural areas of the country. The government approach still to a large extent, treats the environment issues as symptoms rather than aims to treat the root cause of the problems. The process of participation from the people, which is seen to be one of the most important features to deal with these problems, because they are basically behavioral linked issues, is still needed to be followed up more closely.

This study therefore investigates the air pollution problem in Bangkok where the population is approaching 10 millions. Air pollution generates the most unhealthy impact to the people and has been chosen as the focus of the study for that reason. A large and increasing number of Bangkok residents suffer from respiratory problems and related complications. The concentration of air pollution in this city has by far exceeded the standard and is expected to be worsen year by year. The major pollutants include suspended particulate matter (SPM), carbon monoxide (CO), and lead and nitrogen dioxide (NO₂). The important underlying factor is mainly the fuel consumption in transportation. Besides, traffic congestion leading to incomplete combustion, overloaded buses and trucks, two-stroke engines of motorcycles, and the high growth rate of vehicles all add to the problems of the rapidly urbanizing city of Bangkok.

The demand for vehicles and fuel consumption also correlates with a number of demographic and socio-economic factors. The economy of

Bangkok and its peripheral provinces has been growing rapidly and has absorbed in-migrants to account for at least one-third of its current population. The rapid increase in the population of labor force age and the blue and white collar occupations implies a substantial demand for vehicles for commuting and for a greater variety of economic activities as well as for education and other cultural functions. The more “modern” pattern of consumption interacts with these social, economic and demographic changes in generating rising fuel use and air pollution.

The main objectives of this study are to investigate the link between population, consumption and environment as far as the air pollution in Bangkok is concerned. Three main perspectives guiding this investigation are the Malthusian and Boserupian framework which focuses on the carrying capacity and the relationship between population growth, technological change and the environment, the multiplicative equation, which emphasizes the interaction among population, consumption and technology and its impact on the environment, and the mediating thesis which includes social, cultural and institutional factors into the investigation of this relationship. Thus carrying capacity, technological change, the population (size, growth, density and distribution), as well as the social, cultural and institutional efforts at the household, community, national and international levels are all taken into consideration as factors. The macro, household and individual level analyses are the central methodological focuses.

At the macro and household level, the Household Socio-economic Survey 1994 conducted by the National Statistical Office of Thailand is used for the quantitative study. A Report on Thailand’s Pollution Situation by the the Department of Toxic Control of the Ministry of Sciences, Technology and Environment is also an important source of information about the amount of air pollution emission by mode of transportation measured in terms of tons/year. In this case, the air pollutant SPM is investigated as the dependent variable. At the household level, air pollution emission is calculated from the household expenditures on gasoline for cars or motorcycles. The demographic, socio-economic and household characteristics at the household level are treated as important independent variables.

At the individual level, focus group and in-depth interviews are used for qualitative investigations. The interview guidelines were constructed carefully. Seventeen main questions were finally developed for six focus group sessions and nine topics or questions were for 20 in-depth interviews. The content included people’s perceptions, attitudes and visions on the link of population

and air pollution, its relations to the individual's behavior, technological changes, and social organization that are related to the solutions to the problems. The guidelines were pretested and improved. The moderators received feedbacks for the clarity, the flexibility and the continuity of the questions as well as for the logistics of conducting sessions and skill improvement. Selection of participants was purposive and classified into three income levels and two age brackets. In each focus group session, there were eight participants, four males and four females. A total of 20 key informants were also interviewed in-depth. They were government officials, state enterprise workers and key persons from private sector and non-government organizations, purposively selected aiming for the best knowledge and good expression of attitudes and opinions on the issues. The interviews and the focus group sessions were tape recorded and transcribed. The analyses are carried out by merging the quantitative and qualitative findings together as much as possible.

The research results are presented in four areas, namely, the urban air pollution impact on health, the behavioral and structural causes, the dynamics of the link between consumption behavior of the population and air pollution and finally, the solutions. Since the main analyses are qualitative in nature and the quantitative investigation is supplementary, generalization of the situations is only made with great caution. Instead, broader assessment of the situation will be discussed. Comparison across socio-economic groups and different administrative offices will be carefully investigated. These results are then meant to identify the ranges of possible links between population and its consumption behavior, and the pollution, rather than to test all specific hypotheses with statistical exercises.

The health threatening problem due to the air pollution in Bangkok can be measured in terms of the suspended particulate matter (SPM), carbon monoxide (CO) and lead. A large number of people in Bangkok especially those living in the heavy traffic congested areas report that they become ill from respiratory diseases. As recently as in 1993 onwards, respiratory disease has become the first leading cause of illness in Bangkok. As for the invisible killer, carbon monoxide, participants from the focus groups feel that this toxin is at a very dangerous level, being able to make them exhausted and drowsy or even faint. The threat to health is very clear among the Bangkok population. Fortunately, the problem from lead is now solved. As of January 1, 1997, use of lead in gasoline is prohibited. Its level is currently under the standard limit.

Causes of air pollution in Bangkok are both behavioral and structural. The results from the quantitative study show that at the household level, the amount of pollution emission per household is associated with various socio-economic and demographic characteristics of the household heads. Other things being equal, gender, income and occupation status of the household heads and the family structure of the household significantly relate to the amount of emission of SPM. Male heads of household emit about 2.7 kilograms of SPM per year more than their female counterparts. Those in the professional or administrative categories produce 3.7 to 4.6 kilograms more SPM per year than those in the sale/service and production work. An increase in monthly income of 1,000 Baht can cause an increase in emission of about 0.1 kilogram per year. Extended and nuclear families produce about 5.3 and 3.5 kilograms of SPM per year more than the single individual households respectively. These findings point to the significance of the changing consumption behavior in relation to the affluence and the life style of the growing subgroups of the population of Bangkok.

In terms of the structural consideration, poor public transportation explains a great deal of the air pollution in Bangkok. Public transportation in Bangkok is seen to be slow, overcrowded and unreliable. Focus group study results point out that some people use private vehicles because of the poor condition or the shortage of public transportation. Others use it for certain occupational needs and also for convenience. It is also speculated that even when the public transportation is improved, without the raising of awareness, people may still use private cars to a large extent just because of the convenience and comfort. Solutions to the problems therefore have to take into account both structural and behavioral aspects.

The study reveals that another important structural innovation is needed in the area of city planning. Since the 1950s, land use of Bangkok has quickly spilled over the boundary into several adjacent provinces. The expansion is characterized by "ribbon development", where the areas along the routes of major roads extending from Bangkok have been built up first. The distribution of residential areas and workplaces is not planned but shaped by land prices. New and popular housing estates are more and more located further away from the center of Bangkok. Residential and workplace developments therefore lead to increasing and more lengthy commuting to work. Focus group study results reveal that city planning or land use planning is clearly called for by residents of Bangkok. Qualitative study points to the important fact that the obstacles are seen to be the interest groups involved in the price of land and the lack of continuity of the Thai government.

This also leads to the problem of confused transportation policy. Solutions to transportation problems in Bangkok have been proposed by many consultant groups for several years now. Although planners and engineers approved the proposals, very little is implemented. Too many organizations are responsible for the public transportation system. Each wants to promote their own projects. With the coalition government of Thailand, different political parties may be responsible for different projects. Conflict becomes a political issue. The focus group participants feel that the conflict may be based on self-interest. The management is not transparent. Political parties also make promises before election but never keep them after they are elected.

The root cause of pollution is the rapid urbanization and the primacy of the extremely congested city of Bangkok. Migration leads to an increase in demand for commuting and transportation. This brings about the crisis of traffic jams which force the cars to waste the gasoline and emit pollution. The process is observed from across all income levels, the poor and the affluent. The heavy use of diesel engines of the overloaded buses and the two stroke engines of motorcycles generates smoke. For the higher income group, the use of private cars is also without limit. The deep rooted behavior of Thai individualism together with the values of materialism and consumerism add to all of these problems. The majority of the Bangkok population including migrants do not yet follow the urban way of life. The process of urbanization without urbanism delays the development of community participation and civil society involvement.

5.2 Recommendations

The first recommendation given by the respondents under study concerns the long debate over the issue of keeping Bangkok small by stopping the process of centralization. Although this is a long term goal, it is time that the government should start, seriously, to implement the decentralization of development and industries to rural areas and other provincial towns. The centralization of Bangkok to the point of being the only primate city of the country can be quite dangerous and unsustainable in the long run. The reduction of in-migration to Bangkok will not only decrease the city pollution problem but will also restore rural communities both economically and culturally.

Secondly, the study reveals that a good and feasible city planning for Bangkok is desperately needed. The land use plan will determine proper

zoning of commercial and business, residential and green areas leading to a more healthy city with proper flow of traffic. With a good master plan, the coordination among organizations working to provide public utilities can be greatly improved. The respondents believe that the public projects like the green area zone (mentioned above) or the “dust-free road” program, where certain roads in Bangkok are announced to be strictly patrolled, as well as campaigns against polluters, would significantly lead to the reduction of air pollution.

Thirdly, the legal measures to reduce air pollution are discussed. Punishment such as fines for black smoke producers should be continuously implemented, predictable and non-discriminating. Legal measures that are not fair and contradictory to people’s life style would not work. The legal measures should also be backed up quickly with public campaigns. Raising awareness without serious legal actions on the other hand would be too slow to solve the problem.

Finally and most importantly, as mentioned above, there is a need for raising awareness among the public on how to protect the environment. The key factor is community mobilization. The community itself needs to set up management bodies to share among themselves skill and experience in fighting for the better environment in their own community. The study also shows that to start up this awareness, both government and private organizations through various forms of mass media, i.e. newspapers, radio, television and publications should implement a campaign. These campaigns should focus on the raising of sense of social responsibility, self-discipline and respect for rights of others. A half-day seminar organized at the end of this study, between university researchers and key mass media community revealed a number of techniques to launch the campaign. Constantly making environmental concern a “news issue” is one way to keep attention. Backing up by IE &C (information, education and communication) from the mass media is also required. Lastly, the seminar results from the mass media professionals point out that a push from the mass media community targeted directly to the key decision-makers or the “authority in charge” of the environment problem can be very politically effective.

References

- Arbhabharama A. 1972. *Human and Society, Society and Culture*. Kasetsart University, Bangkok (in Thai).
- Archavanitkul, K., Pongsomlee, A., Punpuing, S. Tongchonlatip, K. and Vasiriamorn, Y. 1993. *Quality of Life of Capital City Residents and Environmental Problems in Bangkok*. Publication No. 170, Institute for Population and Social Research, Nakhon Pathom (in Thai).
- Australian Academy of Science. 1976. *Report of a Committee on the Problem of Noise*. Report number 20, Canberra.
- Ayal, E.B. 1992. Thailand's Development: the Role of Bangkok. *Pacific Affairs* 65(3): 353-367.
- Bangkok Metropolitan Administration (BMA). 1991. *The Fourth Bangkok Development Plan (1992-1996)*. Department of Policy and Planning, Bangkok (in Thai).
- Bangkok Post. 1992. *Land Price up 8.5 Per cent*. December 28.
- . 1994. *Boonchu Bemoans Failure to Implement Projects to Ease Traffic Congestion: Traffic Plans 'going nowhere'*. May 8.
- . (Year-End Economic Review). 1994. *Major Projects Stuck in First Year*. December 31.
- . 1995. *Traffic Nightmare Looms*. February 2.
- . 1995. *Public Health Ministry to Set Up Own Air-quality Standards*. February 7.
- . 1995. *Traffic Congestion Forces Changes in City Development*. April 17.
- . 1995. *Gasping for Breath*. June 30.
- Bonneuil, N. 1994. Capital Accumulation, Inertia of Consumption and Norm of Reproduction. *Population Economic*.
- Boonpragob, K. 1996. Climate Change: Thailand's Role in a Global Context. Paper presented at Linking Local Solutions to Global Needs: Thailand's Environment Agenda in the 21st Century, July 9, Bangkok. Thailand Environment Institute 1996 Annual Conference.

- Browder, J.O., Bohland, J., Scarpaci, J.L. and Office of International Research and Development Virginia Polytechnic Institute and State University. 1992. Patterns of Development on the Metropolitan Fringe: Peri-urban Expansion in Bangkok, Jakarta and Santiago. Working Paper 92-2, Centre for Urban and Regional Studies, Virginia Polytechnic Institute and State University, Virginia.
- Chamrathirong, A., Archavanitkul, K., Richter, K., Guest, P., Thongthai, V., Boonchalaksi, W., Piriathamwong, N., and Vong-Ek, P. 1995. *National Migration Survey of Thailand*. Institute for Population and Social Research (IPSR), Mahidol University. IPSR Publication No. 188.
- Chamrathirong, A., Prasartkul, P., Thongthai, V., Guest, P. 1997. *National Contraceptive Prevalence Survey 1996*. Institute for Population and Social Research (IPSR), Mahidol University. IPSR Publication No. 212.
- Changrien, P. and Stimson, R.J. 1992. Bangkok: Jewel in Thailand's Crown. In Blakely, E.J. and Stimson, R.J. (eds). *New Cities of the Pacific Rim*. Institute of Urban and Regional Development, University of California at Berkeley, Berkeley. Chapter 15: 1-39.
- Commoner, B. 1972. The Environmental Cost of Economic Growth. In *Population, Resources and the Environment*. Washington DC. Government Printing Office: 339-363.
- _____. 1991. Rapid Population Growth and Environmental Stress. *International Journal of Health Services* 21 (2): 199-227.
- Daily News. 1994. "School Bus" Fails. December 22 (in Thai).
- Daniere, A.G. 1993. Transportation Planning and Implementation in Bangkok: Economic Growth and Fractured Purposes. Unpublished Paper of Graduate Program in Urban and Regional Planning, University of California, Irvine.
- DaVanzo, J. 1981. Microeconomic Approaches to Studying Migration Decisions. In De Jong, G. and Gradner, R (eds). *Migration Decision Making*. Pergamon Press, New York: 90-129.
- Department of Toxic Control, Ministry of Science Technology and Environment. 1990. *Report on Air and Noise Qualities in Thailand*. Bangkok (in Thai).
- _____. 1994. *Report on Air Pollution Situation in Thailand*. Bangkok (in Thai).
- _____. 1996. *Pollution Situation in Thailand 1994*. Bangkok (in Thai).

- Department of Land Transport, Ministry of Transport and Communications. 1992. *Report on Registered Vehicles for the Whole Country*. Transport Statistic Division, Bangkok (in Thai).
- Development Alternatives, Inc. 1994. Environmental Profile Thailand. Report prepared for the United States Agency for International Development Regional Support Mission for East Asia, Bangkok.
- Dowall, D.E. 1992. A Second Look at the Bangkok Land and Housing Market. *Urban Studies* 29 (1): 25-37.
- Economic Commission for Asia and Far East. 1973. Comparative Study of Mortality Trends in ECAFE Countries, *Asian Population*. Series No. 14, Bangkok: Economic Commission for Asia and Far East.
- Economic and Social Commission Asian Pacific (ESCAP). 1993. Urbanization and Socio-Economic Development in Asia and the Pacific. *Asian Population Studies*, No. 122. New York: 96-118.
- Ehrlich, P R. 1972. Impact of Population Growth. In *Population, Resource and the Environment*. Washington DC, Government Printing Office: 365-377.
- _____ and Ann H. Ehrlich. 1990. *The Population Explosion*. New York: Simon and Schuster.
- Gakenheimer, R. and Gelfan, A. 1995 Air Pollution in Bangkok. *Strategic Planning for Metropolitan Bangkok : Draft Final Report During Phase IV*. Concept Plan for Bangkok Metropolitan Development, Bangkok.
- Greenberg, C. 1994. Region Based Urbanization in Bangkok's Extended Periphery. (Ph.D. Thesis. Department of Geography, University of British Columbia, Vancouver).
- Habison, S.F. 1981. Family Structure and Family Strategy in Migration Decision Making. In De Jong, G.F. and Gardner, R.W (eds). *Migration Decision Making, Multidisciplinary Approaches to Microlevel Studies in Developed and Developing Countries*. Pergamon Press, New York : 225-251.
- Harrison, P. 1993. *The Third Revolution: Population, Environment and a Sustainable World*. Penguin Books. London.
- Health Department, Ministry of Public Health. 1995. Environmental Situations and Impacts on Health in Thailand. The Report prepared for World Health Organization. Institute for Health Research : Nonthaburi.

- Heggie, I.G. 1978. Behavioural Dimensions of Travel Choice. In Hensher, D.A. and Dalvi, Q. (eds). *Determinants of Travel Choice*. Saxon House, Westmead: 100-124.
- Heggie, I.G. 1976. Diagnostic Survey of Urban Journey-to-Work Behaviour. In Heggie, I.G. (ed). *Modal Choice and the Value of Travel Time*. Clarendon Press, Oxford : 5-47.
- Henderson, B.E. et al. 1975. Lung Cancer and Air Pollution in Southcentral Los Angeles Country. *American Journal of Epidemiology*, Vol. 101.
- Institute for Population and Social Research, Mahidol University. 1993. Policy-Maker Interviews by IPSR Staff During the Period 1993-1994. Part of the Project Impacts of Modernisation and Urbanisation in Bangkok: An Integrative Ecological and Biosocial Study.
- . 1996. *Mahidol Population Gazette*, Vol.5, No.1.
- . 1998. *Mahidol Population Gazette*, Vol.6, No.2.
- International Institute for Energy Conservation (IIEC). 1992. *Assessment of Transportation Growth in Asia and Its Effects on Energy Use, the Environment, and Traffic Congestion : Case Study of Bangkok, Thailand*.
- . 1994. Introduction to Integrated Resource Planning and Demand Side Management. Presentation to Philippine Non-Governmental Organizations Workshop, Tagaytay, Philippines. Bangkok, International Institute for Energy Conservation.
- Japan International Cooperation Agency (JICA). 1990. *The Study on Medium to Long Term Improvement / Management Plan of Road and Road Transport in Bangkok : Medium to Long Term Road Improvement Plan*. Main Report.
- Jesdapipat, S. 1996. Thailand's Policy Responses to Climate Change Crises : an Analysis of Critical Sectors. Paper presented at Linking Local Solutions to Global Needs : Thailand's Environment Agenda in the 21st Century, July 9, Bangkok Thailand Environment Institute 1996 Annual Conference.
- Kirananda, T. 1993. Population and Poverty Alleviation Issues. *The Fourth Asian and Pacific Population Conference*. United Nations, New York. .
- Koanatakool, P.C. and Askew, M. 1993. Urban Life and Urban People in Transition. Synthesis Reports Volume II of the 1993 Year-End Conference: Who Gets What and How?: Challenges for the Future. Chon Buri, December 10-11.

- Madden, J.F. 1981. Why Women Work Closer to Home. *Urban Studies* 18 (2): 181-194.
- Manning, I. 1978. *The Journey to Work*. Sydney George Allen & Unwin, London.
- Manopimoke, S. 1992. *Environmental Economics*. Faculty of Economic, Thammasat University, Thailand.
- Matichon. 1994. School Buses Provide Free Service: BMA Asked Government for Subsidy. May 17 (in Thai).
- Ministry of Public Health, Thailand. 1970. *Report on Public Health Statistics*.
- . 1980. *Report on Public Health Statistics*.
- . 1990. *Report on Public Health Statistics*.
- Ministry of Interior, Thailand, 1997. *Registration Report in 1997*.
- Marquette, C.M. and Bilsborrow, R. 1994. *Population and the Environment in Developing Countries : A Literature Survey and Research Bibliography*. Preliminary unedited version prepared for the Population Division of the Department for Economic and Social Information and Policy Analysis, United Nations Secretariat. pp. 3-6.
- Mulder, N.J.A. 1994. *Inside Thai Society: An Interpretation of Everyday Life*. Fourth revised and expanded edition. Editions Duang Kamol, Bangkok.
- National Economic and Social Development Board (NESDB), Thailand. 1985. *Population Projections of Thailand : Whole Kingdom, 1980-2015*.
- . 1994. *Thailand : National Report on Population and Development*. A Report prepared by Thailand Working Committee for Preparation of the International Conference on Population and Development.
- . 1995. *Population Projections for Thailand, 1990-2020*. (in Thai).
- . 1996. *National Income of Thailand*. Bangkok.
- . United Nations Development Programme (UNDP), and Thailand Development Research Institute (TDRI). n.d but 1991. National Urban Development Policy Framework, Final Report (Volume 1 and 2). Bangkok.

- National Statistical Office (NSO), Thailand. 1960. *Population and Housing Census*. Bangkok.
- . 1965. *Report on the Survey of Population Change, 1964-65*.
- . 1970. *Population and Housing Census*. Bangkok.
- . 1980. *Population and Housing Census*. Bangkok.
- . 1984. *Statistical Handbook of Thailand*. Bangkok.
- . 1989. *Report on Education Statistics (detail characteristics)*. Bangkok (in Thai).
- . 1990a. *Population and Housing Census*. Bangkok.
- . 1990b. *Subject Report No.1 Migration*. Bangkok.
- . 1990c. *Key Statistics of Thailand*. Bangkok.
- . 1991a. *Report on the Survey of Population Change, 1991*. Bangkok.
- . 1991b. *Report of the Health and Welfare Survey*. Bangkok.
- . 1992. *Key Statistics of Thailand*. Bangkok.
- . 1994. *Statistical Handbook of Thailand*. Bangkok.
- . 1996a. *Report on the Survey of Population Change, 1995-96*. Bangkok.
- . 1996b. *Household Socio-Economic Survey*. Bangkok.
- Orians, C E. and Skumanich M. 1995. The Population-Environment Connection: What Does It Mean for Environmental Policy? Paper prepared for Futures Studies Unit, Office of Policy Planning and Evaluation. U.S. Environmental Protection Agency.
- Pananiramai, M. 1991. Family Structure and Its Members Welfare. Paper presented at Workshop on Family and Youth in Thai Society. Bangkok, November 11-13 (in Thai).
- Panich, S., Boonyakarnkul T. and Sritusnee U. 1998. Future Health Study for Bangkok: the Health Impacts due to Environmental Pollution with Special Emphasis on Air Pollution. Paper presented at Workshop on Health Future Studies. Bangkok, January 19-21.

- Parnwell, M. 1993. *Population Movements and the Third World*. Routledge, London.
- Peerapun, W. and Silapacharanan, S. 1992. The Patterns and Problems of Urban Development in Bangkok. Paper presented at the International Workshop on Research and Planning Methodologies for Metropolitan/Regional Development. Bangkok, June 29-July 3.
- Penner, P.R. 1992. Urban Transport Policy, Planning, and Implementation in the Bangkok Metropolitan Region: A Case Study. (Masters Thesis. Interdisciplinary Studies Program: International studies, the University of Oregon, Oregon).
- Pianuan, K., Kaosa-ard, M. and Pienchob, P. 1994. Bangkok Traffic Congestion: is there a Solution? *TDRI Quarterly Review* 9 (2): 20-23.
- Poboorn, C. and Kenworthy, J. 1995. Bangkok: Toward a Sustainable Traffic Solution. Paper presented at the International Conference, Urban Habitat: the Environment of Tomorrow. Delft, February 15-17.
- Phang, S-Y. 1989. The Effects of Government Policies on Housing, Location and Commute Decisions in Singapore : Theory and Evidence. (Ph.D. thesis. Harvard University).
- Phantumvanit, D. 1987. *Thailand Natural Resources Profile*. Thailand Development Research Institute, Bangkok.
- Punpuing, S. 1996. Commuting Behaviour Patterns in Bangkok. (Ph.D. thesis. Centre for Resource and Environmental Studies; The Australia National University, Canberra).
- Punyaratabandhu, P., Suchirarat, D. and Narksawat, K. 1997. Health Situation and Trends in the Future in Thailand. Paper prepared for the Ministry of Public Health.
- Setchell, C.A. 1991. Urban Transportation in Thailand: a Review and Evaluation of Policy and Research Needs. A report to the International Development Research Centre and Social Research Institute, Chulalongkorn University, Bangkok.
- Siam Post. 1994. "School Bus" will be cancelled?. December 13 (in Thai).
- Sternstein, L. 1976. *Thailand the Environment of Modernisation*. McGraw-Hill, Sydney.

- . 1995. Bangkok Metropolitan Region : Population Change from the Censuses of 1960, 1970, 1980, 1990. Working paper for Kiat Consultants Limited Partnership, Bangkok.
- Stickland, R. 1993. Bangkok's Urban Transport Crisis. *The Urban Age* 2(1): 1-6.
- Tanaboriboon, Y. and Jin, F. n.d but 1995. Effect of the School Trips... a Case Study in Bangkok. Selected proceedings paper of the Sixth World Conference on Transport Section Land Use, Development and Globalisation Espace, Development et Globalisation.
- Thai Environment Institute (TEI). 1994. Crisis on Travel and Pollution Problem. Report prepared for 1994 Annual Conference on the New Solutions for Sustainable Development - Linking Policies with Action. Ambassador Hotel, Bangkok (in Thai).
- Thai Environment Institute (TEI), Chulalongkorn University and Radian Cupertino Ltd. 1993. Critical Thinking and Pollution Problems. Paper presented at the Annual Seminar on Environment Critical Solutions: from Thinking to Practicality. Bangkok, July 29 (in Thai).
- Thai Rath. 1995. Bus Route Reformed: Start April 12, 95. January 24 (in Thai).
- Thailand Development Research Institute (TDRI). 1991. Interim Report of the Study for the Fourth Bangkok Development Plan. Bangkok (draft and in Thai).
- The Canberra Times. 1993. *ASIA's Toxic Cities*. October 23.
- The Economist Intelligence unit (EIU). 1992. *Country Profile 1991-1992: Thailand, Myanmar*. The Economist Intelligence Unit Limited, London.
- . 1993. *Country Report 2 and Quarter: Thailand, Myanmar*. The Economist Intelligence Unit Limited, London.
- The Government of Thailand. 1995. *Thailand National Report : World Summit for Social Development*. Copenhagen; Denmark.
- The Nation. 1995. King Raps Government Traffic Strategy: Rare Royal Criticism Raises Doubts about Wisdom of Parties Splitting Responsibility. August 18.
- Todaro, M.P. 1976. *Internal Migration in Developing Countries, A Review of Theory, Evidence, Methodology, and Research Priority*. International Labor Office. Geneva.

- United Nations Development Plan (UNDP). 1994. *Human Development Report 1994*. United Nations Development Program, Delhi.
- Vena, J. E. 1982. Air Pollution as a Risk Factor in Lung Cancer. *American Journal of Epidemiology*, Vol. 116, pp. 42-56.
- Webster, D. 1995. The Urban Environment in Southeast Asia : Challenges and Opportunities. *Southeast Asian Affairs* : 1-19.
- Wibulswas, P. 1997. Emission from Transportation in Thailand. *Mahidol Journal*; 4 (2): 99-102.
- World Bank. 1992. *World Development Report 1992 : Development and the Environment*. Published for the World Bank. Oxford University Press, New York.
- . 1994. *Thailand Mitigating Pollution and Congestion Impacts in a High-growth Economy : Country Economic Report*. Washington D.C.
- World Health Organization (WHO). 1976. Air Quality Criteria and Guides for Urban Air Pollutants. *Manual on Urban Air Quality Management*. World Health Organization : Copenhagen.

Appendix A

Focus Group Discussion Guidelines

1. Introduction:
 - Explain our study, its purpose
 - Answer any questions, establish rapport.
2. What do you see as the main urban air pollution that affects you?
3. Does air pollution affect you or general population?
How does air pollution affect you?
4. In your opinion, what are the major causes of air pollution?
What do you think can solve air pollution?
5. In your opinion, does over population in Bangkok affect air pollution?
6. How do you think households contribute to air pollution especially traveling in the city?
7. Do you have a choice of transportation in the city?
If yes, what would it be?
8. Do have a car; what brand is it? Why do you use it?
9. Do you think individuals have a choice of transportation in the city?
10. What are the choices of individuals for transportation in the city?
11. Is air pollution improving or not?
12. Do you think there are personal opportunities to do something for better air?
13. Do you think the government is doing enough on air pollution?
What is the government doing on air pollution?
14. Do you think air pollution must be solved by changes in personal behaviour in traveling?
15. If yes, how do you think this problem can be solved?
16. In your opinion, who is the most likely to do something for better air?
17. What is the future of air pollution in Bangkok? Better air or not?
Do you live in Bangkok or not?

In-depth Interview Guildelines

1. Introduction:
 - Explain our study, its purpose
 - Answer any questions, establish rapport.
2. What do you think of the air pollution problem in Bangkok?
Do you see air pollution as a problem; what are causes and reasons?
Why?
3. In your opinion, what do you see as opportunities to solve the urban air pollution?
4. Do you think the air pollution problem occurred as a result of migration and over population in the city?
5. If yes, how would you solve this problem?
6. What are the causes of the air pollution problem in Bangkok?
How does air pollution affect you?
7. How are these causes contributing to air pollution?
8. Do you think air pollution depends on transportation in Bangkok? Why?
9. How do you think this problem can be solved?

Appendix B

List of Names for In-depth Interview

Government Organizations/State Enterprises

The House of Representatives:

1. Mr. Sanit Kulcharoen (Chairman of Committee on Environment)
2. Mr. Aong-ard Klampaiboon (A Member of Committee on Environment)

Ministry of Science, Technology and Environment:

3. Mr.Thana Iamthanivudhi (An Adviser of Deputy Ministry of Science, Technology and Environment)

Pollution Control Department:

4. Dr. Supat Wangwongwatana (Director of Air Quality and Noise Management Division of Pollution Control Department)
5. Mrs. Nisakorn Kositrat(Director of Water Quality Management Division)

Department of Environmental Quality Promotion:

6. Mr. Suvat Saganwongse(Secretary General of Department of Environmental Quality Promotion)

Office Of Environmental Policy and Planning:

7. Dr. Saksit Tridech(Secretary General of Office of Environmental Policy and Planning)

Office of the National Economic and Social Development Board:

8. Mrs. Narumol Dhramaraksa (Director of Technology and Environmental Planning Division)

Bangkok Metropolitan Administration:

9. Mr.Kaew Heosontaty(A Member of Environmental Committee of Bangkok Metropolitan Assembly)
10. Mrs. Nathanon Thavisin(An Adviser to Office of the Permanent Secretary for Bangkok Metropolitan Administration)
11. Mrs.Usa Lertyaso(Chief of Instructor and Environment Planning Sector)
12. Mrs. Naphaporn Reungyudhpakorn(Assistant Director of Khet Bang Rak)

Expressway and Rapid Transit Authority of Thailand:

13. Mr. Pricha Sritongsuk (Deputy Governor for Administration of Expressway and Rapid Transit Authority of Thailand)

Petroleum Authority of Thailand:

14. Mr. Sawang Boonyasuwat (Assistant Governor, Research and Development Center of Petroleum Authority of Thailand)

The Bangkok Mass Transit Authority:

15. Mr. Yanyong Kurovat (Director of the Bangkok Mass Transit Authority)

Privates

16. Dr. Weerawat Chantanakome (Director of Energy and Environment Project, Thailand Environment Institute)
17. Dr. Anuchat Pongsomlee (Lobbyist)
18. Khunying Chodchoy Sophonpanich (President of Thai Environmental, Community and Development Association)
19. Ms. Siwaporn Yanwithyakul (Announcer of The Pacific Corporation, JS100)

Non-Government Organization (NGOs)

20. Dr. Saranarat Kanjanavanit (Secretary General of Green World Foundation, Thailand)

Appendix C Stochastic Model

In the study of macro and household level analysis we used an empirical model linking population growth, energy consumption pattern and air quality in the form of a simple causal model to incorporate and control for effect of other causal factors such as socio-economic change and changes in technology. The IPAT model used is expressed as follows:-

$$I = P \times A \times T$$

when;	I	=	A pollutant or environmental impact
	P	=	Population
	A	=	Affluence activity or consumption per capita
	T	=	Technology

As a definitional identity, the model has been useful for accounting purposes such as attributing shares of I to each of the three causal factors, but it is virtually useless for empirical research, and it should be converted to a stochastic model. The coefficients can be empirically estimated that show the relative contributions of the three causal factors. The most obvious stochastic model is a standard economic production function in logarithmic form:-

$$\ln(I) = b_0 + b_1 \ln(P) + b_2 \ln(A) + b_3 \ln(T) + e$$

A number of additional modifications to the IPAT model make it more useful in research. Analysis of emissions should be disaggregated by pollutant and by source in order to estimate the causal impact of population because each type of air pollutant come from different sources. If emissions are aggregated for all sources, the estimated effects of population will represent a weighted average of true causal effects, with the composition of production and consumption serving as weights. The other modification of the stochastic IPAT model is the treatment of population. This model specifies population as the number of persons in a region which assume that individuals or households are fundamentally responsible for the activities that produce pollution. It is consistent with micro-level models of polluting behavior, so P (Population) should be a count of individuals or households. If polluting behaviors are generated by households rather than by individuals, P (Population) should be a households.

**INSTITUTE FOR POPULATION AND SOCIAL RESEARCH
MAHIDOL UNIVERSITY**

Salaya, Phuthamnthon, Nakhon Pathom 73170

Tel. (662) 441-9666, 441-0201-4 Ext. 115

Fax : (662) 441-9333

E-mail : directpr@mahidol.ac.th

Homepage : URL <http://www.mahidol.ac.th/mahidol/pr/pr.html>