INDUSTRY, WATER AND PEOPLE IN GREATER BANGKOK: A CASE STUDY OF SAMUT PRAKAN

By

Sittipong Dilokwanich

A Thesis Submitted for the Degree of

Doctor of Philosophy

at the Australian National University

June 1995

Declaration

Except where otherwise indicated,

this thesis is my own work.

Sittipong Dilokwanich

June 1995

ACKNOWLEDGMENTS

I could not have completed this thesis were it not for the kind help from the following organisations and individuals.

Equity and Merit Scholarship Scheme for providing financial support to my study in Australia between 1990-94. The Department of Human Geography, Research School of Pacific Studies, Division of Society and Environment, the Australian National University, for granting me fieldwork budget in Thailand between April and September 1991.

Dr. P. J. Rimmer, Head of Department of Human Geography, Research School of Pacific Studies, the Australian National University, and Prof. D. K. Forbes, Head of Geography Department, School of Social Science, Flinders University, who persuaded me to investigate the interrelationship between environmental elements and the city evolution. Prof. H. C. Brookfield, former Head of Department of Human Geography, Research School of Pacific Studies, the Australian National University, also gave me valuable inspiration. However, Dr. Rimmer untiringly encouraged me to write down what I usually think in forms of picture and diagram.

Dr. Orapin Eamsiri, former Dean of Faculty of Environment and Resources Studies, Mahidol University who provided me with fieldwork and laboratory facilities. Special thanks also goes to technicians, staff and students of the Faculty who assisted me in water sample collection and analysis. Further sincere acknowledgment goes to Ms. Panee Vong-Ek from the Population Studies, Faculty of Humanity, Mahidol University and Dr. Suntaree Komin from the National Institute of Development Administration for sharing their research experience on social change.

Mr. Adirek Ratirattananont, Marketing Consultant, the Royal Norwegian Embassy who introduced me to Mr. Apiluk Lohachitkul, General Manager of Driessen - Aircraft Interior Systems, who provided information of his industrial management and gave me access to other entrepreneurs in the Bang Pli Industrial Estate. Ms. Suchada Panichakul, General Manager of Kaidummahakit Ltd., for discussing industrial management problems in the Estate. Mr. Nimit Visutthirangsri-urai, General Manager of Chemmin Corporation Ltd., for supporting information on changing industrial activity in his surrounding area and helping me to contact other entrepreneurs in Amphoes Bang Pli and Bang Bo. Mr. Bovorn Vironmahawongse, General Manager of Eternal Resin Co., Ltd, for sharing his valuable time to discuss production systems and giving access to his other industries in Amphoes Bang Pli and Bang Bo.

Ms. Araya Nuntapotidech and Ms. Krisana Choeypun from the Office of National Environment Board, and Ms. Nittaya Srisarin from the Department of Industrial Works, for giving me valuable information about previous studies in Samut Prakan on industrial production processes and pollution protection and control. Mr. Wibun Worawichai and Mr. Surasak Patimaprakhon from the Provincial Office of Industry in Samut Prakan, for giving me access to their statistical records and lists of entrepreneurs in Amphoes Bang Pli and Bang Bo. Mr. Manoon Theppithaksak from the Industrial Estate Authority of Thailand, for giving me information on industrial promotion zone. Mr. Suchat Watchawatthana, Manager of Bang Pli Industrial Estate, for providing an insight on waste management and other related problems in the Estate. Ms. Aranya Fuangsawat from the Groundwater Division, Department of Mineral Resources for providing me with information on water consumption of industrial activity in Amphoes Bang Pli and Bang Bo. Mr. Wichai Kettapan from Division of Regional and Town Planning, Office of National Economic and Social Development Board and Mr. Thongchai Roachanakanan and his colleagues from the Department of Town and Country Planning, for discussing problems on urban planning. Mr. Samit-Bunchom Panwatwichai from the Division of Planning and Projects, Ms. Chudarat Intharawichai from the Provincial Administrative

Organisation and Mr. Somkhit Sirisom from the Provincial Office of Public Works, for supporting information on environmental problems of Samut Prakan Province.

Ms. Vacharin McFadden, a Thai librarian of the Australian National Library, for giving me additional information that I missed from fieldwork. Ms. Penny Hanley for excellent proof reading. Mr. Keith Mitchell for reproducing all the fine maps. Also, there are friends who shared their information, ideas and experiences to the benefit of the thesis. I want to give my sincere thanks to Porphant Ouyyanont, Julaporn Euaruksku1, Sureeporn Punpuing, Tosporn Boonyarith, Orawan Poo-Israkij, Kulya Nitirungjarus, Taisuke Miyauchi, Suthinee Kupa, Michael Southon, Patrick Jory, Elizabeth Lawrence, Peter Van Diermen, Yvonne Byron, Sakkarin Niyomsilpa, Merv Commons, Rapin Quinn and Peter Urich.

Unforgettably, local residents in Amphoes Bang Pli and Bang Bo, Samut Prakan who shared their experience and feeling on environmental change. My parents, brothers and sisters who have never failed to encourage me to finish my study. Without their support, I could hardly have accomplished my fieldwork in Samut Prakan on time.

Abstract

This thesis links the transformation of urban environment to city evolution under different phases of capitalism. Soja's interpretation of city evolution based on industrialisation and urban form was elaborated to include physical and social environmental changes and illustrated in reference to three cities — Manchester as a competitive industrial city (1840s-1910s), Chicago as a corporate-monopoly city (1920s-1940s), and Tokyo as a state-managed city (1950s-1970s). Bangkok differed from that prototype and exhibited three different phases of development — the post-*Sakdina* city (1850s-1920s), the bureaucrat-managed city (1930s-1950s), and the privatised city (1960s-1970s). Whereas economic turbulence and social unrest underpinned Soja's model, political instability or power struggles was the main cause of urban change in Bangkok.

Since the mid-1980s, the influx of direct foreign investment has poured into Greater Bangkok sustaining the 'privatised' city. As it is difficult to investigate the interrelationship between industry, water and community throughout Greater Bangkok, a case study was undertaken of Amphoes Bang Pli and Bang Bo in Samut Prakan. Rising investment resulted in rapid industrialisation and accelerated urbanisation which, in turn, has led to a deterioration in surface water quality and harmed the pre-existing peasant economy and society. With the support of the Thai State, private enterprise has transformed a once pristine environment into built environment to extract profit without investing in environmental protection and control.

The State and external pressure groups (i.e. superpower nations and international financial organisations) have competed with each other to influence policy making. Although the State is mainly responsible for urban maintenance and service, Thailand's administrative structure and bureaucratic system have been major barriers to better environmental management. The central government intervened in provincial and local urban management to ensure either national economic and social development guidelines were met or the needs of Cabinet were accommodated. However, no one can benefit from the privatised city if the urban environment continues to deteriorate at an accelerating rate.

Table of Contents

Page

List of Tables

Page

Page

Page

List of Figures

Page

Page

Abbreviation

APHA	American Public Health Association
AWWA	American Water Works Association
BMA	Bangkok Metropolitan Area
BOD	Biochemical oxygen demand
BOD_5	Biochemical oxygen demand within 5 days
BOI	Board of Investment, the Office of the Prime Minister
BOT	Bank of Thailand
CBD	Central business district
CCRDPL	Cooperation Centre of Rural Development at Provincial Level
CD	Customs Department, Ministry of Finance
CDD	Community Development Department, Ministry of Interior
DA	Department of Aviation, Ministry of Transport and Communication
DF	Department of Fisheries, Ministry of Agriculture and Cooperative
DH	Department of Health, Ministry of Public Health
DIW	Department of Industrial Works, Ministry of Industry
DO	Dissolved oxygen
DPP	Division of Planning and Projects, Samut Prakan
DPW	Department of Public Works, Ministry of Interior
DTCP	Department of Town and Country Planning
FPDPC	Five-Year Provincial Development Planning Committee
GPP	Gross Provincial Product
GRP	Gross Regional Product
GSI	Geographical Survey Institute
IEAT	Industrial Estate Authority of Thailand
IEAT	Industrial Estate Authority of Thailand, Ministry of Industry
JPPCC	Joint Public and Private Sector Consultative Committee
LDD	Land Development Department, Ministry of Agriculture and Cooperative

MAC	Ministry of Agriculture & Cooperative
MC	Ministry of Commerce
MD	Ministry of Defence
ME	Ministry of Education
MF	Ministry of Finance
MFA	Ministry of Foreign Affairs
mg/l	milligramme per litre or part per million
MI	Ministry of Interior
MJ	Ministry of Justice
MNEs	Multinational enterprises
MOI	Ministry of Industry
MP	Ministry of Public Health
MPN/100 ml	most probable number per 100 millilitres
MSTE	Ministry of Sciences, Technology & Environment
MTC	Ministry of Transport & Communications
MU	Ministry of University Affairs
MWA	Metropolitan Waterworks Authority, Ministry of Interior
NED	Non-formal Education Department, Ministry of Education
NHA	National Housing Authority, Ministry of Interior
NSO	National Statistical Office
ONEB	Office of National Environment Board
ONESDB	Office of National Economic and Social Development Board
OPM	Office of the Prime Minister
PAO	Provincial Administrative Organisation
POI	Provincial Office of Industry
POPH	Provincial Office of Public Health
POPW	Provincial Office of Public Works
POSP	Provincial Office of Samut Prakan
RFD	The Royal Forestry Department, Ministry of Agriculture and Cooperative
RD	Revenue Department, Ministry of Finance

RID	The Royal Irrigation Department, Ministry of Agriculture and Cooperative
RTG	The Royal Thai Government
SISAT	Seatec Institutional Southeast Asia Technology
TDRI	Thailand Development Research Institute
TISTR	Thailand Institute of Scientific and Technological Research
TMG	Tokyo Metropolitan Government
TMM	Town Municipality of Muang, Samut Prakan
TMP	Town Municipality of Phrapradaeng, Samut Prakan
TSS	Total suspended solids
µg/l	microgramme per litre
WPCF	Water Pollution Control Federation

INTRODUCTION

TRANSFORMING THE SAMRONG CANAL

Mai pen rai [Never mind!]
Common Thai saying

In the 1970s, agricultural and fish-farming areas along the Samrong Canal in Greater Bangkok's Samut Prakan were peaceful and pleasant districts (Figure 0.1). The Canal was essential to daily life of the local people. They bathed, caught fish, and regularly pumped water into their farms from the Samrong Canal. Farmers used to paddle boats (*rua phai*) to go about their business, send their children to school and attend the temple or mosque. Above all, they obtained good harvests and received good prices from both middlemen and Bangkok's Pakkhlong Talat market.

Now the area is virtually surrounded by new factories, fresh housing developments with their distinctive appearances from low budget matchbox shop-houses to expensive Spanish and Grecian-style villas, lavish shopping plazas, new golf courses, busy transport terminals and the exciting King Kong Island theme park. These developments have put a premium on fresh water causing several farmers to abandon their livelihood. Others have been pressured by their landlords to leave so that the landlords can sell the land to developers.

These threats to existing economic activity reflect the accelerating sprawl of Greater Bangkok. Urbanisation and industrialisation have drawn heavily on ground water resources triggering land subsidence. Every year, annual floods bring most parts of Bangkok's land transport to a halt. Furthermore, heavy reliance on motor vehicles has created a serious air pollution problem, and indiscriminate disposal of factory and human waste has polluted waterways. All these negative effects not only perturb the communities but they also lead entrepreneurs to consider relocating their industries.

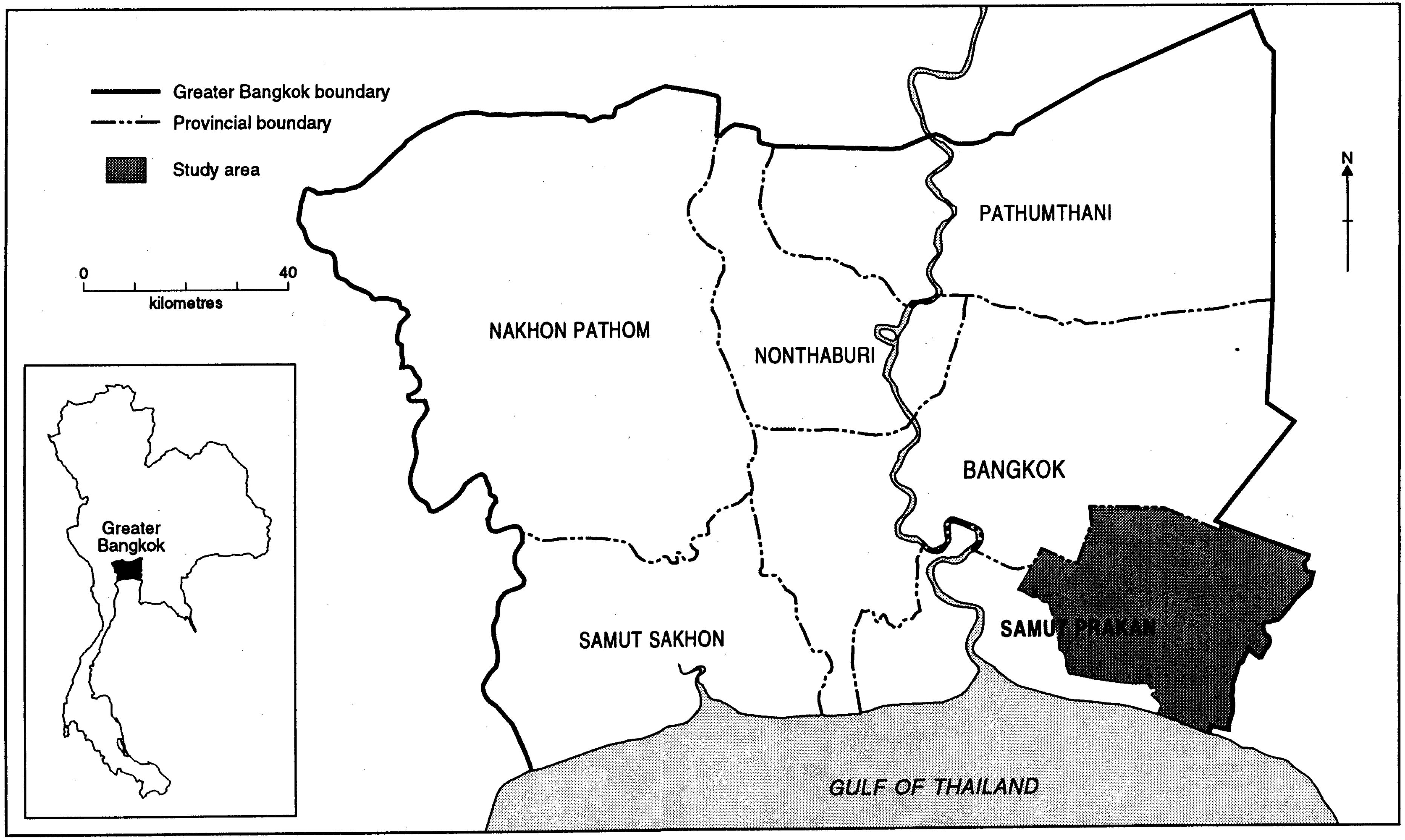


Figure 0.1 Greater Bangkok and Site of the Study Area, Amphoe Bang Pli and Amphoe Bang Bo

If this process continues, the long-term sustainability of Greater Bangkok is questionable with soothsayers predicting that it will suffer the same fate of the once vibrant Thai and Khmer cities of U Thong, Phimai, Chiang Saen, Srisatchanalai, Sukhothai, and Lopburi. The decline of these cities, however, pre-dated Thailand's incorporation into the capitalist world economy.

Issues

The threat to Greater Bangkok is different from the fate of those ancient cities predating Thailand's entry into the capitalist system. It stems from the incorporation of Thailand into the capitalist world economy. In the past, there has been a long tradition of exploiting Thailand's natural resources — the decimation of its teak forests bears stark testimony to that practice. Now, the same type of exploitative mentality is being applied in a new phase of capitalist development. The extended metropolitan areas being created in response to direct foreign investment provides devastating evidences of the State's passive reaction to market forces. Although laws exist, the political system is unwilling to control the trajectory of privatised development. Social costs are ignored. Consequently, Greater Bangkok's urban environment is deteriorating rapidly.

Before suggesting how the system can be controlled questions about city evolution and its relationship to environmental processes need to be asked. Because this paper focuses attention on material flows, it is necessary to know how the urbanisation and industrialisation process in Greater Bangkok differs from cities in nineteenth century England, early-twentieth century United States and mid-twentieth century Japan.

During the 1980s the unprecedented rate of direct foreign investment in Thailand has attracted several new manufacturing industries that have had a severe environmental impact on the community. The environmental degradation of these new industries are concentrated on Greater Bangkok's Eastern Corridor which provides the link between the Thai Capital and the booming Eastern Seaboard. In gauging the extent of the degradation we need to know how polluting industries, such as food processing, plastics, chemical and metal products affect the community. Then we will be in a position to consider the policy implications.

Thesis Structure

Concerning the previous discussion we will focus on determining the key issues that affect Greater Bangkok's sustainability. In particular, we need to outline how they can be investigated. In considering these issues the thesis is divided into three parts (Figure 0.2).

Part I provides a context for examining the relationship between city evolution and how it is related to the environmental processes by forging a link between the production system and the physical and social environment. This link is explored in a series of case studies to determine the changing connection between city evolution and the nature of industrialisation at critical stages in economic development since the Industrial Revolution (Chapter 1). Then the development of Bangkok is assessed in terms of how it has differed from the conventional pattern of urbanisation and industrial progress (Chapter 2). The historical investigation provides the springboard for understanding current Greater Bangkok and Samut Prakan. Background information on political, economic, environmental and social aspects crystallises the two different scales of conceptual framework suitable for studying contemporary Greater Bangkok (Chapter 3).

Part II discusses the existing nature of industry, water quality and people in two districts — Amphoe Bang Pli and Amphoe Bang Bo, Samut Prakan. As production is of critical importance in determining the nature of the relationship between industry, water and people, an examination is made of the production processes and their wastes of four different industrial activities — chemicals and chemical products, fabricated metal products, plastic and allied products, and food processing industries (Chapter 4). Then attention is directed to the quality of surface water that receives waste water from the

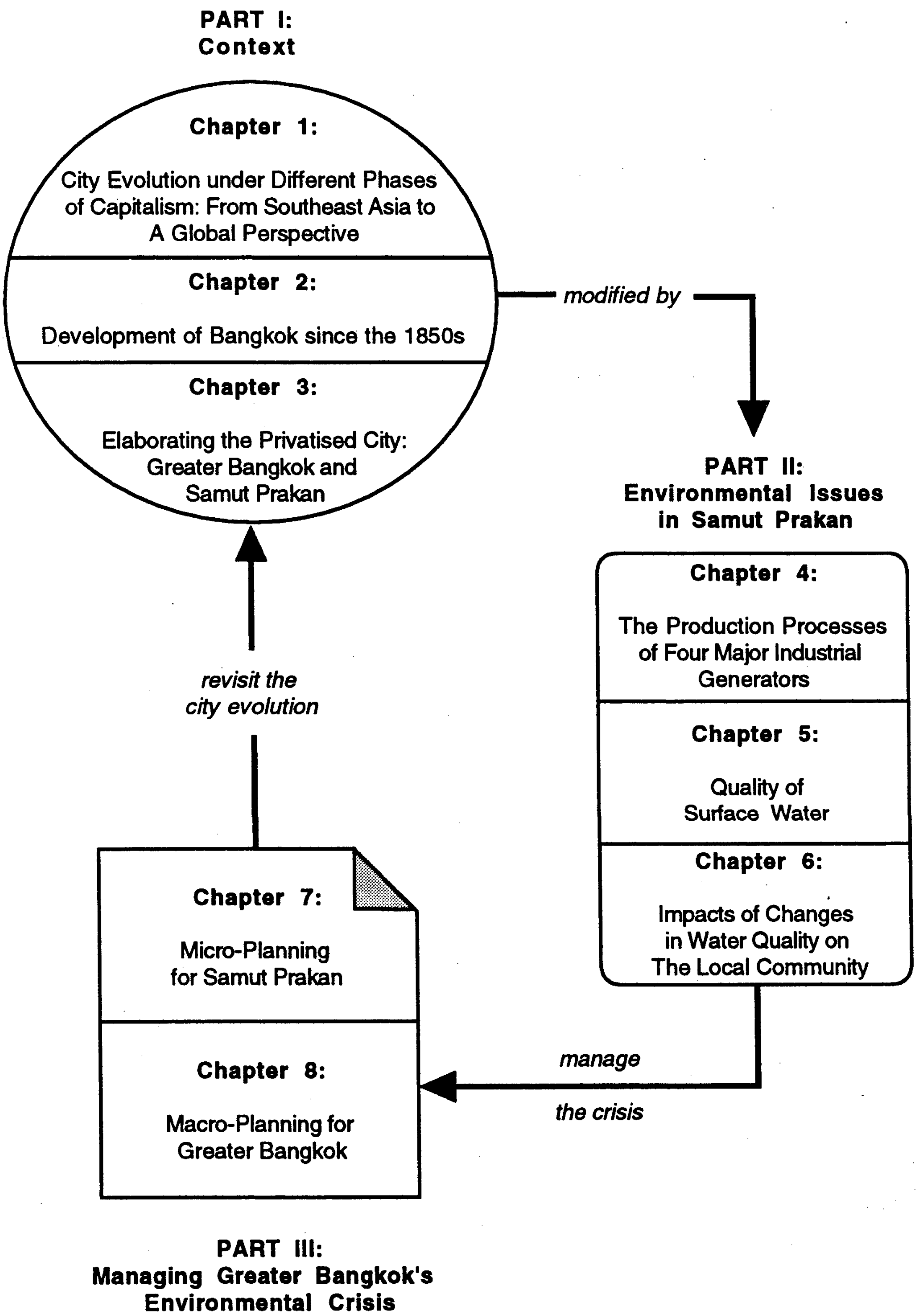


Figure 0.2 Thesis Structure

industries and communities (Chapter 5). Later the impact of water pollution on the local people and communities' actions to the problems are considered (Chapter 6).

Finally, Part III suggests methods for managing the crisis. In the light of the study undertaken in Amphoes Bang Pli and Bang Bo, micro-planning methods are reassessed through the examination of the Provincial Government's role, the State intervention and State-business relation in urban environmental management (Chapter 7). Then macro-planning procedures for Greater Bangkok are reconsidered by investigating the effectiveness of industrial, urban and environmental policies and bureaucratic systems (Chapter 8). The Conclusion of the thesis reviews these findings in terms of Greater Bangkok's role in an evolving world economy. Before proceeding to outline the context of the study we need to elaborate the key components of an appropriate conceptual framework.

Conceptual framework

A conceptual framework is established for studying case studies of selected cities at different phases in the evolution of the world economy and Greater Bangkok. Before elaborating on this framework at appropriate stages of the thesis recurring elemental features need to be defined and interrelationships between them established. The conceptual framework focuses upon the relationship between city evolution and the production system. As shown in Figure 0.3, it examines linkages between three elements.

I. The production system

Attention is focused on tracing inputs of resources, energy and technology into the production system, the nature of technology and the outputs of goods and waste.

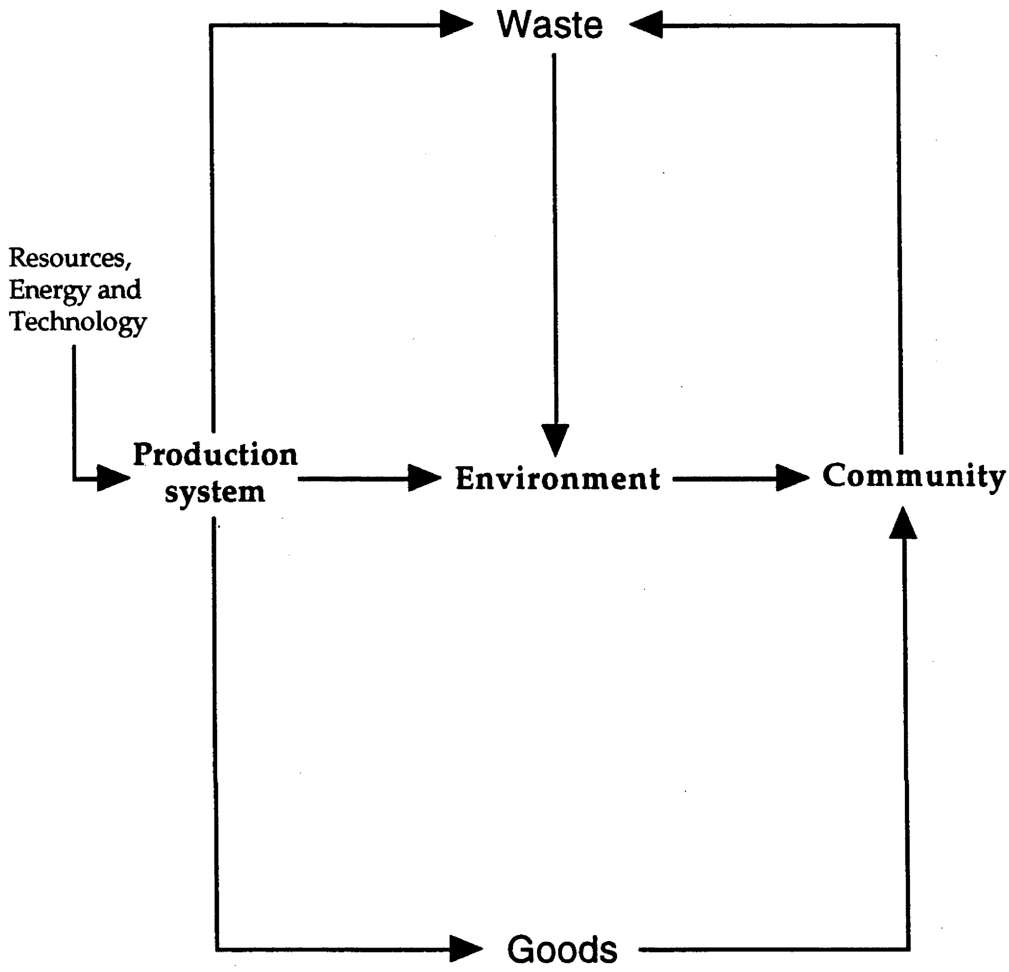


Figure 0.3 Interrelationship between Production System, Environment and Community

II. Environment

Interest is concentrated on waste products, particularly those that enter the water cycle (e.g. drainage system).

III. Community

Consideration is then given to the effects of waste products on: (a) the local economy, notably farms and fishing; (b) household economy including both formal and informal activities; and (c) individuals covering both amenity and aspect of the quality of life (e.g. health).

Consequently, all inputs to the production system are from the city, its vicinity and overseas (i.e. resources, energy and technology). The quality of outputs (i.e. goods and waste) depends upon the level of industrial technology or innovation. Therefore harmful waste from the production system affects the environment and, in turn, the communities. In addition the community generates significant waste. If the city and vicinity cannot manage its waste, its society and economy will be destroyed. After identifying the major relationships between key components we are in a position to discuss the evolution of the urban form.

PART I

CONTEXT

CHAPTER I

CITY EVOLUTION UNDER DIFFERENT PHASES OF CAPITALISM: FROM SOUTHEAST ASIA TO A GLOBAL PERSPECTIVE

Changes in the nature of cities since the mid-nineteenth century have been the focus of endless debate. Initially, scholars were content to outline size, form and function. In the early twentieth century, with the inception of the Chicago School, interest switched to the ecology of cities — the distribution and segregation of race, culture, income and occupation. Subsequently, these studies were criticised by political scientists for their preoccupation with static pictures of the city rather than its evolution (Tabb and Sawers, 1978: 7).

This criticism led to a new focus which saw the size, shape and function of the city as the outcome of the activities of capitalist agents — construction contractor, developers and real estate agents — and an accommodating local and national state. In addition, all cities are unique. Bangkok's experience, therefore, is distinctive. Geographers, however, seek to generalise from the experience of individual cities. This creates a problem because it is not possible to study all cities. How can they be grouped together so that general lessons can be obtained from their experiences? More specifically, what is the appropriate reference group for Bangkok? Should attention be confined to cities in Thailand; is Southeast Asia a more appropriate focus; or should Bangkok be seen part of a hierarchy of world cities?

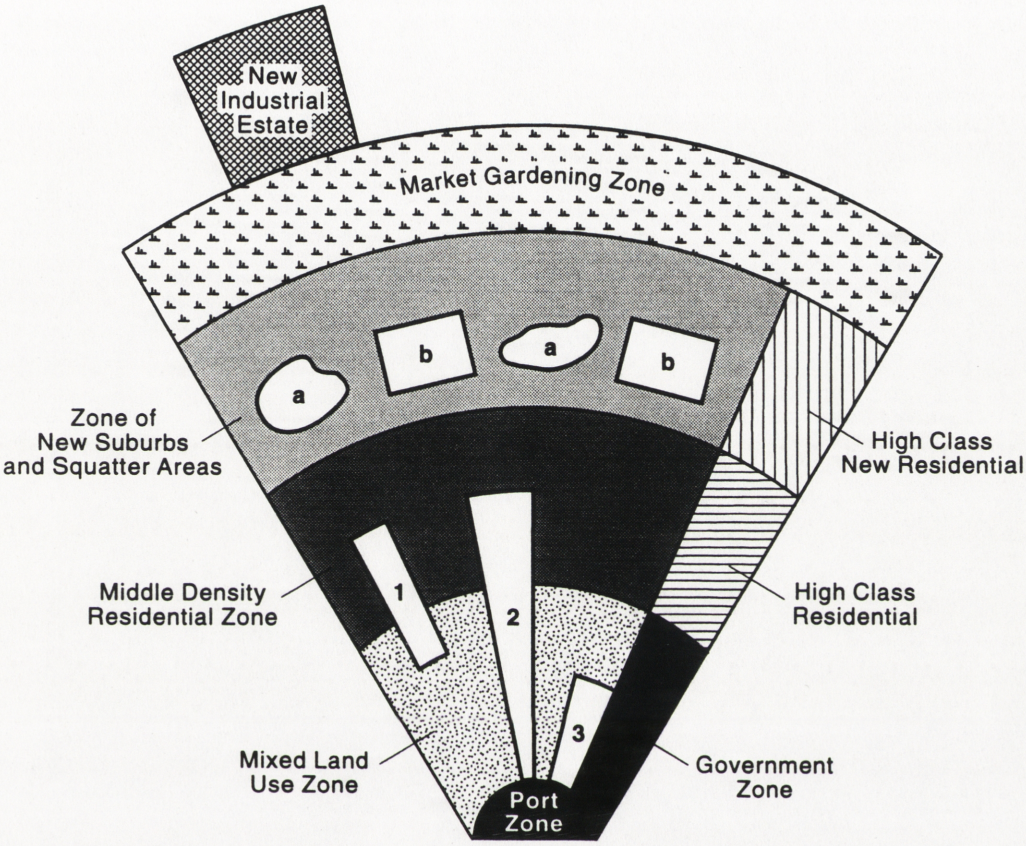
These issues are addressed by initially examining Bangkok as a Southeast Asian city. Particular attention is paid to McGee's (1967) model of a Southeast Asian city. The analysis shows Bangkok does not fit neatly into a model based on Southeast Asian experience (Section 1). This finding led to an attempt to fit Bangkok into a hierarchy of world cities (Section 2). Specific reference is made to Soja's (1989) model. Although this model pays particular attention to the changing political economy of cities over time it does not consider environmental impacts arising from rapid urbanisation and accelerated industrialisation. Attention was, therefore, focused on exploring these impacts by examining industrialisation, water quality and community in the competitive industrial city, the corporate-monopoly city and the state-managed Fordist city typified by Manchester in the 1870s (Section 3), Chicago in the 1920s (Section 4) and Tokyo in the 1970s (Section 5). The results of this exercise were used to highlight the degree to impacts of contemporary industrialisation differed from the past. Evidence form Bangkok can then be used in the Conclusion to determine if its experience has lessons for other mega Southeast Asian cities or even neglected Thai cities.

1. BANGKOK AS A SOUTHEAST ASIAN CITY?

McGee's (1967) classic analysis of Southeast Asian cities highlights the three periods of transition experienced in their evolution. Initially, he identified the period of indigenous urban development prior to the sixteenth century and featured the sacred cities (e.g. Angkor Thom of the Khmer Empire) and the market or port cities (e.g. Pattani and Malacca). Then he outlined the colonial phase and the rise of the port cities (e.g. Batavia, Manila and Singapore) and Kuala Lumpur's mining origins. Finally, he considered the post-independence phase when governments and their large bureaucracies sought to develop symbolic cities for new nation-states.

These patterns led McGee (1967: 128) to formulate his Southeast Asian city 'model' which differed from the generalised concentric model in Western cities (Figure 1.1). It featured:

(a) The Port Zone;
(b) The Mixed Land Use/Government Zones;
(c) The Middle Density Residential/High Class Residential Zones;
(d) Zone of New Suburbs and Squatter Areas/High Class New Residential;
(e) Market Gardening Zone;
(f) New Industrial Estate.



a Squatter Areas

b Suburbs

Source: McGee, 1967

1 Alien Commercial Zone

2 Alien Commercial Zone

3 Western Commercial Zone

Figure 1.1 Generalised Diagram of The Main Land Use Areas of The Largest Southeast Asian City

As Thailand was never colonised Bangkok's urban structure differed from McGee's (1967) model drawn from the colonial cities. Although Bangkok had a Port Zone and Market Gardening Zone (with New Industrial Estate attached) it never had a distinct Central Business District comparable to Jakarta, Saigon and Singapore. In some ways Bangkok, therefore, was an 'atypical city' in the late 1960s with the bazaar economy overwhelming its firm-centred counterpart (McGee, 1967: 127).

After the publication of McGee's *Southeast Asian City* Singapore diverged from its counterparts by becoming one of the Newly Industrialising Economies. Although Singapore enjoyed the boom from increased industrialisation the city-state managed the environmental effects of rapid industrialisation better than Hong Kong, Seoul and Taipei. This result was attributed to superior planning and government intervention in a model 'Tropical City' (Savage, 1992).

When industrialisation spread to Malaysia its planners were able to contain some of its worst environmental impacts in Kuala Lumpur by drawing on Singapore's experience (and their common British planning backgrounds). This has not been the case in Indonesia, the Philippines and Thailand. Rapid industrialisation and population growth from heavy in-migration has seen the development of extended metropolitan areas with severe urban problems — inadequate housing, traffic congestion and environmental problems (Table 1.1). Attention here is focused on those environmental problems involving water quality.

In Jakarta two-thirds of the city's population derives its water exclusively from ground water. As many of these wells have been overdrawn they have been affected by seawater and abandoned. Water quality has been affected up to 8 kilometres from the coast in northern Jakarta. It costs $US20-30 million per year to boil water for home use (Sharma, 1986 cited in Lee, Nickum and Gregory, 1992; World Bank, 1991: 156).

Table 1.1 Population Number and Growth in Singapore, Kuala Lumpur, Bangkok, Manila and Jakarta in 1960, 1970, 1980 and 1990

Cities	1960		1970		1980		1990	
	Population no.	Growth (%)	Population no.	Growth (%)	Population no.	Growth (%)	Population no.	Growth (%)
Singapore	1,023,700	-	2,074,507	102.6	2,390,800	15.2	3,002,800	25.6
Kuala Lumpur	316,230[a]	-	451,977	42.9	919,610	103.5	n.a.	-
Bangkok	1,704,774	-	2,495,286	46.4	4,697,071	88.2	5,876,000	25.1
Manila	1,138,611	-	1,330,788	16.9	1,630,485	22.5	1,876,195	15.1
Jakarta	2,906,533	-	4,576,009[b]	57.4	6,503,449	42.1	n.a.	-

Note: a - 1957, b - 1971, n.a. - not available

Source: United Nations, various issues of *Demographic Yearbook*

In Manila an estimated 600 tonnes of solid waste are left on the streets each day or dumped directly into storm drains, canals, and rivers. Often hazardous wastes from industry are disposed of in regular public dump sites or in waterways (Hechanova, 1990 cited in Lee, Nickum and Gregory, 1992).

In Bangkok most low-income communities consist of housing constructed over areas of constant flooding. They lack both sewerage and public garbage services. Discharge of industrial and domestic waste into canals have given rise to obnoxious smells (Yab, 1989 cited in Douglass, 1991: 6).

Jakarta, Manila and Bangkok have similar environmental problems but the forces driving them are not confined to Southeast Asia. They are international and global in scope. Rather than compare Bangkok to Jakarta and Manila and seek to derive lessons from Singapore and Kuala Lumpur it is preferable to examine the development of cities in a wider historical and geographical context.

More specifically, how does the impact of industrialisation on Bangkok's environment differ from that in Manchester during the 1870s, Chicago during the 1920s and Tokyo during the 1970s. Such questions need a new model. While McGee's (1967) model was appropriate for the late 1960s a new model is required for the 1990s which reflects the international dimension of urbanisation. This led to a consideration of Soja's model.

2. SOJA'S FRAMEWORK

Basically capitalism always operates to extract profits. If capitalism fails to restore rising surpluses, it usually seeks to restructure physical and social formations in order to start a new growth of earnings. From this point of view, the evolution of urban form has followed the restless rhythm of formation and reformation that has shaped the macro-geographical landscape of capital. Edward W. Soja (1989: 173-83) captured this fundamental perception of capitalism. In his book: *Postmodern Geographies,* he describes how the city has evolved through three phases corresponding to qualitative changes in the nature of capitalism. As outlined in Figure 1.2, during the period from 1820s-1970s Soja recognised four prototypes of the North American city:

(a) the *mercantile city* characterised by the port and mill town;

(b) the *competitive industrial city* marked by the emergence of a distinct Central Business District (CBD), industrial district and working class residential area;

(c) the *corporate-monopoly city* distinguished by the tertiarisation of service activities in the CBD, the shift of the industrial district and creation of satellites, spread of working class residential area and emergence of a more distinct residential area; and

(d) the *state-managed Fordist city* typified by the internationalisation of the CBD, urban renewal and gentrification, the expansion of working class and élite residential areas and increased number of minority ghettoes, and an emerging outer city incorporating a new industrial district.

The transition from one stage to another was marked by a crisis in the nature of capitalism, underlining Harvey's (1989: 162) contention that:

> Capitalism builds a physical and social landscape in its own images, appropriate to its own condition at a particular moment in time, only to have to revolutionise that landscape, usually in the course of crises of creative destruction at subsequent point of time.

Recession, depression and social upheaval led to the old form being jettisoned and a new one being adopted. A period of expansive growth occurred during which the distinctive form evolved until it too fell victim to recession, depression and upheaval.

As shown in Table 1.2, the competitive industrial city, typified by Baltimore, Boston, Manchester, New Orleans and Philadelphia, was the dominant form between the 1840s and the 1910s. It was brought to an end by the depression of the last decade of the nineteenth century and the First World War (1914-1918). The corporate-monopoly city,

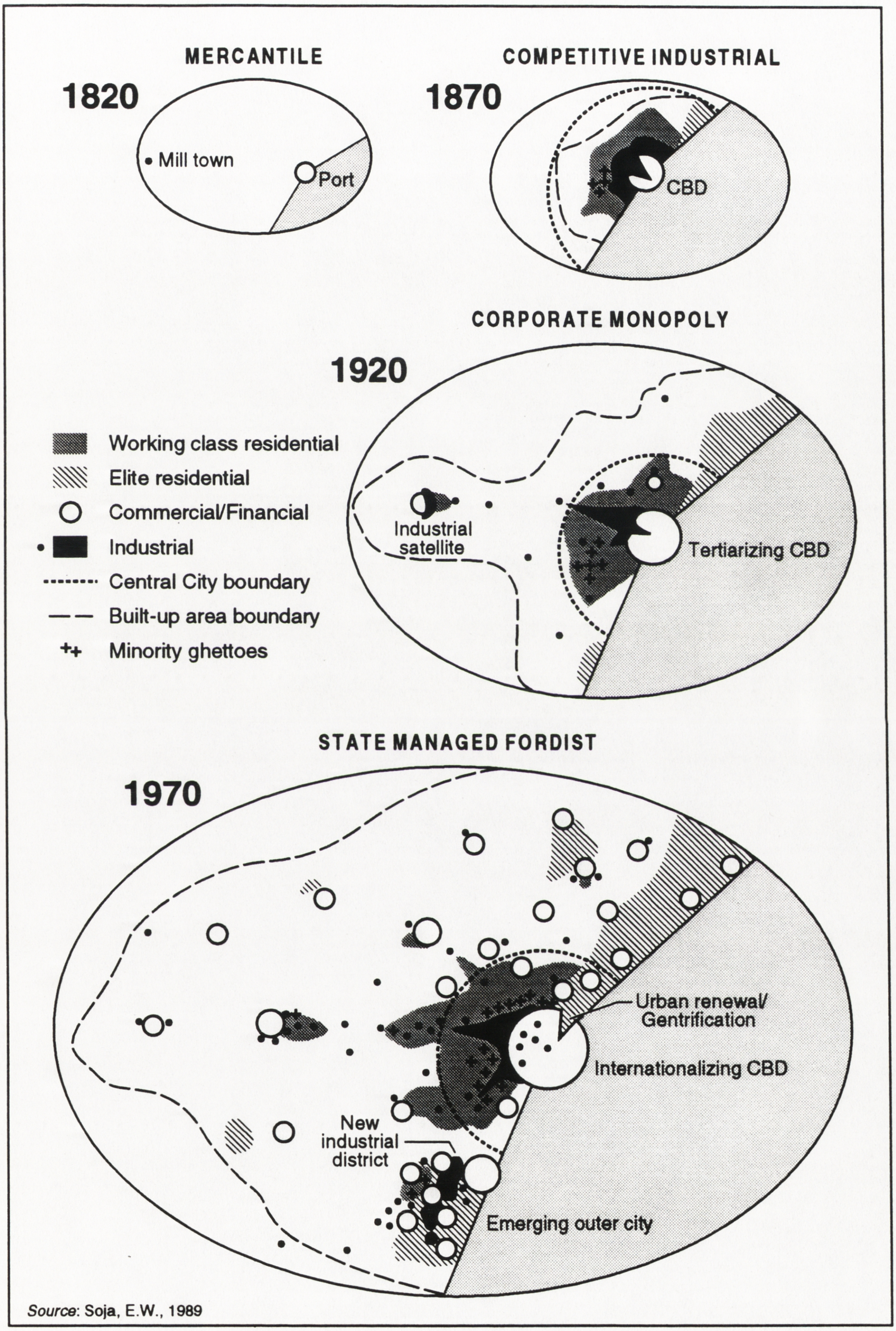


Figure 1.2 The Evolution of Urban Form: Prototypes of the North American City, 1820-1970

Table 1.2 The Evolution of City in Different Phases of Capitalism

City type	Dates	Characteristics	Examples
Competitive Industrial City	1840s-1910s	Never before was industrial capital and production concentrated in the city. This capital nodality had formed social segregation of wealth and employment. Each social class is homogeneous forming urban compartments and enclosures. It was clearly seen that spatial organisations or hierarchical city-systems created the growing traditional function of social control, commercial accumulation, and political administration.	Baltimore Boston Manchester New Orleans Philadelphia
Corporate Monopoly City	1920s-1940s	In an emerging age of imperialism, capitalism was markedly intensified through the increasing concentration of capital in corporate monopolies. Industrial production became less concentrated around the city centre, as factories spread into the formerly residential inner areas or into satellite industrial centres. The old urban cores became increasingly tertiarized with an expanding number of corporate headquarters, government offices, financial institutions, and supportive service and surveillance activities.	Chicago Detroit Dusseldorf Los Angeles Lyons
State-Managed Fordist City	1950s-1970s	After the Great Depression, there was an expansive metropolitanisation, which was caused by increasing centralisation, concentration, and internationalisation of corporate capital; increasing segregation of labour based on a changing organisation of the production process; increasing urban political fragmentation and disagglomeration of working-class communities; and greater role for the state in both fostering accumulation and maintaining legitimised labour discipline.	London Hong Kong New York Sydney Tokyo

Note: The above table is derived from Soja's work (1989) illustrated by Chicago, Detroit, Dusseldorf, Los Angeles and Lyons, was the distinctive pattern between the 1920s and the 1940s. It was terminated by the Great Depression of the 1930s and the Second World War (1939-1945). Since the 1950s, the state-managed city, exemplified by Hong Kong, London, New York, Tokyo and Sydney, has been the leading urban form.

This sequential framework has been valuable in distinguishing different city prototypes in terms of qualitative changes in the nature of capitalism. Moreover, it considerably indicates that each type of the city has not been marked by great turnabouts and complete system replacements, but rather by an evolving sequence of partial and selective restructuring that does not erase the past or destroy the deep structural conditions of capitalist social and spatial relations. However, Soja and other scholars in urban studies, have never mentioned the impact of these changes on the physical environment — air, water and land — or to the resident communities. In a bid to discuss these neglected aspects, an examination is made of the interrelationships between industry, and the physical and social environment for each of Soja's city prototypes using a series of case studies.

3. COMPETITIVE INDUSTRIAL CITY — MANCHESTER

As a means of discussing the interrelationships between industry, and the physical and social environment within the competitive industrial city an examination is made of Engels' Manchester (1892) in *The Condition of the Working-Class in England in 1844*. Engels showed that Manchester characterised the competitive industrial city. As it was a centre of finance and commerce its circular spatial pattern featured a CBD comprising offices and warehouses but few residences. Factories were interspersed within the working class residential areas to the south and centre of the city and surrounding towns such as Bury, Rochdale, Oldham, Ashton and Stockport. Middle and upper classes were located to the north and west of the CBD in Salford, Hulme, Broughton and Cheetham Hill (Figure 1.3).

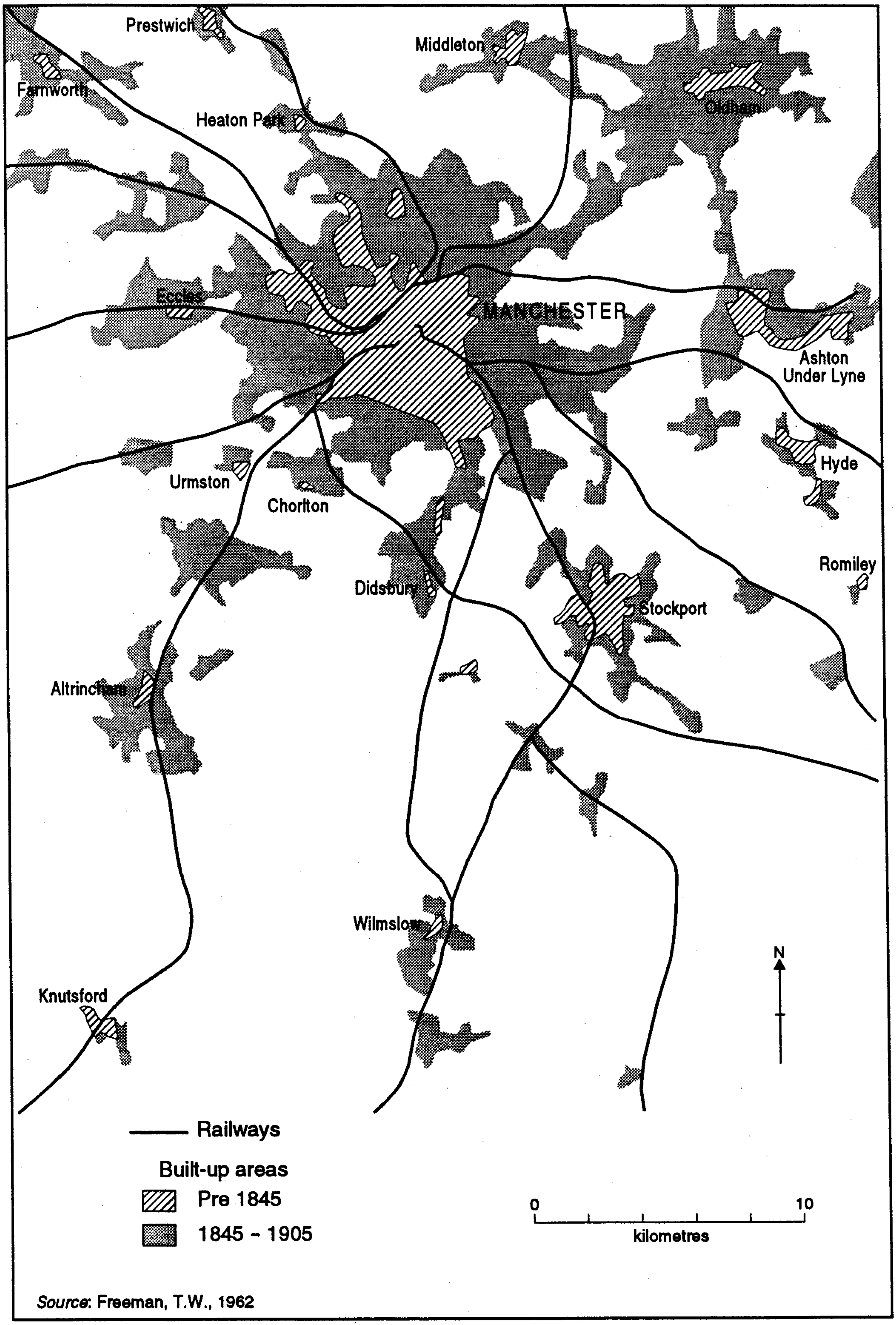


Figure 1.3 Map of Manchester during 1845-1905

A recurrent feature of an analysis can be drawn as a flow chart illustrating the interrelationship between the production system, urban environment and community, and the flow of goods, capital and pollution (Figure 1.4).

Manchester, 1840s-1910s

As reflected in Figure 1.3, Manchester's urban area was shaped by flows of capital, goods and waste. Its early nineteenth century transformation into a competitive industrial city was brought about by the changeover from water-powered to steam-powered production. In particular, cotton textile production facilities had migrated from their water-powered sites in the back country into a central location which could take advantage of both coal supplies brought by river, canal and eventually rail and banking services. In 1841, the Parish of Manchester had 125 cotton factories and thirty silk mills. By the mid-1850s, with the advent of the railways the suburbanisation and specialisation of industry was already evident (Carter, 1983; Messinger, 1985: 115-117; Shaw, 1989: 74). Activities associated with the textile industry, such as dyemaking and machinery, grew rapidly and provided the basis of chemical and engineering industries. Simultaneously, Manchester population grew from 180,000 in 1838 (municipal borough) to over 500,000 (city) in 1900.

The accelerated development of production led to the generation of industrial waste and air pollution. Much stemmed from the textile industry, particularly from its chimneys and bleaching and dyeing processes. However, as Manchester grew this was added to by wastes derived from other activities attracted to the growing industrial city. As noted by Engels (1892: 50) 'all drains and refuse from tanneries, bone mills, and gasworks find their way into the Irk'.[1] Clearly, the waterways in Manchester became a huge receiver of all industrial wastes.

---

[1] The Irk is one of the major waterways flowing through Manchester.

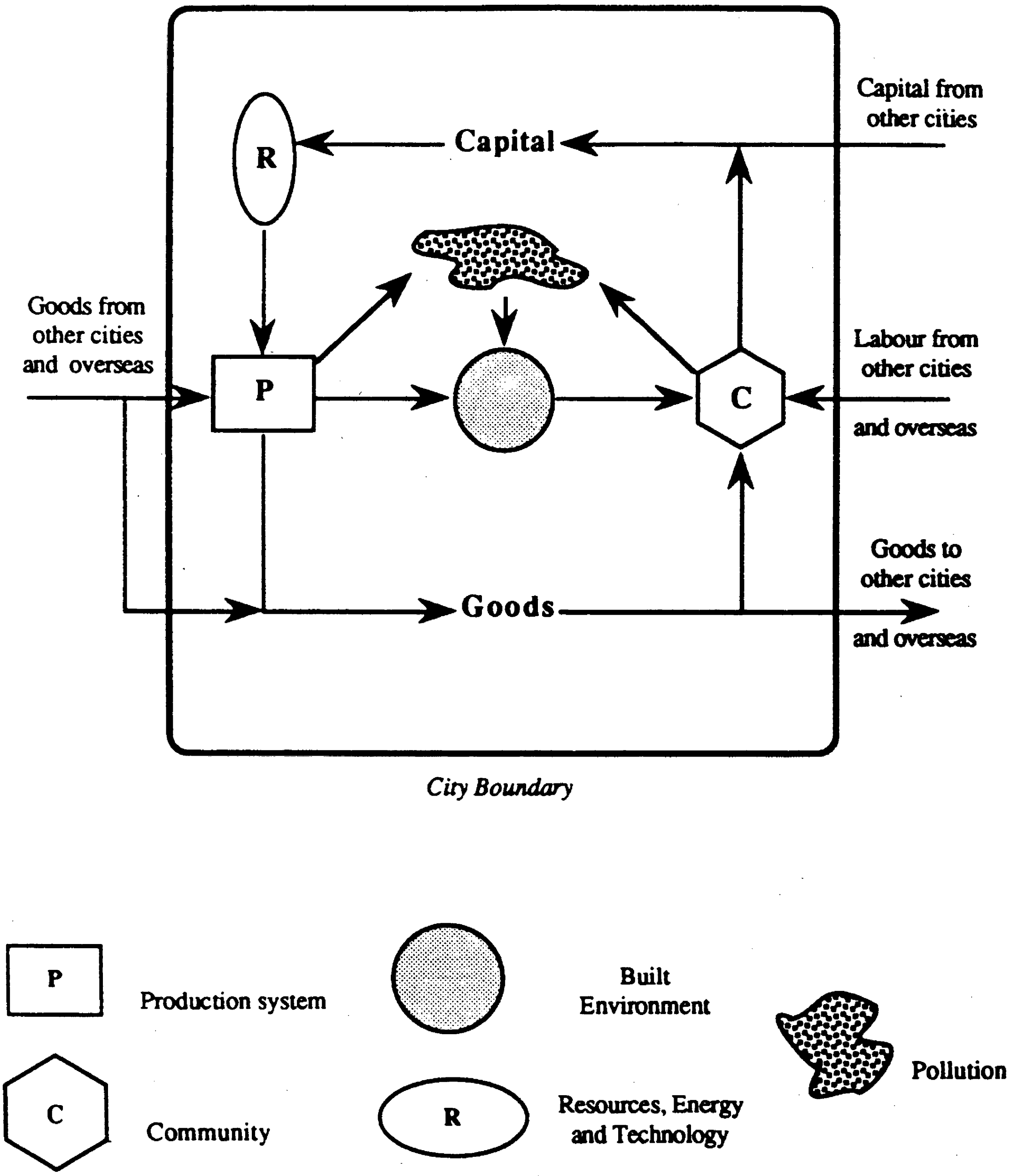


Figure 1.4 Competitive Industrial City, 1840s-1910s

Harmful industrial outflows were further augmented by community waste derived from the rapid influx of migration, particularly from Ireland, and housing construction. As Engels (1892: 50) highlighted, the Irk 'receives further the contents of all neighbouring sewers and privies. It may be easily imagined, therefore, what sort of residue the stream deposits'. Most working districts, however, had no common sewers and slops were thrown from windows into narrow and unpaved alleys. These alley ways were the haunt of numerous pigs which rooted in offal heaps.

The polluted water supplies and smoke affected community health. Engels (1892: 98-99) gave evidence that many people suffered from digestive ailments and typhoid besides lung problems. These problems were compounded by hot and damp working conditions in the mills (especially for women and children) and poor housing arrangements. The latter stemmed from the activities of 'jerry builders' who laid mean, two-storey houses in long straight streets, off which ran thousands of lanes and cul-de-sacs (Messinger, 1985: 24). Although residences were small, Engels (1892: 64-65) noted multiple occupancy particularly among the Irish immigrants:

> In a single house, there were two families in two rooms. All slept in one, and use the other as a kitchen and dining room in common. Often more than one family lived in a single damp cellar, in whose pestilent atmosphere twelve to sixteen persons were crowded together.

Small, badly-ventilated and damp, it was not surprising that Manchester's death rate was higher than in country districts. Most people were unhealthy. They were 'pale, lank, narrow-chested, hollow-eyed ghosts, languid, flabby faces, incapable of the slightest energetic expression' (Engels, 1892: 98).

According to Engels, Manchester's working-class were the victims of the city's unmanageable growth while individual industrialists enjoyed the benefits of capital accumulation. The tax base, however, was weak and local government was slow to exercise effective control over uncontrolled industrial and residential activities. Once this was effected adequate public utilities — gas, water, electricity, markets, parks, libraries and trams — could be provided and pollution regulated. The polluters moved beyond the city limits.

Manchester experienced minor recessions (e.g. business panic in 1857 and cotton famine during the American Civil War). Although cotton production moved overseas it continued as a prosperous commercial city until the Great Depression of the 1890s. By 1900 its economic power had attracted thirty-six governments to establish consular or other diplomatic offices in the city (Messinger, 1985: 116). While the classic industrial (Victorian) city revived until the First World War the nature of technology and capitalism was changing (Ward, 1983). A new dominant city form was emerging typified by Chicago.

4. CORPORATE-MONOPOLY — CHICAGO

The interrelationships between industry, physical environment and the resident communities within the corporate-monopoly are discussed by reference to Chicago between the 1920s-1940s (Figure 1.5). The headquarters of corporate monopolies were concentrated in the central area or the Loop tertiarized by government offices, financial institutions, service and surveillance activities. The old working-class districts around the Loop were mostly transformed into racial and ethnic ghetto enclaves. New working class housing was scattered around the metropolitan areas and increasingly segmented. The middle and upper classes escaped into separate suburbs. Industrial activities became less concentrated around the city centre, as they spread into the formerly residential inner areas or into satellite industrial centres within the State of Illinois such as Aurora, Berwyn, Cicero, Evanston, Harvey, Joliet, and Skokie and to the State of Indiana such as Gary and East Chicago. The urban landscape was apparently sprawling outward but broken into many pieces. The sprawl was accompanied by pollution because heavy manufacturing was moving to the peripheries — the result of uncoordinated site selection decisions by a variety of industrial corporations. Indeed, entrepreneurs often put

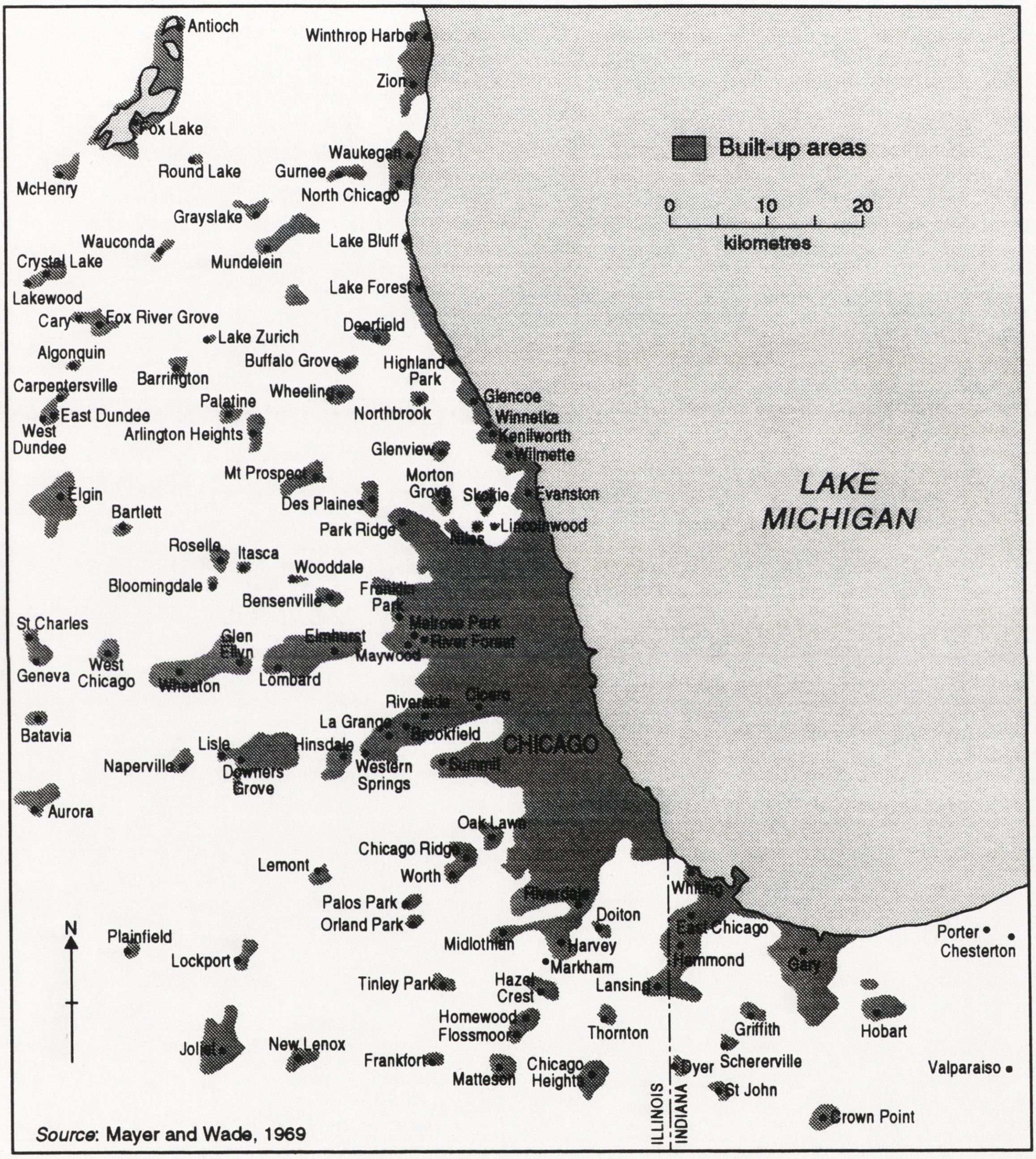


Figure 1.5 Map of Chicago in the mid-1940s

factories and new working class housing together in one controlled area without thought of environmental management.

A distinct pattern of corporate-monopoly city can be illustrated showing the interrelationship between production process, urban areas and community, and the courses of capital, goods and waste (Figure 1.6).

Chicago, 1920s-1940s

Figure 1.6 shows the marked changes in the qualitative and quantitative flows of capital, goods and waste in the corporate-monopoly city as compared to the early phase. Chicago in the first half of the twentieth century had transformed its industrial process from a steam-powered base to diesel- and electric-powered production. Industrial structure and size were diversified and broadened due to additional innovation and financial strength under the monopoly capitalism of large firms. Many firms modified their industrial structure from primary manufacturing such as meat packing and food processing to more capital and technological intensive industries. Steel, agricultural and electrical machineries, electronics equipment, chemical and oil refinery, for instance, started to come off the assembly line in modest numbers. The modern industries grew rapidly and randomly, influenced by low land costs, good rail or motorway connection and sufficient service of electricity in the periphery or the new satellite towns of Chicago in the States of Illinois and Indiana, whereas the corporate headquarters were mainly in the city. Concurrently, the population of Chicago jumped from 2,700,000 in 1920 to 3,376,000 in 1930 (Mayer and Wade, 1969: 290).

The rapid growth of new industries and sophisticated production processes brought about complex and increased volume of water and air pollution. They distributed dirt and ugliness along the edges of Lake Michigan in the States of Illinois and Indiana and to the hinterlands to the West of Chicago. As Mayer and Wade (1969: 350-52) noted there existed extensive areas of heavy industry in the South of the city:

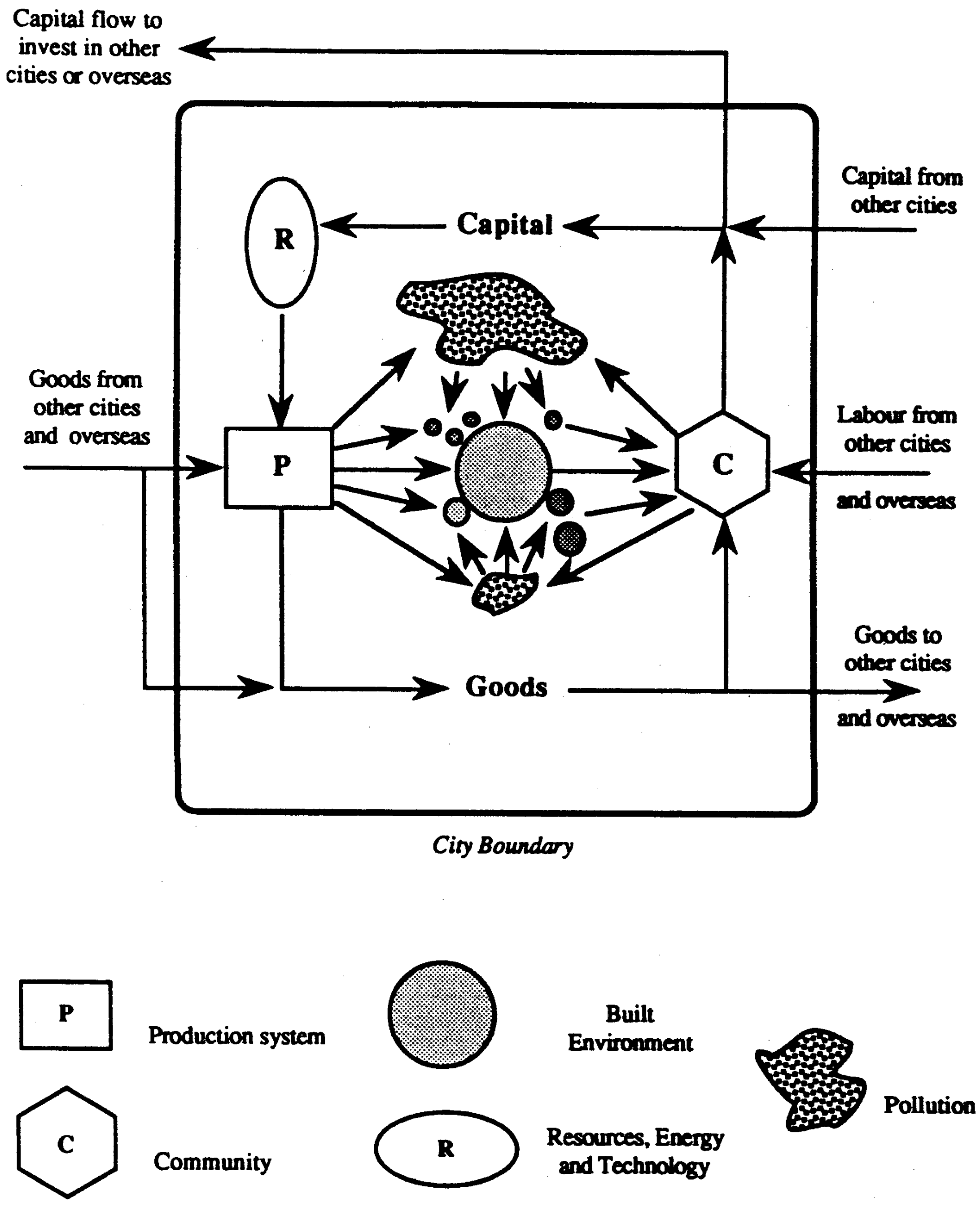


Figure 1.6 Corporate-Monopoly City, 1920s-1940s

> The six miles along the river between Lake Michigan and Lake Calumet became the axis of one of the world's great industrial complexes. Huge blast furnaces and rolling mills, acres of stockpiled ore, coal, and stone, towering grain elevators, the exposed tubing of chemical and paint works, large gantry cranes hovering over wharves and ships, and mile upon mile of drab, almost sullen buildings, crowded in around the water.

While most of Chicagoans were proud of their industries vigorously producing goods for domestic and international markets, their activities were also creating tremendous waste to themselves. It was obvious that 'Fire and smoke charged into the sky as a constant reminder to the world of Chicago's brute industrial growth' (Mayer and Wade, 1969: 352). Moreover, untreated waste water from a number of factories threatened the source of water supply from the Lake.

Community waste, especially from the city of Chicago, was very serious before the turn of the twentieth century. It was properly treated when the local government subsequently constructed a sewage system (Keating, 1988: 41-43). However, new residences built for the working class and afterwards the sites of heavy industries around Chicago had an inadequate sewage system. Although corporations had intended to guarantee themselves a stabilised labour force through subsidised housing support for workers, the housing programme did not provide proper infrastructure such as roads, water supply and waste control. All harmful outflows, both community sewage and industrial waste water, were managed similarly by releasing them into streams and the Lake of Michigan.

During the 1920s-1940s the dominant characteristics of communities were changing. In the early 1920s the influx of immigrants radically increased the congestion of ghettos and other low-cost housings which were just beyond the central business district. It was apparent that the old residential areas within four miles of State and Madison showed up as 'blighted areas'. As remarked by Mayer and Wade (1969: 316) 'The houses averaged well over forty years old; the residents were lowest on the economic and social scale, and delinquency, vice, and crime thrived'. Later there was certainly a building boom of new substantial residences for low-income families in the city, suburbs and the industrial satellites. At the same time some wealthier Chicagoans tended to move away from the congestion of central areas to the pleasant and uncluttered edges of the city. Some went farther out and built in the bourgeoning suburbs such as the 'Gold Coast' on the Near North Side (Mayer and Wade, 1969: 250-52).

In the 1930s-1940s more development took place outside of the city. However the living condition of the working class was still unpleasant, even though some corporations established housing programmes in different suburbs or satellite towns. As Mayer and Wade (1969: 244) noted: 'Housing for the workers was put up so quickly that the jerry-built character of the multiple-unit dwellings could not be disguised'. In addition many residents, living side by side with the factories, had to tolerate the industrial wastes. Crenson (1971: 37) also drew attention to the existing condition of the working class in two industrial centres of Chicago in the Indiana State: 'Gary and East Chicago are kindred cities, the homes of massive manufacturing installations ... in East Chicago it is not uncommon for a resident to see factory smokestacks from his back yard ... and in Gary it is not sufficient to put factories out of sight and smell'.

From the above description it is apparent that the working-class were the sufferers of the growing metropolis while the bourgeoisie and the industrial entrepreneurs took pleasure from Chicago's prosperity. According to Mayer and Wade (1969: 375), the city government could not earn adequate taxes for urban improvement because of the rapid suburbanisation:

> The suburban expansion drew away many of Chicago's substantial taxpayers, even the commercial and industrial base of the city dwindled as more and more firms located new establishments in the surrounding areas. As older middle-class residents left for the suburbs, low-income newcomers took their place. These people not only had fewer resources, they also had greater problems. Hence the city had to do more than before — in the way of housing, education, and welfare — with less money.

Although the local governments in suburbs and industrial towns gained taxes from the increasing industrial activity, it could not improve the urban problems and in particular the pollution. Such problems could not be solved by passing regulations, since this would have imposed significant costs upon the corporations. Furthermore it would have been costly for local governments to cope with the complicated problems.

Since the Great Depression of the 1930s and the Second World War affected revenue of the industrial corporations, local governments had to face a shortage of income, especially from their municipal tax bases. This is harmonious to Sinclair's critique (1907: 12) that 'the industrial capitalism system is based upon profits, and that a failure of profit would lead to its collapse'. It is almost certain that this was Chicago's downfall. One solution to this problem is for the corporate city to ask for additional support from the federal government. This condition leads to the intervention by the state in reshaping industrial structures and development and rearranging the city. This distinct city model was the next phase, epitomised by Tokyo.

5. STATE-MANAGED FORDIST CITY — TOKYO

As a tool for discussing the interrelationships between industry, and the physical and social environment within the state-managed Fordist city an investigation is made of Tokyo between the 1950s and the 1970s.[2] After the Pacific War, increasing centralisation, concentration, and internationalisation of corporate capital led to the expansion of the Tokyo Metropolis. Public institutes and domestic and foreign private offices were concentrated in the CBD and the adjacent district of Ginza. Subsequently there was a spillover of the offices into nearby wards — Shinjuku and Shibuya. A large

---

[2] The Fordist phase of capitalism was marked by the imposition of Taylorist labour processes in important sectors, associated with a considerable extension of wage labour; whilst at the same time making labour conditions relatively similar. The industrial mass production of consumer goods became the basis for an extensive capitalisation of the sphere of reproduction. It then consisted of strong processes of concentration and the new mass industries, the development of bureaucratised and centralised trade unions with a tendency for all workers to be included in the right to representation and thus to have the opportunity to conclude comprehensive pay agreements, and the expansion of the bureaucratised welfare state. As a result, the image of the Fordist city was characterised by strong agglomeration processes, the standardisation and industrialisation of construction, the nuclearisation of the family and far-reaching processes of disintegration, resulting in the erosion of the traditional sociocultural milieux. Supported by the large-scale imposition of the car, extreme spatial-functional differentiations developed, characterised by suburbanism, the formation of satellite towns, and the depopulation of the inner cities (Esser and Hirsch, 1989: 420-423).

area within inner Tokyo had been converted from industrial uses to residential estates and green spaces, especially in the eastern part of the city. Small-scale industries were shifted by the government to the north and northeast of the core to Adachi, Arakawa, Edogawa, Katsushika and Koto Wards, while large-scale industries were located in the south particularly in Ota and Shinagawa Wards and even to the neighbouring prefecture of Kanagawa. New industrial activities were also promoted in the Tama district, west of Tokyo (Figure 1.7).

Increasing segmentation of labour occurred, based on the changing organisation of the production process — the distinction between large and small industries and the subcontractor. Most of working class residential areas were scattered around the core or in the industrial districts. The middle and upper classes lived in distinct areas to the southwest of Tokyo (e.g. Meguro and Setaguya). Tokyo has few ghettoes though minority groups especially Korean, Chinese and other ethnics lived around the core city to the north of Asakusa in the Arakawa ward, Yoshiwara and Shinjuku Westmouth.

The depiction of the state-managed Fordist city can be re-drawn for further analysis as a flow chart showing the interrelationship between the circuit of capital, goods and waste and the courses of production process, urban area and community (Figure 1.8).

Tokyo, 1950s-1970s

The model of state-managed Fordist city (Figure 1.8) reveals that since the end of the Pacific War or since the early 1950s external elements in terms of direct foreign investment, economic assistance, and political influence as well as the internal component of state intervention have initially re-organised capital to effectively invest particular industries and caused the relocation of factories. The United States, for instance, poured in economic and technical assistance to Japanese industry while the Japanese Government

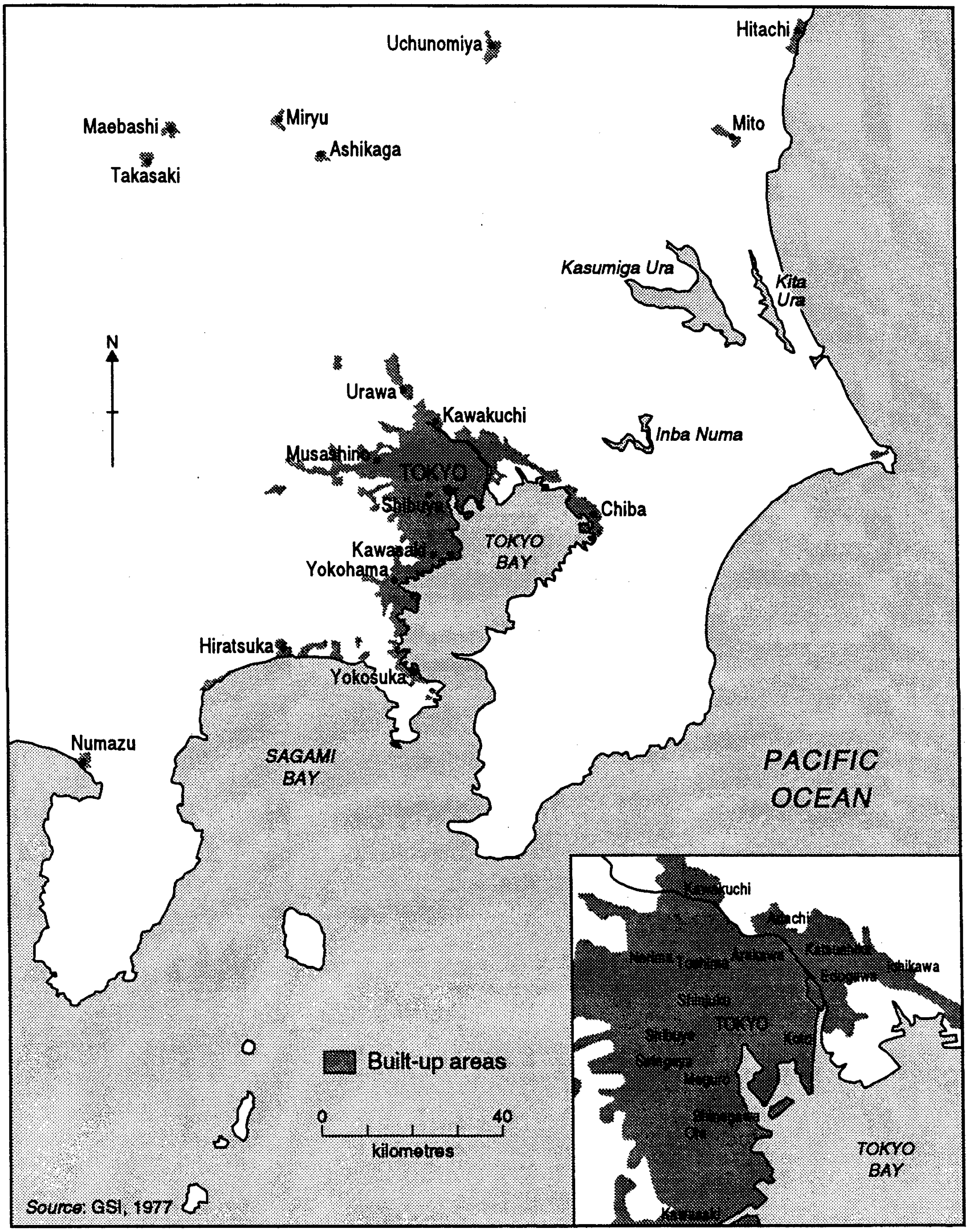


Figure 1.7 Map of Tokyo in the mid-1970s

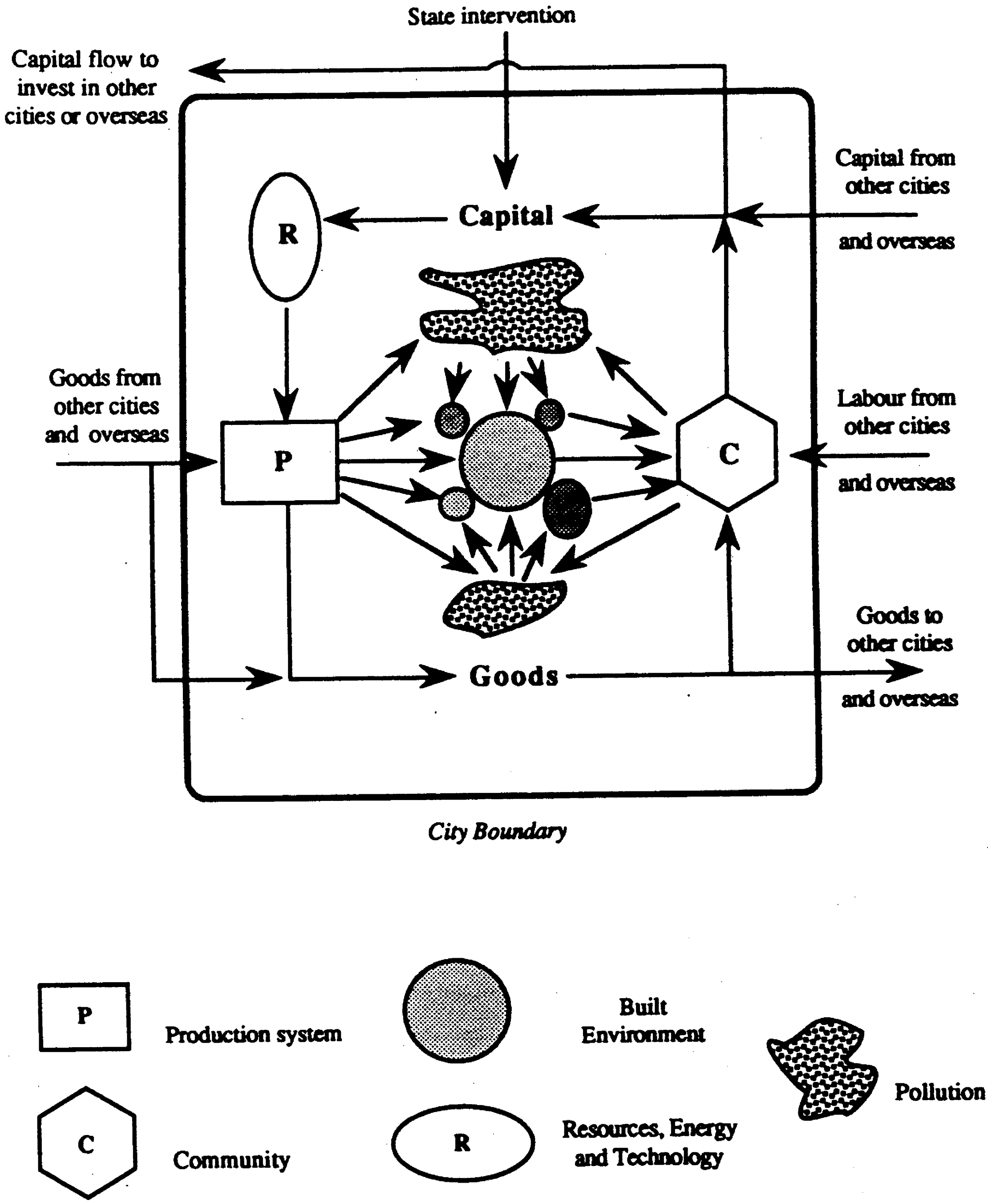


Figure 1.8 State-Managed Fordist City, 1950s-1970s

established financial institutions and set up a series of national economic policies in order to upgrade its industrial strength to compete internationally.

Since the late 1950s Japan has switched its energy source of production process from coal to oil and nuclear electric power (Kornhauser, 1976: 127-33). Correspondingly, a large number of new industrial estates and parks were nourished around Tokyo. Petrochemical, steel, electrical machinery and other heavy industries were in the south and southwest of the city and to the satellite city in Kanagawa Prefecture particularly in Kawasaki whereas light industries such as apparel, toys, footwear and sundry goods were in the north and northeast of Tokyo. Furthermore, there exist many subcontractors who are working on a piecework basis for bigger firms such as printing, carpentry and metal stamping. These activities were mainly in the inner Tokyo. In contrast to the most central core areas large corporations, financial centres and other international institutions were located in the central business districts and the adjacent precincts. Tokyo has definitely attracted more people than any other city in Japan. The Greater Tokyo Metropolitan area alone expanded its population by approximately 10 million people between 1950 and 1970, increasing from 8.8 to 17.7 million people (Douglass, 1988: 428).

The segmentation between light and heavy industries distributed wastes to the suburban areas and outside of the Tokyo Metropolis. During the 1960s, sulphur oxide from heavy industries was a major air pollutant that was harmful to plants and people in the south of Tokyo and in the industrial satellite, Kawasaki (Fukuoka and Yamashita, 1970: 228-230). Most of the canals and rivers in the metropolitan area, such as the Arakawa and Sumida Rivers in the north and Meguro Canal and Tama River in the south, were also contaminated by industrial waste. The streams were filthy with very low dissolved oxygen and critical biochemical oxygen demand.[3] Moreover, Tokyo Bay received the influx of degraded water from the rivers pouring into it. Heavy metals and

[3] Biochemical oxygen demand (BOD) is the amount of dissolved oxygen consumed by microorganisms as they decompose organic material in polluted water. Measurement of the rate of oxygen take-up is used as a standard test to detect the polluting capacity of effluent; the greater the BOD value, the greater the volume of pollutant present (Jones, Robertson, Forbes and Hollier, 1990).

other poisonous substances from heavy industries that mixed in the river flows were very destructive to all living organisms in the Bay (TMG, 1971: 90-100).

The accelerated growth of industrialisation in Tokyo created problems. In the 1960s nearly two-third of residents in Tokyo were without sewers and they depended on night-soil trucks to haul away their wastes (Seidensticker, 1990: 234). In the following decade, almost 75 per cent of the population of the ward area occupied sewered dwellings, but in Tama district the proportion was still below 50 per cent. As a result, treated and untreated waste water from residential areas together with the industrial effluences compounded the water pollution. By 1970 all the major rivers flowing through Tokyo had contamination loads averaging three times the maximum allowed by government standards (Douglass, 1988: 430). It is certainly the case that Tokyo was considerably more plagued with water pollution than most other cities in advanced countries (Nakamura and White, 1988: 140).

Rapid urbanisation also created rocketing land price and a shortage of housing. The working-class once again were the victims of city's economic growth, although the government had intervened to reorganise Tokyo. Home for millions of residents in Tokyo was a single room with a shared kitchen and toilet. Some could afford a room of 40 square metres with shared facilities (Thomas, 1989: 184). Nonetheless, the trend of housing construction offered little hope for living improvement. Although housing for low-income families was provided by employers for their workers in the industrial districts, and others by local government or the national Japan Housing Corporation, especially in the inner city and suburban areas, forty-seven per cent of housing units built in Tokyo between 1961 and 1965 were less than 29 square metres (Cybriwsky, 1991: 95-133).

Subsequently older houses in the CBD or on the outskirts gave way to new constructions and single-family structures yielded to multi-family buildings and apartments. The new living condition was still unpleasant, as Cybriwsky (1991: 134) indicated:

> Typically the accommodations are planned clusters of drab multi-storey apartments ... all with tiny units described as having privacy provided by lock, steel door and private bath. Their scale is often several units at one site, which often happens to be a less accessible place where land is cheaper.

Many people could not afford the new accommodation. The poor families in the inner area of Tokyo such as Koto and Sumida Wards were living and working together in tiny wooden houses. As noted further by Cybriwsky (1991: 171) 'These districts were homes to thousands of small and generally unheralded companies functioning at the broad base of the city's economic pyramid, supporting with their work of the enterprises of big corporations above them'. Certainly there was a high risk of fire from these wooden factory-houses. In contrast the homes of the wealthier were in southwest or northwest of Tokyo, where they were far from industrial activity. Their residences were often luxurious and many larger housing units with full facilities existed there.

Since the late 1950s the ceaseless attempt by State and local governments in creating regulations to restrict expansion of most industrial sites within Tokyo Metropolis clearly created two effects. First, Tama district and neighbouring prefectures could enjoy economic growth from the industrial relocation. Secondly, Tokyo could reduce urban pollution, inadequate public utilities, housing shortages and traffic congestion (Cybriwsky, 1991: 108). However, this did not allow the expenditures on pollution control by the Tokyo Metropolitan Government to decrease. General budget spending rose from 0.06 per cent in 1965 to 0.19 per cent in 1970. In 1970, around 70 per cent of this expenditure in pollution control were spent only for sewerage improvements. Moreover, central Tokyo had evidently lost its population to the suburban areas and satellite towns. The depopulation problem caused concern for local government in municipal tax raising. Some public facilities became idle because of the shortages of users but the amount of public expenditure required for their maintenance remained the same (TMG, 1971: 45-49; Nakamura and White, 1988: 127).

In the late 1970s the Fordist mass production prototype was not fully operative in Japan and the other industrialised countries because the fierce competition among themselves in the international market and trade protectionism could no longer permit their re-implantation. The oil shocks also made States re-think the uncertainty and insecurity of energy consumption in the manufacturing activity. Moreover environmental protest and awareness of people in Tokyo and other big cities has put pressure on the government to reconsider its national plans and policies. As a result, Japanese entrepreneurs have shifted their manufacturing investments outside the country in order to gain a competitive edge. Large-scale factories, especially heavy-polluted industry, have shifted to overseas locations in search of cheaper labour and land, less environmental control and secured market and resources (Douglass, 1988: 432-438, Storper, 1990: 429). It is unquestionable that the State still has an important role in reshaping the industrial structures and in reviving the city's economy and environment.

RESUME

The main aim of this chapter has recognised the approach of political science or political economy in comprehending the transformation of cities. The ideal framework indicates that capitalism is the major catalyst of the changing urban landscape in terms of physical and social perspectives. The explanation clearly gives a non-static picture of the city that is contrary to the mainstream (the Chicago School) perception of the ecology of cities.

As it is not possible to derive lessons from any city in order to understand Bangkok, it is preferable to examine the development of cities in historical and geographical context that reflects the international dimension of urbanisation. Soja's illustration of city evolution that links shifts in industrialisation to qualitative changes in the nature of capitalism has provided a solid base for further description of interrelationship between the production process, urban environment and the community.

In addition, three examples were raised to clarify the transformation of the city: the competitive industrial city exemplified by Manchester, the corporate-monopoly city typified by Chicago and the state-managed Fordist city revealed by Tokyo.

Each case study provides evidence that whoever (private or public enterprise) dominates the capital always changes the urban landscape to its own image in order to gain maximum profits. The capitalist rarely takes good care of its urban environment or community because it is costly. When problems occur, the solution of the capitalist is often to shift the difficulties out of sight, out of mind, to another place and another time. However, the deterioration of common resources can cause social upheaval or economic stagnation that leads to the crisis of capitalism. The result often brings collapse to both the entrepreneur and the city.

Soja's interpretation of three phases of city transition is extremely useful to describe the city of industrial countries especially in North America. However, it is not possible to explain the characteristics of the Third World's City with this approach because of their unique economic, social and cultural backgrounds. We therefore need to develop another appropriate framework in Chapter II to provide specific and suitable transformation of the Third World's City., particularly Bangkok.

CHAPTER II

DEVELOPMENT OF BANGKOK SINCE THE 1850s

Since the 1960s industrial capitalism has turned Bangkok into a major powerhouse of Thai industry. Large sums of direct foreign investment have poured into the capital city, bringing in new production systems and unusual environmental effects. Rapid industrialisation has certainly caused unmanageable city growth. At the time that Manchester was undergoing its first industrial revolution, Bangkok was only a trading city in Southeast Asia with sparkling palaces and temples in the centre surrounded by vast areas of vegetable gardens, orchards and paddy fields.

Soja's approach (1989) to city evolution is very useful for investigating the urban transition through qualitative changes in capitalism. However, if we apply Soja's analytical approach to Bangkok, the transformation of the city differs in two important respects: the timing and the successive stages in the development of capitalism, and the nature of the process involved in the transition from one stage to the next. This raises the question, how do urban types and sequential evolution in Bangkok contrast to the cities in North America or other industrial countries?

In examining Bangkok's transformation, we propose to modify slightly the time-span used by Soja, described in the first chapter. We begin drawing another specific framework of Bangkok reflecting Soja's interpretation of city evolution (Section 1). In enhancing the new framework we investigate Bangkok under the first influence of imperial capitalism between the 1850s and the 1920s, comparing it to the competitive industrial city — Manchester between the 1840s and the 1910s (Section 2). Then we examine Bangkok under a different phase of state capitalism, between the 1930s and the 1950s, a stage that corresponds to the corporate-monopoly city of Chicago during the 1920s-1940s (Section 3). Finally we concentrate on how Bangkok was changed by domestic and international capitalism between the 1960s and the 1970s when the state-managed Fordist city of Tokyo was developing between the 1950s and the 1970s (Section 4).

1. DISTINCT FRAMEWORK OF BANGKOK

As mentioned in the previous chapter, Soja's approach provides a valuable framework for investigating the transformation of the city, but his classification of city types in North America may not be an appropriate framework for cities in other parts of the world. Bangkok certainly has unique political, cultural and economic backgrounds. Therefore another framework is required for Bangkok.

Following Soja's time duration — between the 1820s and the 1970s, Bangkok has developed four city-prototypes through different phases of capitalism as illustrated in Figure 2.1:

(a) the *Sakdina* city typified by the fortification of royal palaces and the élite residences in the central city, the port and the surrounding areas of orchards and paddy fields [1];

(b) the *post-Sakdina city* marked by the fortification of royal palaces in the central city, the extension of élite residential areas, the emergence of alien labour involving industrial, transportation and commercial sectors as well as the establishment of labour unions, the depopulation in the central city and the growth of a mixed district of commercial, industrial and residential activities in the outlying area;

---

1 *Sakdina* literally means 'power of the field' a term that was employed to classify social formation before the early twentieth century. Social rank and size of land indicate an individual's power. For instance, nobles in the lowest rank own at least 400 *rai* (160 acres) of land while the commoners who are not slaves occupy land in the range of 10-400 *rai* (4-160 acres). In the case of Bangkok (the *Sakdina* city) the frame of *Sakdina* social formation consisted of two main classes — nobles and the commoners. Nobles were either aristocrats in a direct kin relationship to the king or bureaucrats appointed by the ruler. Theoretically, all holders of political power were forced to reside in the capital behind the city wall under close control of the king. Commoners or *phrai* were all people who had no political power, living mainly outside the city wall. The latter group of people were the main source of surplus labour and the ruling class usually used this labour to pay corvée labour or taxes (money and kind).

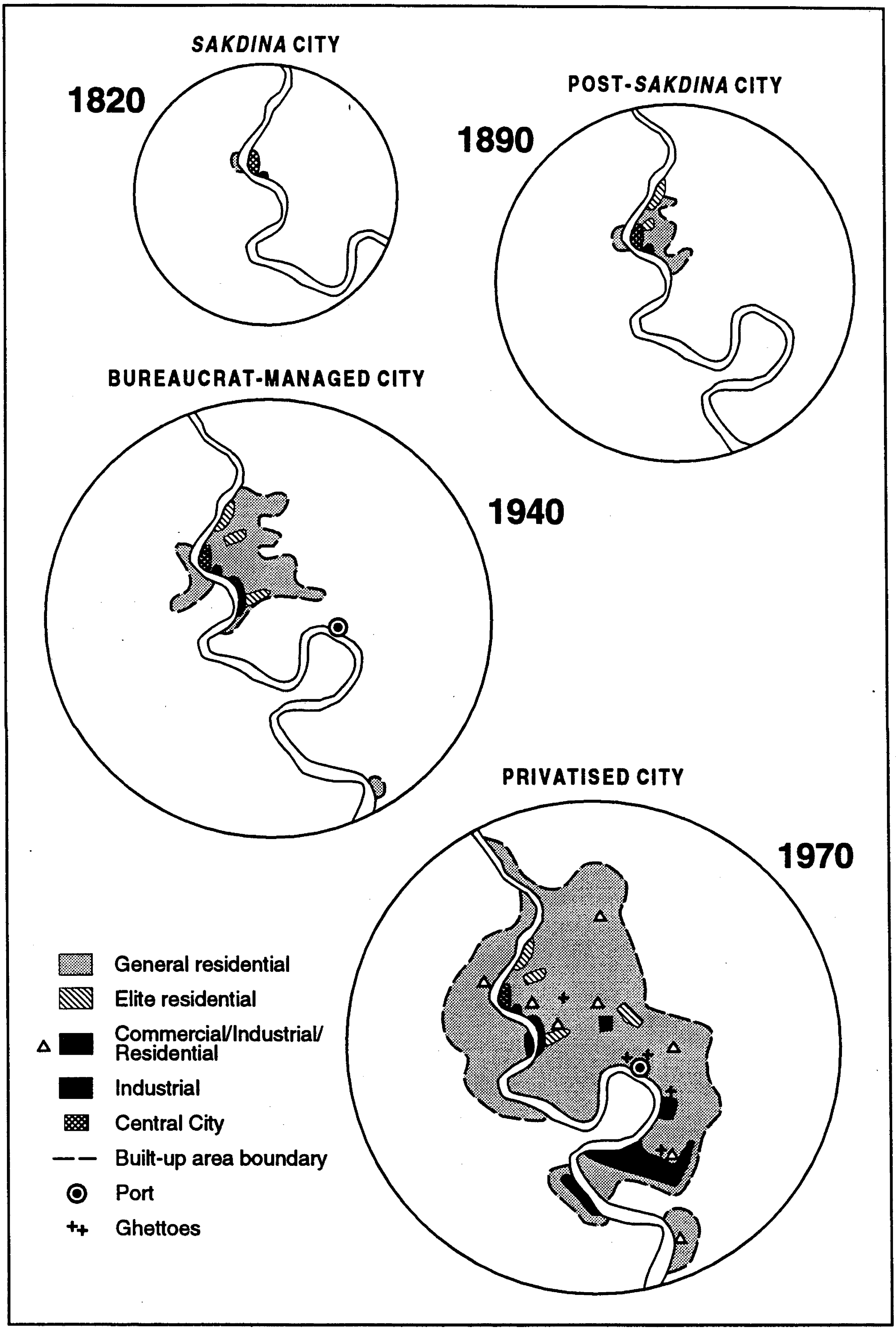


Figure 2.1 The Development of Urban Form: Prototypes of Bangkok, 1820-1970

(c) the *bureaucrat-managed city* distinguished by the expansion of the mixed district, the increasing number of state industrial enterprises and indigenous working class, and the shift of foreign residential areas;

(d) the *privatised city* characterised by the decreasing number of state industrial enterprises, the emergence of the internationalisation of the financial centre as well as slums in the public open areas or around the new industrial estates of private enterprises, the rapid expansion of urbanised areas following new industrial activities, and the annexation of municipal areas of the nearby province.

Recession, depression and social upheaval are the major factors that caused the transition from one urban form to another. In the case of Bangkok, political uprising is, however, the most important element in the city evolution.

As can be seen in Table 2.1, three transformations of Bangkok are slightly different from Soja's sequential framework. The post-*Sakdina* city was the significant urban form for Bangkok between the 1850s and the 1920s. The major depression in the late nineteenth century and the eruption of the first World War directly caused the drastic change in the political system in Thailand from absolute monarchy to democracy in the early 1930s. This political upheaval ended the first transition of Bangkok. Between the 1930s and the 1950s, the bureaucrat-managed city was the dominant pattern. It was terminated by the military coup and the intervention of corporate capitalism in the late 1950s. Since the 1970s, the privatised city has been the predominant urban form of Bangkok.

The new framework of Bangkok describes the changing urban patterns at different time periods. Nevertheless there is a need to make a further effort in connecting Bangkok's development to the physical environment and the community. We, therefore, propose to investigate the missing linkages in each city prototype of Bangkok.

Table 2.1 The Evolution of Bangkok in Three Different Phases of Capitalism during the 1850s-1970s

City type	Dates	Characteristics
Post-*Sakdina* City	1850s-1920s	Industrial capitalism was firstly introduced to Bangkok after the British trading treaty (the Bowring Treaty) was effective. The foreigners particularly invested in primary industrial sectors — rice and saw mills. Most of the industrial labourers were markedly imported from overseas. There was no specific area of the working class but they were living in the mixed district of commercial, industrial and residential activities. At the same time the king's power was reduced especially in gaining capital surpluses while the nobles had more bargaining power. Subsequently, the nobles attempted to reside outside the city wall. The State mainly got involved in urban management, although the sanitary administration was established to take on such responsibility.
Bureaucrat-Managed City	1930s-1950s	The political system was dramatically changed. The ruling powers of king and aristocrats were shifted to the new bureaucratic group. Concurrently, the influences of imperialism and international capitalism were weak. The state, then, attempted to establish more industries mainly in their own territories in the inner city and the outlying areas while they were lessening the amount of alien labourers. Although there was an influx of labour from the rural areas, the State did not prepare housing programmes or adequate public utilities. Remarkably, squatters emerged within the city.
Privatised City	1960s-1970s	The state significantly tied the national economy more tightly to international capitalism by encouraging direct foreign investment while they supported domestic capitalists to invest more in industrial sectors. However, most of the investment was dumped into the capital city. There was an expansive metropolitanisation with the annexation of nearby municipal areas. An international financial centre was set up in the inner city. Medium- and large-scale industries mainly shifted to the outlying area of the city where the land cost was low and public utilities were mostly available. Small-scale industries in the form of shop-houses were scattered in the inner city and the outskirts. More slums and private and public housing were apparently developed in the extended areas as well as fresh markets and modern shopping centres.

2. POST-*SAKDINA* CITY — BANGKOK, 1850s-1920s

Prior to the discussion of the first phase of Bangkok, concerning interrelationships between industry and physical and social environment, an investigation of urban pattern of the post-*Sakdina* city between the 1850s and the 1920s is necessary. Many eyewitnesses in the nineteenth century described Bangkok not only as a charming city with magnificent architecture on the left bank of Chao Phraya River but also as a leading trading centre in Southeast Asia. As shown in Figure 2.2, the royal palace was in the central city surrounded by a high wall where the king and the noble élites lived and ruled the country. However, there was an extension of the élite residences to the northeast of the city at the districts of Samsen, Dusit and Phayathai. The southern part of the central city along the River and the New Road was the centre of trade and commerce as well as the port and the residences of the Chinese, European and other ethnic groups. The other parts of Bangkok were orchards and paddy fields with the scattering villages of native people. In 1900, the urbanised area that developed in Bangkok together with Thonburi was around 13 square kilometres.[2] The total population in the same period was about 600,000 people (Donner, 1978: 792; Bupphanat, 1982: 21-26).

From the above description of Bangkok in the period of the 1850s-1920s, a highlight of the post-*Sakdina* city can be drawn for further consideration of the interrelationship between production process, physical and social environment and the circuits of capital, waste and goods (Figure 2.3).

The post-*Sakdina* city as illustrated in Figure 2.3 was firstly tied to the network of imperialism and international capitalism by an unequal commercial treaty with Great Britain, the Bowring Treaty of 1855. The Treaty opened up Bangkok to industrialisation which in turn broke down the subsistence economy of the country (Chatthip and Suthy,

[2] Thonburi, once, was a capital of Thailand during 1767-82. Until 1972, it was annexed to Bangkok to form the Metropolitan City Municipality of Krungthep-Thonburi or the Bangkok Metropolitan Area (BMA).

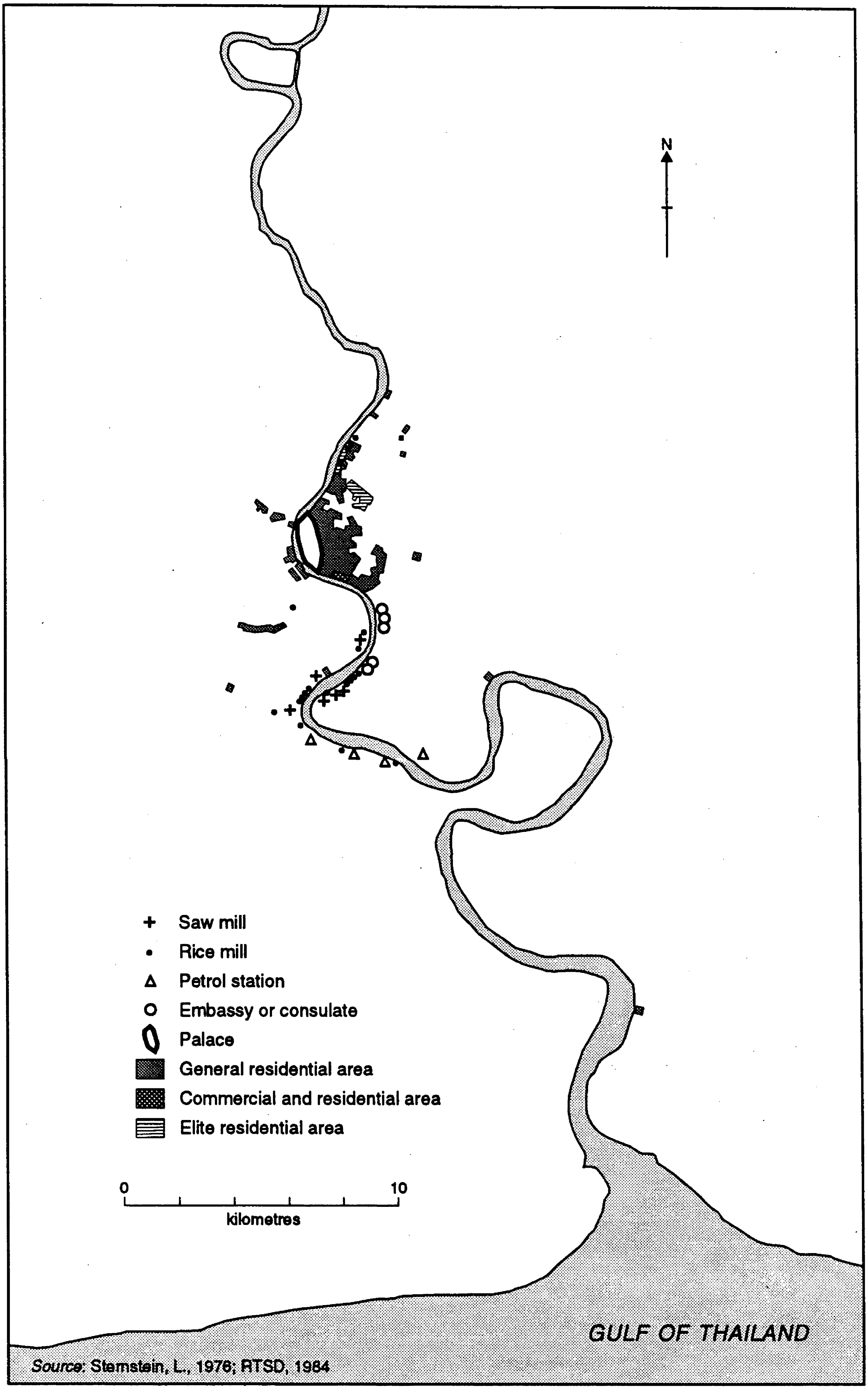


Figure 2.2 Map of Bangkok, 1850s-1920s

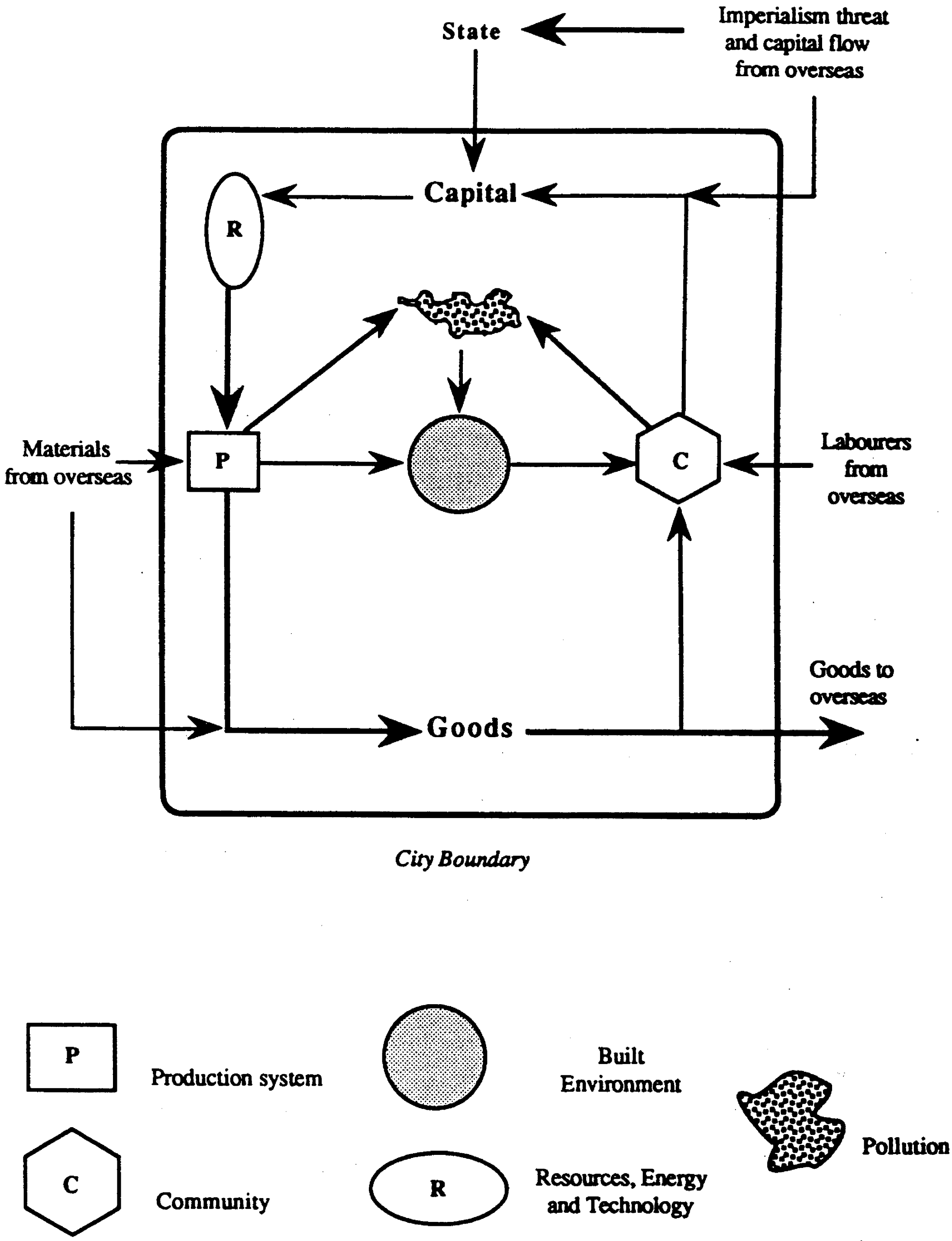


Figure 2.3 Bangkok as the Post-*Sakdina* City, 1850s-1920s

1981: 1-2; Lysa, 1984: 68).[3] Primary industries such as rice and saw mills were clearly dominant activities in this early urban transformation. Rice milling was the most important industry, due to the high demand for rice in Asian colonies of the West. It gave a high revenue not only to Thai aristocrats but also to foreign capitalists. In 1858 the Americans established a steam-powered rice mill in Bangkok, but the business was later transferred to other western firms. In 1870, Chinese merchants began to import the machines for their use and at the turn of this century they took over most of this activity (Chatthip and Suthy, 1981: 8; Sompop, 1989: 47; Suehiro, 1989: 46-8).

In 1895 there were twenty-seven rice mills but sixty-six mills by 1919. During the 1900s, some of the mills converted from steam power to internal combustion. Most of them were large and producing for export, 100-200 tons per day. These mills were situated along the Chao Phraya River to the south of Bangkok. The small mills, producing 30-40 tons per day, were mostly located outside the city or in other provincial towns. Besides rice milling, as the British consul reported in 1919, there were a number of other large-scale manufacturing industries — a cement plant, three aerated-water plants, a soap factory, a cigarette factory and a leather factory. These factories were mainly located along the River in the north and south of the central city. There were also other small-scale or household industries such as wooden boat-building, furniture, silk, weaving, dyeing, biscuits and fish sauce, scattered throughout the city. The labourers employed in these industries, as well as the commercial and trading sectors, were largely Chinese immigrants, whereas most Thai people were engaged in the agricultural sector (Ingram, 1971: 70-133; Hewison, 1989: 123). It is unquestionable that the majority of the population in Bangkok during this period was non-Thai, being imported labourers, former prisoners or slaves from the wars with neighbouring countries, and foreign merchants. According to Bowring (1857: 85), non-Thai residents in Bangkok made up approximately 70 per cent of the total population of 404,000 people in 1850. By 1900

[3] The influx of imported goods and the suggestion of industrialisation soon became major causes of the decline of rural household industry, especially in the Central Plain of Thailand because the Treaty forced Thailand to lower its import duty to 3 per cent which made overseas manufactured goods relatively cheaper than locally-produced goods.

the total population had risen to 600,000 and the non-Thai residents were still the majority (Korff, 1986).

The rising number of rice mills and the burning of wood and rice husk led to an increase in smoke and dust. Evidently, there were significant complaints from the German Consul and other residents in the south of Bangkok about air pollution from the rice mills (Suraphon *et al*, 1984: 66-68). Although there were at least five major manufacturing and other small miscellaneous types in Bangkok, their industrial wastes were less noticeable. Most capitalists paid their attention only to rice production and to their benefit from the international trade in a few primary exports. Therefore it is not surprising that industrial outputs in this period, especially in the form of waste water, did not critically affect the ecological balance of the city.

Unquestionably, the most obvious water pollution was caused by trash from the communities because most residences were situated along the waterways and there was no available sewage system. All forms of residential wastes such as dead animals and human excrement were disposed of directly into the river and canals resulting in the spread of water-borne diseases. There were frequent outcries from the residents about contaminated drinking water (Suraphon *et al*, 1984: 20-21). Residential waste was considerably more harmful to the waterways of Bangkok than industrial waste.

The deterioration of the waterways was definitely harmful to human health and the way of living of Bangkokians. Their livelihood was tied to the water, as most of the households in Bangkok were situated along the river and canals. Both Thai and Chinese lived in the floating bazaars or houses that extended for kilometres along the two banks of the Chao Phraya River (Bowring, 1857: 85). Some people resided in bamboo cottages or wooden houses along the river bank. Although other residents in Bangkok lived in wooden or brick houses farther inland from the river bank, particularly the Chinese at

Sampeng and the foreigners in the south of the city at Bangrak, they mostly depended on the waterways for daily household utilities (Bupphanat, 1982: 22).[4]

In the later stage of the city's transformation, the State directly involved itself in urban management by constructing various public utilities such as electricity, water supply, trams and roads. Seemingly, Bangkok was prosperous from the industrial activity and international trade. Economic surplus was largely restricted to the small group of ruling élites and the foreign capitalists. State expenditure, however, heavily concentrated on defence, internal security and the court due to the threat of imperialism throughout this period (Chatthip and Suthy, 1981: 24, 39-40; Brown, 1988: 171). Although the national budget was small, the State initially established *sukhaphiban* or the sanitary administration for Bangkok to take care the public hygiene. Some production processes, for example fish sauce, soap, tanneries and dyeing, were asked to move the factories out of the municipal area by a new sanitation schedule. Household garbage was collected. However, the sewage system was not managed properly. The residents who lived further inland from the waterways could discharge waste water into public drains that led to the nearby canals or the river (Bupphanat, 1982: 27; Suraphon *et al*, 1984: 12; Hewison, 1989: 123).

In the early 1930s, some Thai noblemen and soldiers overthrew the absolute monarchy and set up a democratic system with constitutional monarchy. This political change altered economic and industrial structure because the new government intended to modernise the country and to create employment for Thai people by fostering industrialisation. (Silcock, 1967a: 5; Suehiro, 1989: 106-108). It is certain that there was a big reshuffle in power among capitalist groups (i.e. the élites, Chinese and Western merchants). The role of royal family and the foreign merchants in capital control was obviously lessened while there was a new group of capitalists in the bureaucracy who

---

[4] Sampeng was an important district of commercial and industrial activity as well as a well-known residential area of the Chinese merchants and imported labourers. It was the so-called Chinatown of Bangkok, located in the south of the central city.

was replacing the former. The influence of new bureaucrat groups undoubtedly affected industrialisation and the urban form of Bangkok.

3. BUREAUCRAT-MANAGED CITY — BANGKOK, 1930s-1950s

Before continuing to examine in detail the interrelationship between industrial production system, its wastes and the residential communities in the second transformation of Bangkok, we contemplate the urban pattern of the bureaucrat-managed city in the period of 1930s-1950s. Since the new group of bureaucrats altered the Thai political system, they rearranged the capital city through the encouragement of industrialisation and the development of military strength. Bangkok was clearly expanding to the northeast and the southeast as illustrated in Figure 2.4. Some governmental and institutional utilities were shifted out of the central city to the new locations in the northeast at the districts of Dusit, Samsen, Phayathai, and Bangsu', and to the far-southeast at Bangkapi, Phrakhanong and Bangna.

Several governmental agencies enthusiastically established their own industries. Many large-scale secondary industries under military-owned or public enterprises were located in the new extended areas of Bangkok such as the Royal Ordinance Factory at Bangsu' and Thai Tobacco Monopoly at Bangkapi. Generally, the additional residential areas grew up around the new extended zones. The élite residential areas were still in the northeast, including the new royal palace, but some parts of them were later transformed into governmental utilities. The Chinese quarter in the south of the central city was still an important commercial and financial centre. However, there was another new commercial district which included warehouses, low-income residents, and private industries. This area belonged to the Chinese and Europeans in the far-south at Bangrak District, the area between New Road in the south and the Chao Phraya River. The other ethnic minorities were living and working in this area while the wealthy Europeans and the consuls preferred to move inland to Sathon. The urbanised area certainly expanded.

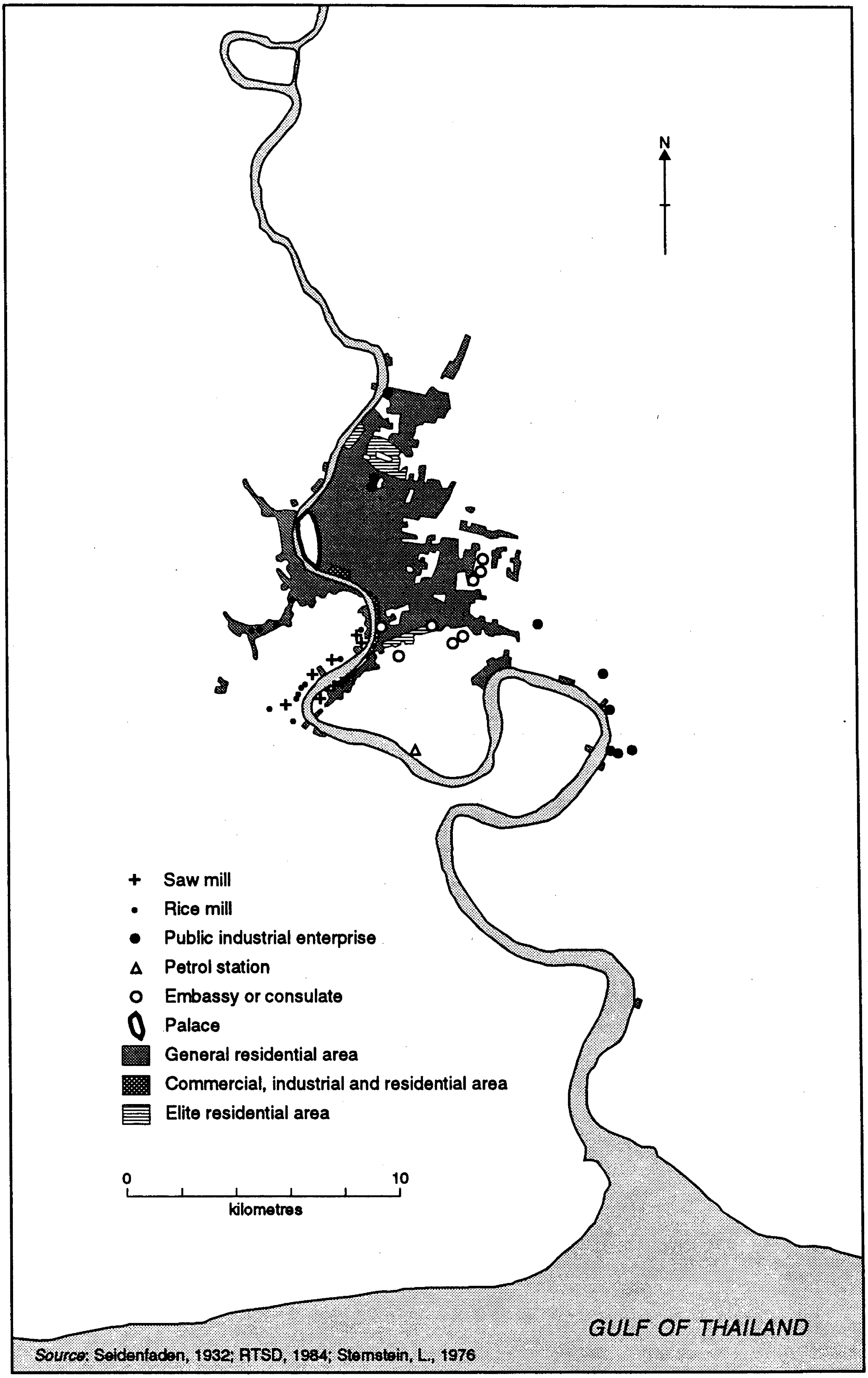


Figure 2.4 Map of Bangkok, 1930s-1950s

In 1958, it was 96 square kilometres or seven times larger than its former size in 1900 (Seidenfaden, 1932: 69-89; Donner, 1978: 792).

The above description of the urban pattern of Bangkok during the 1930s-1950s provides a general background for understanding further the interrelationship between production process, industrial waste and the communities. Another flow chart presenting such interrelationships with the flows of capital, goods and waste of the bureaucrat-managed city is shown in Figure 2.5.

Figure 2.5 shows us that the bureaucrat-managed city was largely free from the interference of imperialism. In the early 1930s, foreign investment and imports obviously decreased due to the Great Depression. Moreover, the worldwide economic crisis directly caused a sharp fall in the price of rice, worsening Thai economy. The government then started employing the 'state-monopoly capitalist system' as derived from nationalist impulse to actively intervene in the overall economic activity (Silcock, 1967b: 258; Suwit, 1980: 128; Suehiro, 1989: 106-108). Evidently, the government attempted to transform industrial structure from primary to more complex and high value-added products in secondary industry.

The State initially developed large-scale resource-based and labour-intensive industries with their own investment such as rice milling, textiles, pharmaceutical businesses and tanneries. These industries were certainly under the state enterprises. However, their productivity did not meet output targets because of insufficient knowledge and technology in industrial management and inadequate capital and skilled labour. Therefore jointly setting up with or taking over private enterprises was another

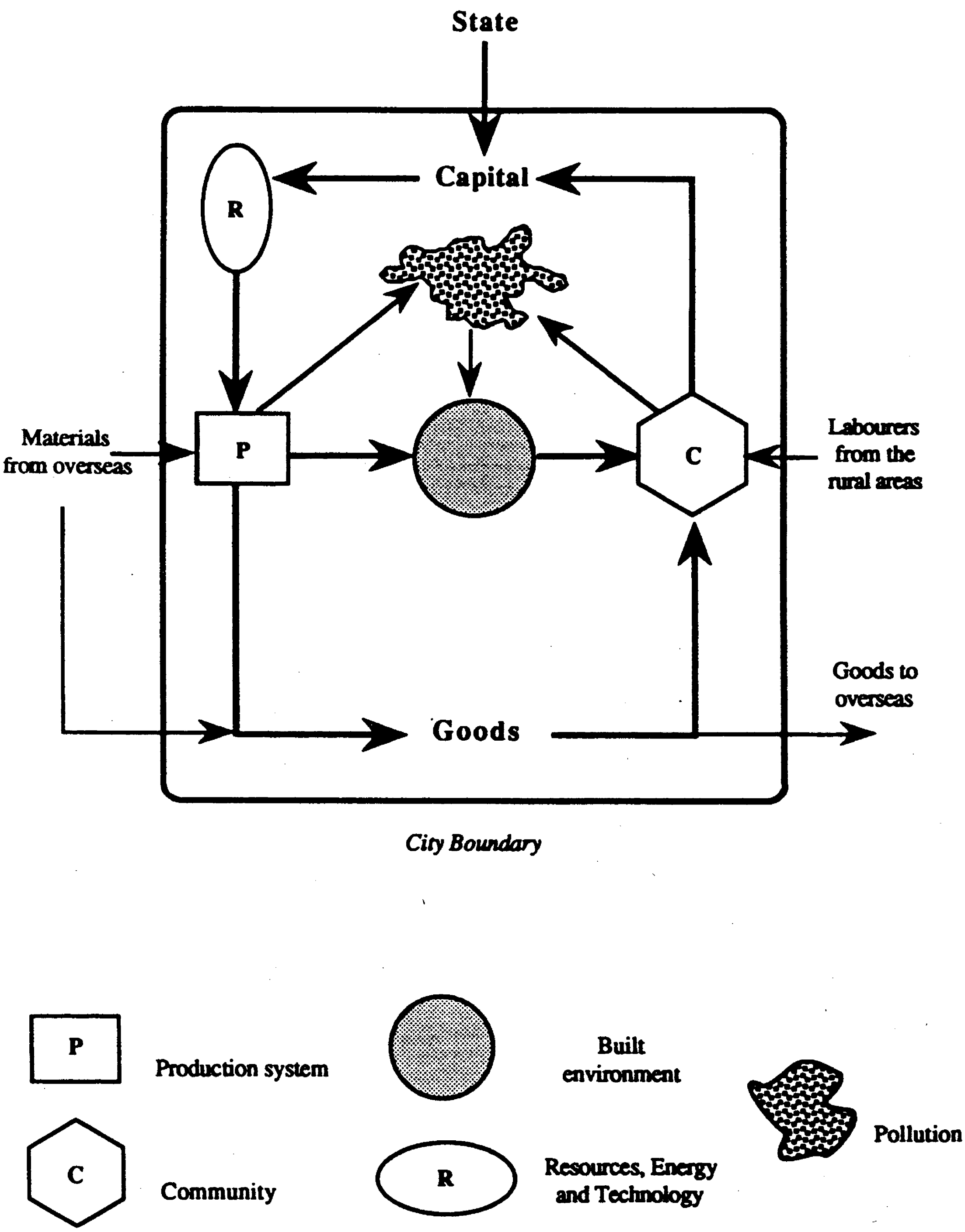


Figure 2.5 Bangkok as the Bureaucrat-Managed City, 1930s-1950s

manoeuvre that satisfactorily alleviated the problems.[5] It is also apparent that most of the production processes shifted their sources of energy from wood, charcoal and rice husk to petroleum and electric power.

In the late 1930s, the number of all industries belonging to public and private enterprises in Bangkok and Thonburi rose dramatically (Table 2.2). The increased number of factories effectively raised more labour force in manufacturing industry, more than the number in the early period of 1850s-1920s. Sompop (1989) investigated that the labour force working in factories in 1937 was around 110,400 people. However, the proportion working in the manufacturing sector was rather small — 2.9 per cent of the total. Most of the labour was still in the agricultural sector and comprised about 79 per cent of the total (Table 2.3). Almost all those working in the manufacturing industry represented labourers in Bangkok. The size of the labour force in the following decade is not known but it is believed that there was not much growth in the manufacturing sector because the labour force was about 133,000 in 1960 (see Table 2.4 in Section 4). At the same time, Bangkok's population rose to 1.3 million, which was double the size of the post-*Sakdina* city (Sternstein, 1976: 102).

The growth of industrialisation, without planning and control, undoubtedly resulted in a deterioration of the urban environment of Bangkok. Light industries, especially food processing, dyeing, glass and saw milling were the major industrial polluters, generating waste water, odour and noise, all of which affected the residents in

---

[5] The State had not seriously attempted to improve the production system by themselves. Industrial technology in this period was mostly imported from overseas by former owners of industries or co-entrepreneurs. Although the seventeenth government in 1946 encouraged a policy of industrial research and development; there had not been any active plans since then up till the late 1950s. Moreover there had not been any independent governmental organisation preparing industrial policy since the revolution of 1932. Until the early 1942 the government launched a comprehensive programme to promote manufacturing industries by setting up the National Committee for the Promotion of Industrial Works and organised another 23 sub-committees which were responsible for the promotion of specific industries such as chemicals, tobacco, sugar, iron, tin smelting and rubber products. However, the promotion of the State was to increase only the number of factories without improvement of industrial management and technological production. There was still no guideline policy or plan on industrialisation. All large-scale industries were owned by the government. There was also an attempt from the State to encourage household industry or small-scale industry in the private sector (Silcock, 1967b: 261: Rangkrit, 1976: Suehiro, 1989: 128-130).

Table 2.2 Industrial Enterprises in Bangkok-Thonburi, 1939

Enterprise	Number
Tanneries	32
Power rice and timber mills	27
Textile factories	26
Food canning and bottling	21
Machinery shops	20
Ice factories	12
Coconut oil plants	5
Match factories	4
Toothpaste and toothbrush factories	4
Soap factories	3
Cigarette and tobacco factories	2
Brewery	1
Glazing works	1
Paper mill	1
Cement plant	1
Metal shops	285
Total	**445**

Source: Hewison (1989: 129) cited in anonymous, "Kan chathung," p. 77.

Table 2.3 National Labour Force in Various Sectors Aged 10-60 Years in 1937

Sectors	('000 persons)	Per cent
Agriculture, forestry and animal husbandry (women excluded)	3,001.2	78.62
Fishing	37.3	0.98
Hotel and personal services	142.1	3.71
Trade and commerce	303.5	7.95
Manufacturing industry	110.4	2.90
Transport and communication	57.9	1.51
Public services	106.9	2.80
Building and other construction	22.8	0.60
Clerical services	17.9	0.47
Mining and quarrying	17.5	0.46
Total	**3,817.6**	**100.00**

Source: Sompop (1989) calculated from Census 1937.

the surrounding areas (Suraphon *et al.,* 1984). Heavy industries did not create any significant pollution because the government had not enough funds to promote the capital-intensive industry. Cement, perhaps, was the only heavy industry in Bangkok that had operated since the late 1900s.

As industrial wastes were more noticeable than in the first transformation of Bangkok, wastes from the communities were also rising, since the urbanised area was expanding. Residents in the municipal area still released waste water from washing and bathing to the drainage system without passing through the treatment process. If they were in the suburbs, residents directly drained waste water to the canals and the river. All waste water from the residential areas markedly compounded the pollution problem because of the increasing volume.

Obviously, the number of residents who lived in floating houses was decreasing. As the government provided more roads and other public utilities, especially water supply and electricity, more people relocated their residences along the roads. Although industrial growth was high and imported labourers, particularly from China, markedly decreased, the government did not create any housing programmes for the low-income people or labourers who migrated from the rural areas. Some low-income residents usually rented rooms or houses in the city. Some constructed temporary cottages made of bamboo or wood. This latter type of accommodation was located in open spaces along the waterways and railways, under the bridges, and on derelict land. When it became overcrowded, squatters became a serious problem of the city (Suraphon *et al.*, 1984).

The expanding urbanised area of Bangkok stimulated the municipality to be more responsible for public hygiene.[6] However, it was obvious that the municipality had no real authority to punish the polluters or to get involved in city planning in the early period of the bureaucrat-managed city. In 1949, the Police Department closed down 13 factories

---

6 In 1930, the Sanitary Administration of Bangkok was reorganised to be the Bangkok Municipal Administration (or later it was the Bangkok Metropolitan Administration) that had to extend its responsibility covering the expanded area (Suraphon *et al,* 1984).

that caused pollution and asked the entrepreneurs to re-locate the factories in Thonburi, along the Chao Phraya River or at the mouth of the river.[7] In 1951, the State issued a regulation of the industrial zone in Bangkok and two years later the municipal administration forbade saw mills to operate in the city. Between 1952 and 1954, the central government recognised the problems of housing shortage and the increase of slums. They initially planned to construct accommodation in the suburban area. In 1955, the State declared that if an entrepreneur wanted to establish a factory in any place, he must ask permission from the local people (Suraphon *et al.*, 1984).

The attempt of the State to handle industrialisation after over-throwing the absolute monarchy undoubtedly failed. Although there were twenty-eight governments during 1932-1958, none of these governments had any effective policies for promoting industrialisation. The State certainly had strong power over industrial activities; unfortunately, most of the state enterprises were inefficiently operated. Furthermore private investors were reluctant to invest in the manufacturing sector to compete with the state enterprises (Ingram, 1971: 287; Somsak, 1989: 89-90). Until the early 1950s, the United States, the World Bank and the International Monetary Fund (IMF) had influenced the Thai government in social and economic development. Their interference caused some Thai bureaucrats to realise that global capitalism could positively develop industrialisation. In 1957, there was, consequently, a military coup that marked the beginning of a new politico-economic system effecting another transformation of Bangkok (Suehiro, 1989: 178).

4. PRIVATISED CITY — BANGKOK, 1960s-1970s

In the third transition of Bangkok, domestic and international capitalism markedly affected the interrelationship between industry, physical and social environment. Before we further investigate these changes, a portrait of the privatised city between the 1960s and the 1970s is presented. In the early 1960s, the new government shifted the

[7] There were 10 food processing factories and 3 dyeing factories (Suraphon *et al*, 1984).

foundation of the economy from state capitalism to private capitalism. This change exerted a decisive influence over the urban pattern of Bangkok. There was rapid and uncontrolled expansion of the urbanised area. As shown in Figure 2.6, Bangkok was expanding into the paddy fields, orchards and vegetable gardens in the northeast at Bangken, Rungsit and Nongchok, in the east at Huamak, Khlongchan and Minburi, and in the southeast, as far as Prapradaeng and Bangpu in Samut Prakan Province. Scattered throughout the extended areas were new industrial parks, fresh private and public housing estates, markets and modern shopping plazas.

The inner city was largely dominated by governmental institutions, commercial and residential areas. There were many slums within the inner city such as at Khlong Toey, Soi Kingphet and Suanmali as well as new constructions of low-income housing at Dindaeng and Khlongprapa and in the outlying area at Khlongchan. Another élite residential area emerged at Bangkapi in the southeast of the central city. Sampeng remained a commercial centre while Silom in Bangrak District took on an important role as the international financial centre. The central city mainly consisted of the royal palace and governmental institutions. In this transformation, Bangkok annexed Thonburi with a population of more than 3 million into its municipal administration in 1972. The total area at this time was approximately 290 square kilometres or three times its size in the late 1950s (Sternstein, 1976: 103-104; Suraphon *et al.,* 1984: 63-6).

The urban pattern of Bangkok during the 1960s and the 1970s, as previously mentioned, was strongly influenced by private capitalism. If we further explore the interrelationship between industry, physical and social environment, we can draw a flow chart showing the correlation of these factors with the flows of goods, capital and waste of the privatised city (Figure 2.7).

As shown in Figure 2.7, Bangkok between the 1960s and the 1970s was under the influence of private capitalism. International capital, in the form of economic and

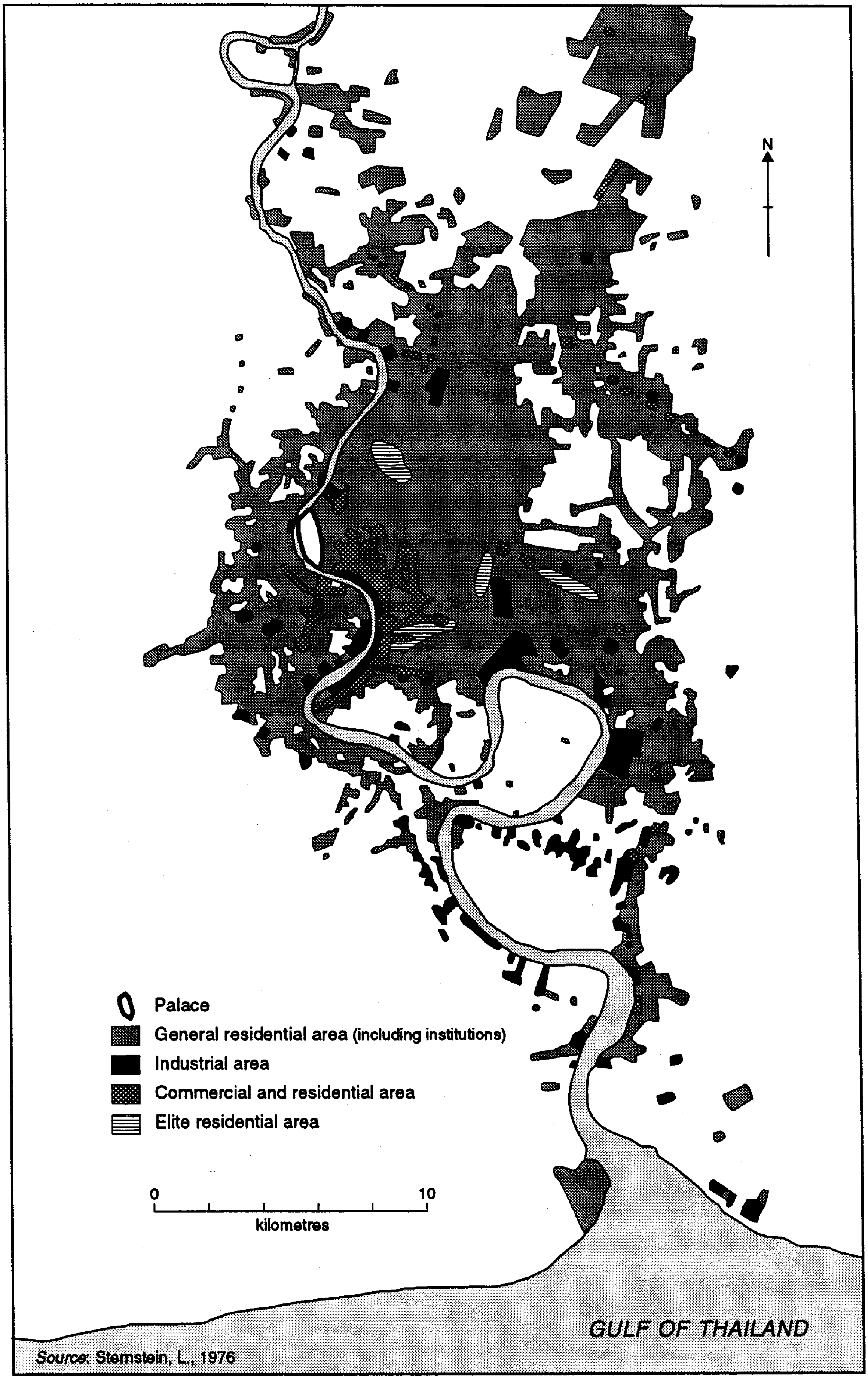


Figure 2.6 Map of Bangkok, 1960s-1970s

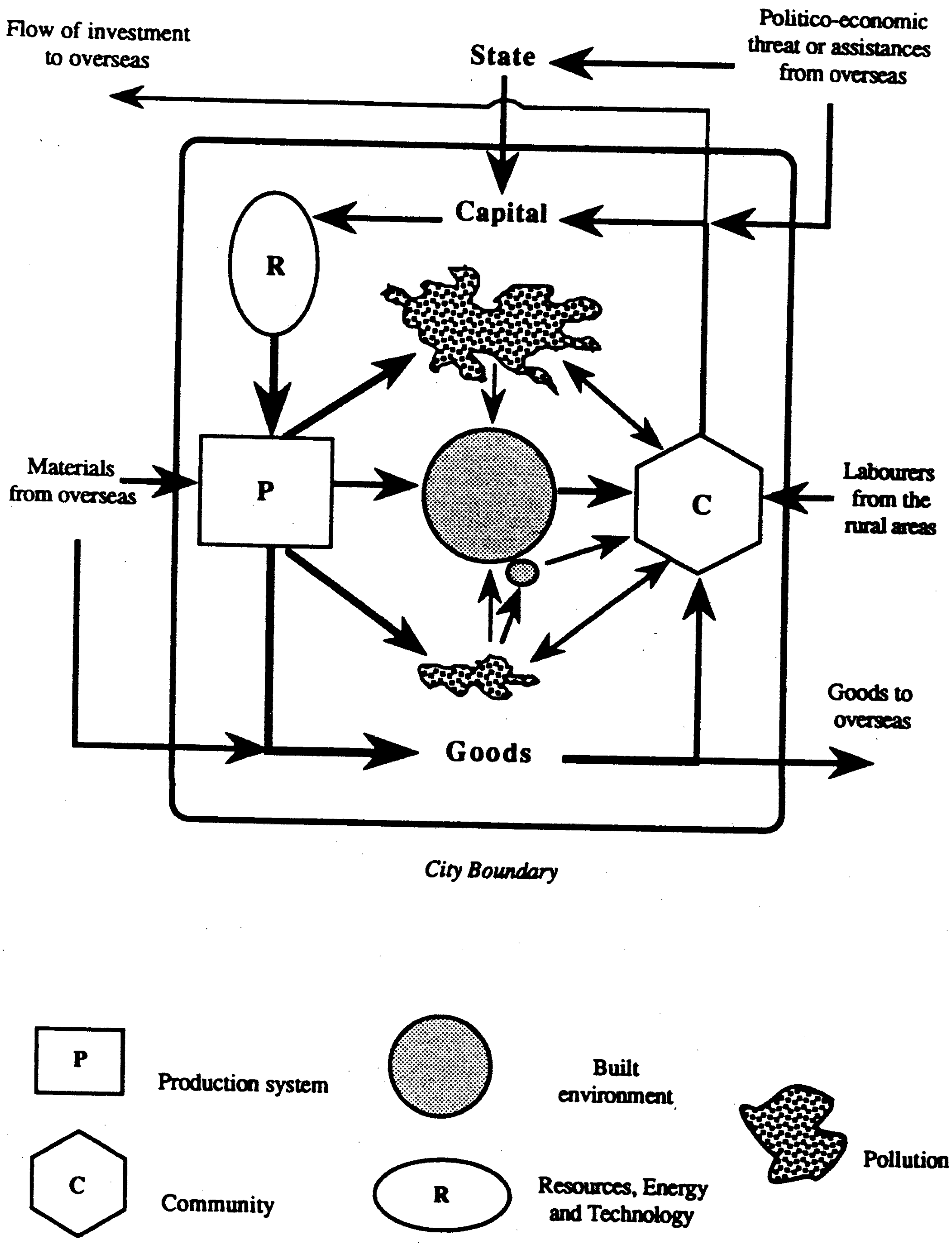


Figure 2.7 Bangkok as the Privatised City, 1960s-1970

social assistance and direct investment, poured into the capital city.[8] Between 1960-72, 32 per cent of registered capital was controlled by multinational corporations, with American and Japanese respectively in the first and second ranks of all investors (Kraisak, 1984: 142). More importantly, a large number of ethnic Chinese merchants shifted their business bases from importing to manufacturing. They rapidly expanded their concerns by depending on both foreign capital and new industrial promotion policies while the number of public enterprises decreased from 141 in 1957 to 69 in 1976 (Rangsan, 1989: 34).

During the 1960s and the 1970s, the number of labourers in the manufacturing sector increased in both Bangkok and the neighbouring province, particularly Samut Prakan (Table 2.4). This rapid growth of the labour force reflected the growing number of factories, especially in Bangkok. In 1970, they were four times higher than in 1939 (Table 2.5). Numerous import-substituting industries were established such as beverages, tobacco, food processing, textiles and textile products, chemical products, electrical appliances and machinery, automobile assembly and transport equipment. Since these industries were labour- and capital-intensive, they caused a decline in small-scale establishment. Moreover, because the government had not seriously developed or encouraged technological production, its improvements in the production process of small-scale industry were quantitative rather than qualitative. There was no development of new merchandise and there was no upgrading old products (Paitoon, 1987: 1; Rangsan, 1989: 90). Electricity was the major power source for industrial firms in the larger area of Greater Bangkok, contributing 59 per cent of total energy consumption.[9]

---

[8] Obviously, the assistance of the World Bank to various projects after the second World War had paralleled its aid in pursuit of American interests in Thailand. Thailand had been pushed towards development policies based on private investment in the productive sectors with the support role of Thai State since the 1960s to provide capital for public utilities, and thereby encouraged the structural dependence of the State on private capital accumulation as well as foreign aid or loans (Grit, 1982: 57, 125). In addition, during the 1960s-1970s, the inflow of direct foreign investment was accelerating on the average of 1,126 million baht per annum with the first direct investment in 1960 of 60.9 million baht and the investment in 1979 of 1,047.7 million baht (*The Bank of Thailand Monthly Bullentin*, 1964, 1969, 1974, 1979; *The Bank of Thailand Quarterly Bullentin*, 1982).

[9] Greater Bangkok consisted of Bangkok Metropolitan Area and the surrounding provinces of Nonthaburi, Pathumthani, Nakhon Pathom, Samut Sakhon and Samut Prakan.

Table 2.4 Distribution of Employed Population 11 Years Old and Over by Major Economic Sectors in Bangkok Metropolitan Area (BMA)* and Samut Prakan, 1960 and 1970

Sectors	1960		1970	
	BMA	Samut Prakan	BMA	Samut Prakan
Agricultural	149,544	74,959	112,743	50,070
Manufacturing	133,431	5,807	214,058	32,038
Construction	18,824	675	62,745	5,686
Commercial	195,681	12,203	246,466	14,704
Services	214,382	7,338	352,615	18,570
Others	99,548	8,321	150,449	10,289
Total	**811,410**	**109,303**	**1,109,076**	**131,357**

*The BMA includes municipal areas of Bangkok and Thonburi.

Source: Vicharat and Thinapan (1976) derived data from Census 1960 and 1970.

Table 2.5 Numbers of Manufacturing Enterprises in Major Industrial Sectors in Bangkok Metropolitan Area (BMA) and Samut Prakan, 1970

Major sectors of industry	BMA		Samut Prakan	
	number	%	number	%
Agricultural products and communities	473	27.0	214	44.3
Minerals, metals and ceramics	267	15.2	83	17.2
Chemicals and chemical products	453	25.8	66	13.7
Mechanical and electrical equipment	264	15.1	67	13.8
Other products	296	16.9	53	11.0
Total	**1,753**	**100.0**	**483**	**100.0**

Source: Re-calculated from Donner (1978: 827) who cited in NSO, Industrial Census, 1970.

Petroleum contributed 29 per cent and other sources such as charcoal, firewood and rice husk comprised the remaining 12 per cent of the energy consumption (Sarkar, 1974: 81).

Industrial pollution became a significant problem in the privatised city. Sarawut (1989: 7) indicates that many small- and medium-scale industries such as metal plating, non-wooden furniture, and mechanical equipment had created hazardous wastes since the 1960s. Although these industries represented a small proportion of total factories, they caused serious problems to the environment, especially to water bodies. The industries, that were producing wastes without treatment, gradually increased in number during the 1970s. There were also reports that the water of the Chao Phraya River passing through Bangkok had no dissolved oxygen and contained very high levels of coliform bacteria (Suraphon *et al.,* 1984). However, the State could not solve the problem because there was no effective environmental protection law, even though the Office of National Environment Board had already been set up in 1975. In addition, the State still paid more attention to economic prosperity rather than environmental quality throughout the 1960s-1970s.

Waste water from communities was the most significant cause of water pollution in Bangkok. Based on a Thailand Development Research Institute (TDRI) survey in 1988, effluent from domestic sources accounted for 75 per cent of the total BOD load. The majority of houses discharged waste water directly into storm drains that normally flowed into nearby waterways. A central water treatment plant for Bangkok has never existed. Although much public housing had its own water treatment system, such housing represented only a small proportion of the city's residential areas.

Rapid urbanisation was noticeable from the accelerating growth of squatters and public and private housing estates all over Bangkok. In 1971, there were approximately 200 slum areas throughout the city. Five years later, the number of slum areas had increased to 365. Their occupants numbered around 400,000 people or 10 per cent of the total population of Bangkok. In 1977, there was another survey of squatters which reported that the number of residents in these areas had doubled (Suraphon *et al.*, 1984: 65). The living conditions of people in the slums were certainly poor because of the overcrowded environment and lack of public utilities. Since 1960, the State has attempted to improve conditions in slums by providing public facilities in many slum areas and constructing new low-income housing in Dindaeng, Khlongchan and Khlongprapa in the form of apartment units. Other new housing, for middle- and high-income people, managed by private enterprises, emerged in the suburban areas especially in the northeast, the east and the southeast of Bangkok.

In the development and planning of the city, the State played a far more important role than the local government. The local government or the Bangkok Metropolitan Administration mainly took care of public hygiene, while the State concerned itself with developing infrastructure in the city in order to attract foreign capital investment. The State had set up additional government agencies to provide services for the growing city.[10] Furthermore, they had tried to reduce the high concentration of economic activities in Bangkok by transferring industry in particular to other major provinces. However, such attempts seemed to be unsuccessful. New factories were attracted to Bangkok and its vicinity because of the availability of public utilities, labour pools, financial centres, head offices, and proximity to sea and air ports. State policies in the 1970s also attempted to promote export-led industry together with import-substitution in some selected industries (Rangsan, 1989: 34). Thus the role of the State was gradually overshadowed by the increasing power of both multinational enterprises and newly emerging domestic capitalists.[11]

---

[10] At least 6 state enterprises were established to ease inadequate services or infrastructure shortages in Bangkok. Those enterprises were Bangkok Mass Transit Authority, Expressway and Rapid Transit Authority of Thailand, Industrial Estate Authority of Thailand, Metropolitan Electricity Authority, Metropolitan Waterworks Authority and National Housing Authority.

[11] By the early 1970s, the former Chinese merchants could form powerful financial industrial corporate groups centring upon the promoted import-substitution industries, for examples Bangkok Bank Group, Saha Union Group, Siam Motors Group, Thai Farmers and Chareon Pokphan, etc (Suehiro, 1989: 184-190; Robison, 1989: 379). In addition, some of them could even expand their financial and industrial corporate groups overseas in the second half of the1970s. Chareon Pokphan Group, for example, has invested in agriculture and other commodities, jewellery, insurance, trading and investment in at least seven countries: Taiwan, Hong Kong, Singapore, Indonesia, The People's Republic of China, Abu Dhabi and the United States. Certainly, domestic capitalist groups have succeeded in capital accumulation and surplus (Narong, 1983: 110-115).

RESUME

This chapter employed Soja's approach, described in the previous chapter, to investigate the changing city of Bangkok. Although his conceptual framework for the North American City cannot directly apply to other cities with different social and economic backgrounds, his approach still provides insights into the processes at work in Bangkok's evolution.

Using Soja's time-span, of the 1820s to the 1970s, it can be seen that Bangkok has developed through four different prototypes: the *Sakdina* city before the 1850s, the post-*Sakdina* city in the 1850s-1920s, the bureaucrat-managed city in the 1930s-1950s and the privatised city in 1960s-1970s. Each city-type has been influenced by different forms of capitalism. The *Sakdina* city in the early nineteenth century was a fortified capital city without any form of capitalism. Until the mid-1850s, the post-*Sakdina* city was forced to accept international capitalism through the threat of imperialism, resulting in a new urban pattern. This is quite different from the second city prototype of Soja's framework — exemplified by the city of Manchester in the early stages of the competitive industrial city — in which domestic capital plays a significant role. In the bureaucrat-managed city, state capitalism clearly dominated Bangkok. The intervention of the State, especially in industrial development, was the key component in transforming the city; in this respect it differs from the corporate-monopoly city of Chicago in the similar period — in which the corporations were influential to the changing city. In the privatised city, domestic and international capital fuelled the expansion of the Bangkok Metropolitan Area with the support of the State in gaining capital accumulation and surplus. Private capitalism has, therefore, been more powerful in changing the urban form than the State. In this respect, Bangkok during this phase is dissimilar to the state-managed city of Tokyo — in which the State rearranged the city in order to attract the capitalists and to maintain legitimised labour.

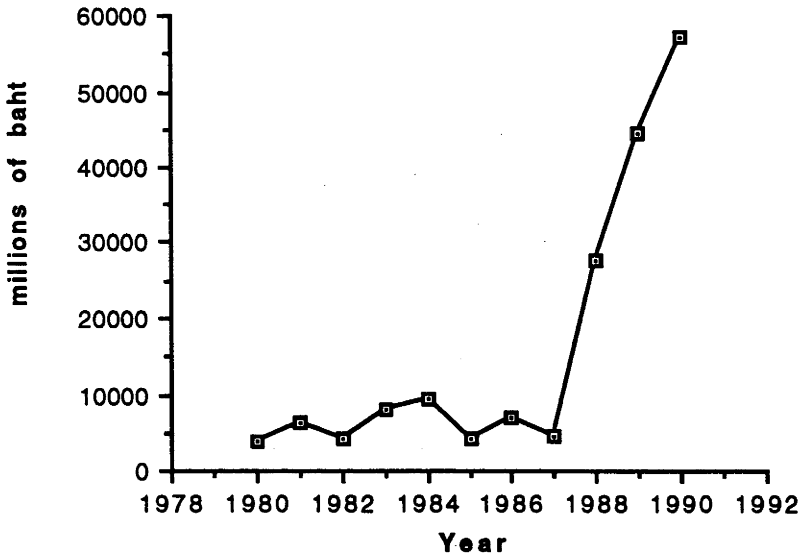
A factor that is common to both frameworks of city evolution, however, is that capitalism in both cases has changed the urban landscape to its own image in order to gain maximum profits. If the capitalist fails to maintain profits, another group of capitalists will attempt to supplant her role. The struggle among the capitalists to exploit resources in the urban environment and labour force in the community goes on endlessly. In the case of Bangkok in the 1970s, the phenomena of oil shocks, global recession and social upheavals affected the privatised city. These events should have terminated the fourth prototype of Bangkok. In the 1980s, global capitalism was, nevertheless, the most influential force on Bangkok and its neighbouring provinces. This condition raises more issues: is Bangkok still a privatised city or is it transforming into a new image? Can we apply the present framework of urban pattern to Greater Bangkok? We will answer these questions and explore a proper framework for Greater Bangkok in 1990 in the next chapter.

CHAPTER III

ELABORATING THE PRIVATISED CITY: GREATER BANGKOK AND SAMUT PRAKAN

Since the mid-1980s, direct foreign investment has poured into Thailand. Between 1986 and 1990, the average level of investment was 28 billion baht per annum. At current prices, it is more than seventeen times the average value of the 1970s. In 1988 alone, capital flow was close to 28 billion baht (Figure 3.1). In 1990, the value of direct foreign investment was double that of 1988. Apparently, much of the investment has been concentrated in the Greater Bangkok Region — the main population centre comprising the Bangkok Metropolitan Area (BMA) and the five provinces of Pathumthani, Nonthaburi, Nakhon Pathom, Samut Sakhon and Samut Prakan. The huge inflow of capital has transformed the privatised city.

The rapid growth of capital has resulted in the Greater Bangkok urban area being restructured. Accelerated industrialisation and associated urbanisation have put great strain on both its infrastructure and services which, in turn, have had negative effects on the urban environment and local communities. Although the Royal Thai Government has sought to rearrange the city by offering investment incentives and supplying public utilities, business interests have been paramount and they have invested in areas where they gain maximum profits. The resultant unmanageable urban growth of the privatised city raises key issues — how has Greater Bangkok's economy been restructured during the 1980s; how has rapid growth reshaped the urban pattern; how has restructuring affected the nature and extent of household and industrial pollution; how have these changes been compounded by the accompanying changes in social geography; and how have state, businessman and local people coped with these changes?



Source: *The Bank of Thailand Quarterly Bulletin*, 1982, 1987, 1991.

Figure 3.1 Direct Foreign Investment in Thailand, 1980-1990 (at current prices)

In examining the above issues, it is not feasible to cover every aspect of Greater Bangkok's urban geography. Attention is, therefore, focused on its Eastern Corridor, particularly that section which falls within Samut Prakan Province. Rather than undertake a separate study of Samut Prakan, however, the opportunity is taken to highlight its key features when discussing Greater Bangkok. Initially, a holistic view is provided of the interrelationship between industry, urban and social environment, first of Greater Bangkok and then of Samut Prakan (Section 1). Afterwards, we focus on how the economy of the two areas has been restructured during the 1980s and early 1990s (Section 2). Then the effect of economic growth on the physical restructuring of Greater Bangkok is considered (Section 3). These changes highlight the damage it has caused to the urban environment, particularly water bodies (Section 4). In turn, these developments have affected the social restructuring of the privatised city (Section 5). Finally, attention is drawn to the conflicts between authorities, business interests and the local people confronted by the transformation (Section 6).

1. GREATER BANGKOK AND SAMUT PRAKAN

Since the 1970s, as highlighted in Chapter 2, Bangkok has become the 'privatised city'. Investment capital in various activities has been concentrated not only in the Bangkok Metropolitan Area, but is now distributed throughout its 'Vicinity'.[1] Private entrepreneurs have dominated the use of urban resources with the aid of the state in providing economic incentives and public utilities and ensuring social stability. As shown in Figure 3.2, their injection of capital has profoundly disturbed the interrelationship between industry and its physical and social environment. This has weakened the privatised city's cohesion.

Since the mid-1980s, capital- and labour-intensive industrial activities have spilled over from the BMA into Nakhon Pathom, Nonthaburi, Pathumthani, Samut Sakhon, and especially Samut Prakan. Direct foreign investment has brought both the capital and advanced industrial technologies to Greater Bangkok. New types of industries such as bearing, integrated circuits, synthetic resins, plastic materials, artificial fibre and petrochemical products have been added to the Thai manufacturing sector. Apparently many small-scale activities have been transformed into medium- and large-scale industries.

Industrial waste has increased in quantity and is more hazardous. Although the production process is more capital-intensive, measurement of pollution control is insufficient. This is due to the irresponsibility of some businessmen on environmental protection. Uncontrolled land zoning of industrial areas has also fostered the small-scale industries, particularly in form of shop-house, boosting in the urbanised areas; whereas larger industries are preferably located in the suburban areas. Nonetheless, the small-scale industries are a major source of pollution because most of them cannot afford to have a waste treatment.

---

[1] It consists of Pathumthani, Nonthaburi, Nakhon Pathom, Samut Sakhon and Samut Prakan.

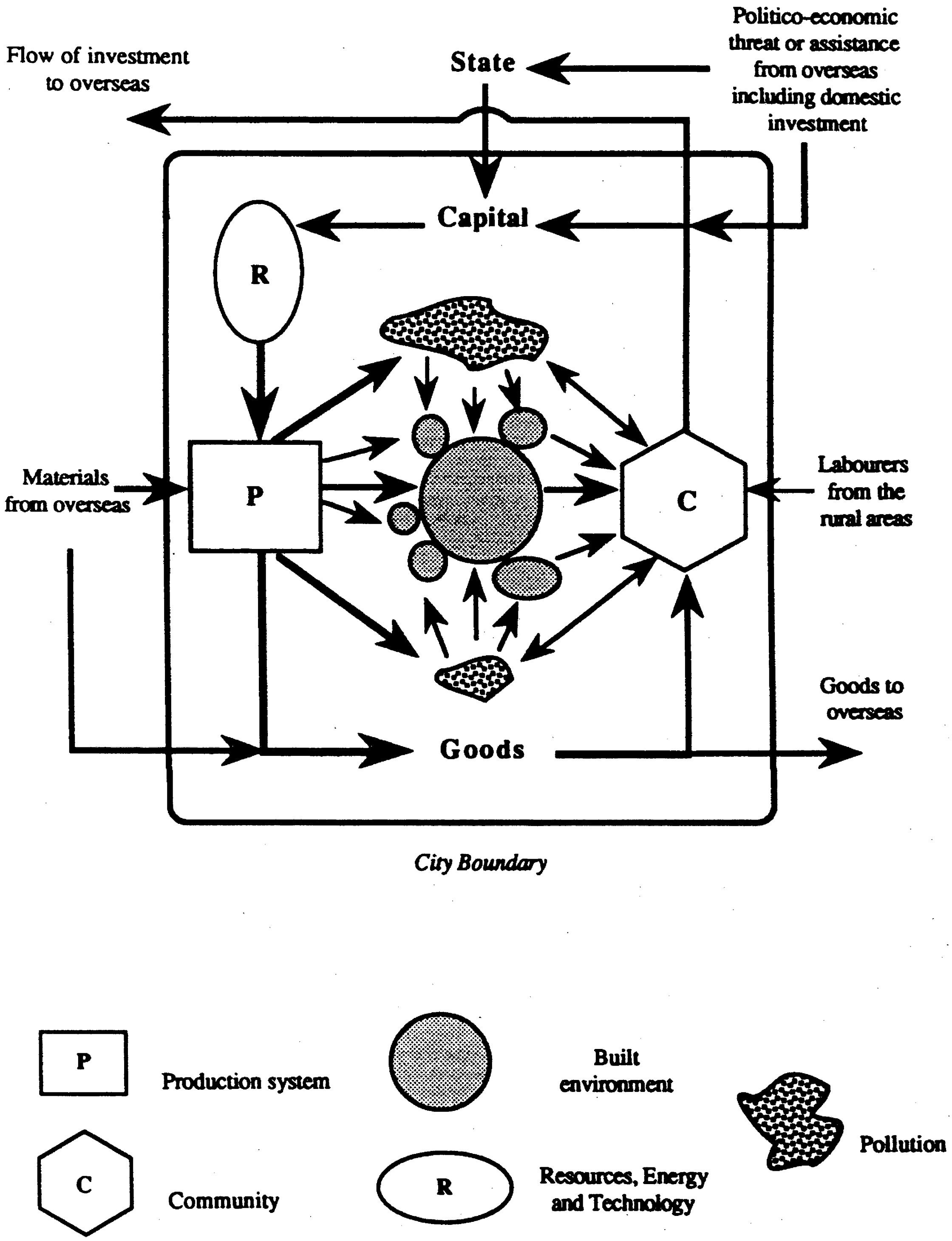


Figure 3.2 Greater Bangkok as the Privatised City, 1990s-

Rapid industrialisation has stimulated speedy urbanisation within Greater Bangkok. Community waste, especially household waste water, has become more serious. Although the quantity of domestic waste has increased, there is still no public water treatment plant. With additional industrial waste, water pollution has worsened. It has contaminated waterways from where most people in the vicinity of BMA draw natural water for their daily needs.

Industrialisation in Greater Bangkok has attracted labour from other provinces at a pace that has outstripped the capacity of urban areas to provide sufficient housing and public utilities. While management personnel can live in attractive areas, rural migrants with low incomes have had to accept sub-standard living conditions. All they can afford is cheap accommodation adjacent to the factories or in slums. Not only are public utilities inadequate but workers suffer from industrial pollution. As the state plays a supportive role to business it has not taken effective action.

The Bangkok Metropolitan Administration is mainly responsible for the capital city's hygiene. Within Greater Bangkok, municipalities and sanitary administrations take care of the urbanised areas. Non-urbanised areas are the responsibility of each Provincial Administrative Organisation (PAO), but in urban management it has no full executive power.[2] Other public services such as electricity, water supply and telephone are state enterprises. Residents or entrepreneurs beyond the municipal or sanitary limits have to assist themselves.

When we concentrate on Samut Prakan, the interrelationship between industry, urban environment and community differs little from that exhibited by Greater Bangkok as a whole. During the 1970s, as shown in Figure 3.3, Samut Prakan attracted domestic and overseas investment into factory construction because of the advantageous location of

[2] In other provinces apart from Bangkok Metropolitan Area and Pattaya, they are governed by the provincial and local administration. In Bangkok, it is governed only by the local administration or the Bangkok Metropolitan Administration. Its status is a special form of political system which is different from the Provincial Administrative Organisation or the Municipality (see Section 1 in Chapter VII).

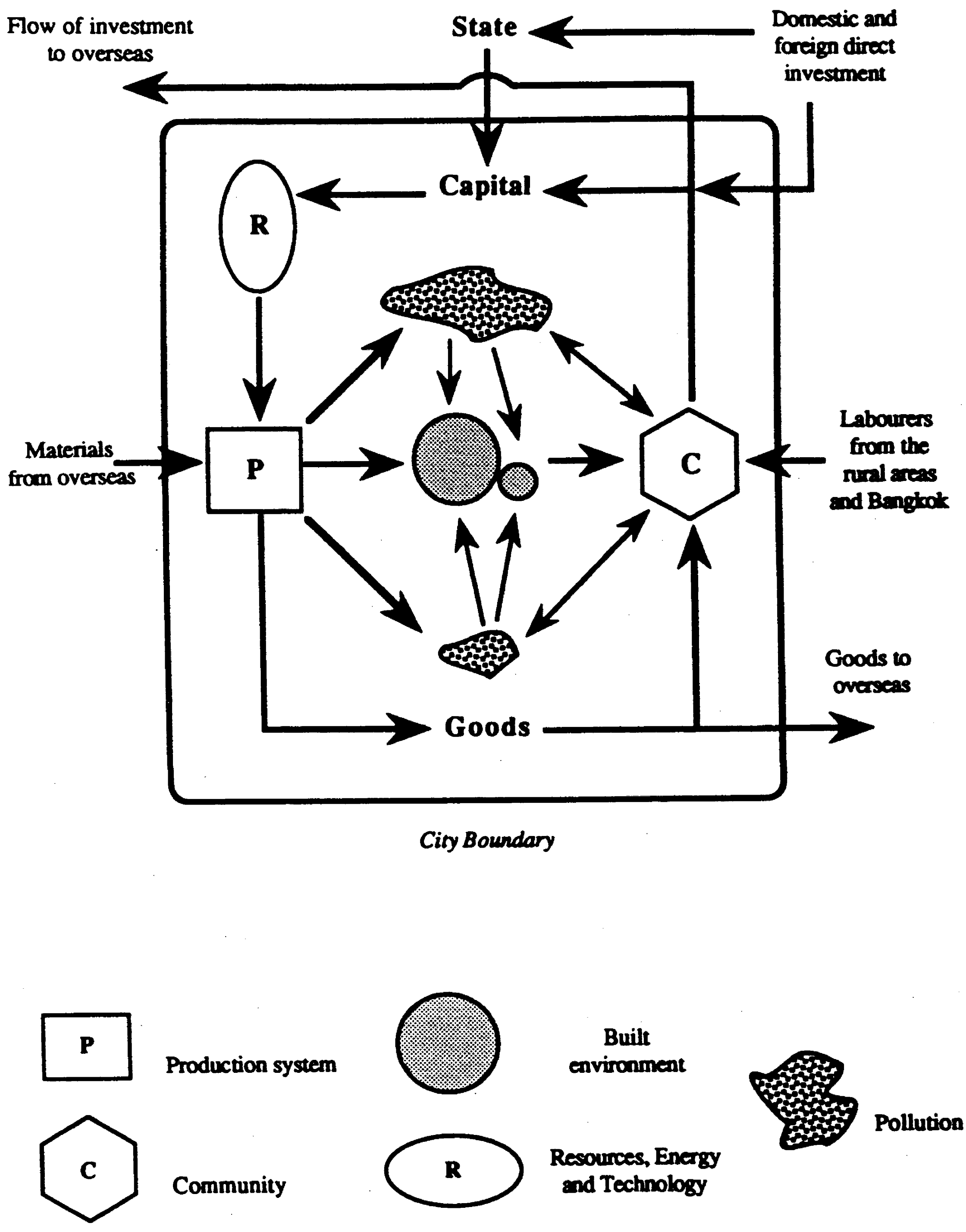


Figure 3.3 Samut Prakan as the Privatised City, 1990s-

Amphoes Muang and Phrapradaeng in relation to Khlong Toey Seaport and Don Muang Airport in the BMA. During the late 1980s, Amphoes Bang Pli and Bang Bo became more attractive to investors due to cheaper land prices, improved public infrastructure and high levels of community acceptance of industrial activities. They also have been assisted by public facilities and other investment incentives provided by both the Provincial Government and the Royal Thai Government (RTG). Many large-scale industries, for instance, are located in industrial estates.

Since the 1970s, industrial waste has increased in the inner city of Samut Prakan. Wastes from food processing, tanneries and metal plating, in particular, have contaminated the canal network in Amphoes Muang and Phrapradaeng. Although the Bangpu' Industrial Estate had been established in Amphoe Muang, there have been complaints from the nearby communities that untreated waste water is often released. As mentioned, industrial activities in the late 1980s spread to Amphoe Bang Pli and, to some extent, to Amphoe Bang Bo. These districts are considered the best choice for new investment because of their proximity to Bangkok's transport terminals and the Eastern Seaboard. They have also attracted polluting industries from the BMA and inner Samut Prakan.

The relocation of polluting industries in Amphoes Bang Pli and Bang Bo has not resolved the inner city's environmental problems. There is still no public waste treatment plant. The inner city is being overwhelmed by new residents working in factories and many new slums can be observed around new factories in the suburbs. These have generally increased domestic waste water which, with waste water from industries, has damaged both the productivity of fish farming and a number of natural flora and fauna in the canals.

Rapid industrialisation has stimulated private entrepreneurs to expand their investments in various high-profit housing developments within the urbanised areas of Amphoes Muang and Phrapradaeng and in the surrounding districts of Bang Pli and Bang

Bo. Only wealthy residents, however, can afford such houses. Blue collar workers have to find rented rooms or construct a shanty near the factories. New housing construction, public infrastructure development, an influx of labour, and environmental degradation, therefore, have had severe effects on the local community.

The Amphoe Muang municipality and the sanitary administration in other districts of the province have inadequate budgets and man-power to resolve the new set of environmental problems. Their responsibilities are also confined within their defined boundaries. Beyond their boundaries, responsibility rests with the Provincial Administrative Organisation, the RTG and other public enterprises based on Bangkok such as the Department of Highways, the National Housing Authority, the Metropolitan Electricity Authority, the Metropolitan Waterworks Authority, and the Telephone Organisation of Thailand. As these organisations cannot keep pace with accelerated urbanisation, the management of many suburban areas has been neglected.

Following this broad overview of the privatised city, we are now in a position to examine different dimensions of the restructuring process. In particular, we examine changes in the economic, physical and social aspects of restructuring in both Greater Bangkok and Samut Prakan.

2. ECONOMIC RESTRUCTURING

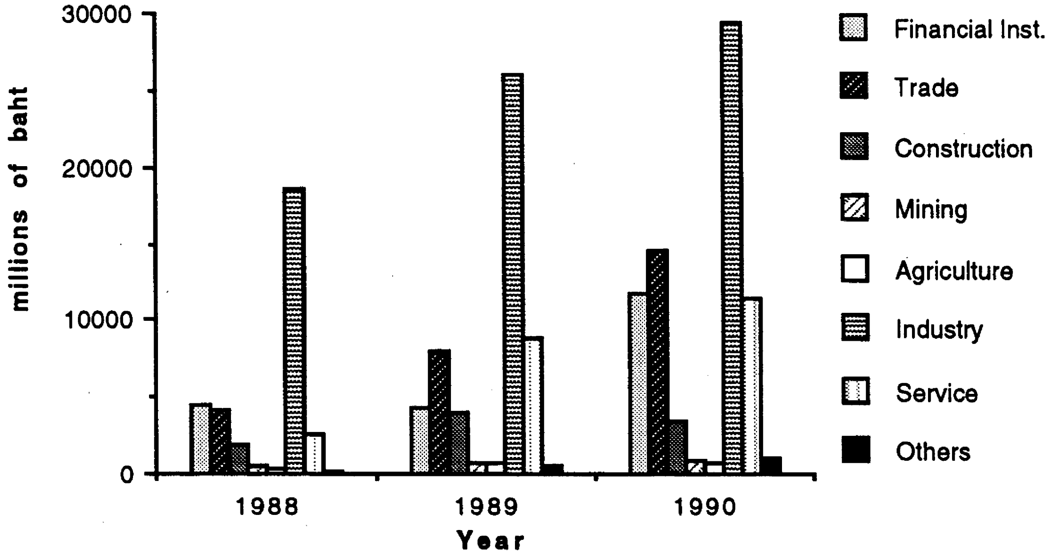
In the early 1980s, the Thai economy was in recession. Following the second oil shock of 1979, it experienced budget and balance of payments deficits. Although they had faded out in the 1970s, external influences, particularly the World Bank and the IMF, significantly re-exerted their role in alleviating debt and capital formation problems. Loans from these bodies now carried conditions which included requirements for structural adjustment: reduction of levels of protection, devaluation and the deregulation of prices. More importantly, they intervened in the Fifth National Economic and Social Development Plan (1982-86) and the early phase of the Sixth National Plan (1987-91) which shifted the Thai economy from import substitution to export-oriented industrialisation (Hewison, 1987: 75; Rangsan, 1989: 36-7). Since then manufacturing has become the mainstay of the Thai economy.

As mentioned, the influx of direct foreign investment has continued to flow into Thailand during the 1980s and the early 1990s. Japan and the Asian NIEs have been the major investors.[3] In 1988 alone, there were 390 and 400 applications from Japanese and Taiwanese investors in Thailand. In this period, proposals involving Japanese ownership rose to US$ 5.9 billion, more than three times the 1987 level, and far more than the US$ 2.2 billion of investment proposed by investors from Taiwan and their Thai partners (Choo and Ali, 1989: 12). This trend is continuing and much of the capital is being invested in the industrial sector (Figure 3.1 and 3.4).

Most of the direct foreign investment was concentrated in Greater Bangkok, and the manufacturing sector has become the region's most important activity. Since 1980, the Gross Regional Product (GRP) in manufacturing has outstripped other sectors — others, trades, services and agriculture (Figure 3.5). The BMA and Samut Prakan have mirrored the regional pattern of the economy in their Gross Provincial Product (GPP). During the 1980s, the extraordinary trend of the manufacturing sector in Samut Prakan, however, has differed from the BMA and Greater Bangkok (Figure 3.6 and 3.7). In 1987, manufacturing contributed 34 per cent to the BMA's economy compared with 56 per cent for Samut Prakan. Comparable figures for Pathumthani, Samut Sakhon, Nonthaburi and Nakhon Pathom were 54, 36, 24 and 19 per cent respectively (NSO, 1990: 111-114).

Between 1984 and 1989, the proportion of manufacturing in BMA decreased whereas it increased in the five provinces of Greater Bangkok. Although the recession of the early 1980s had reduced the growth of factories throughout Greater Bangkok, their increase had been confined to the five provinces (Table 3.1). In particular, Samut Prakan

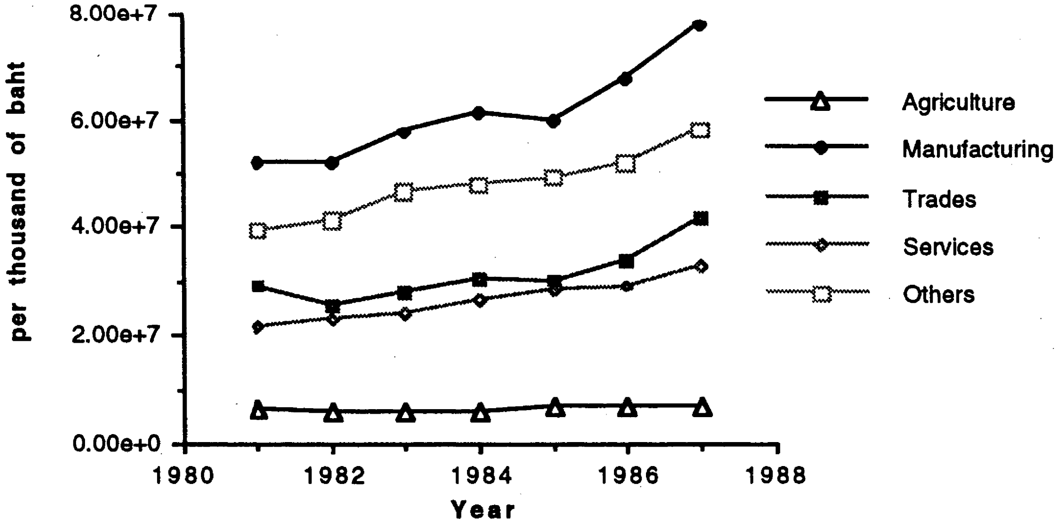
[3] The NIEs comprises South Korea, Taiwan, Hong Kong and Singapore.



Note: * Including loans from parent companies.

Source: BOI, 1989-90

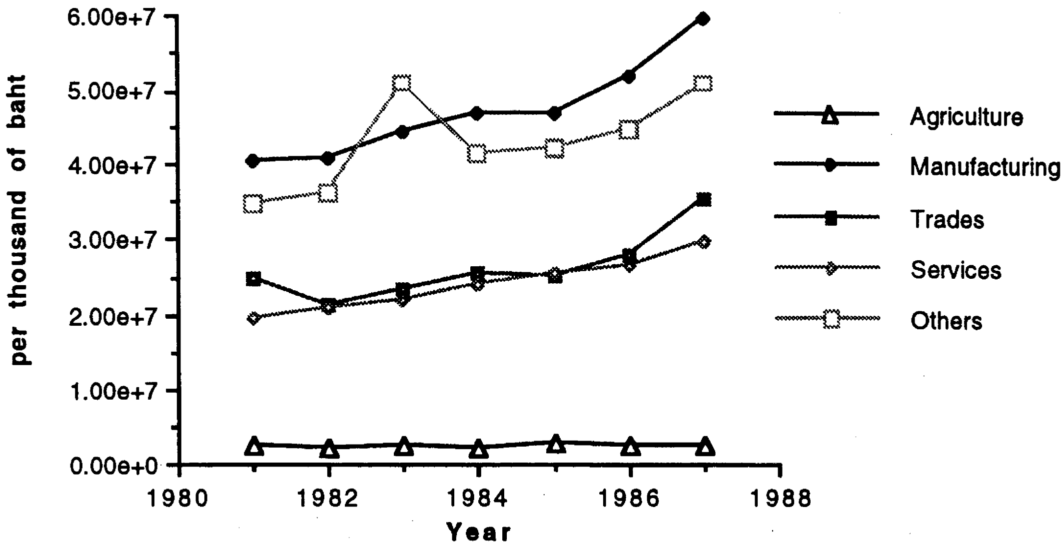
Figure 3.4 Inflow of Direct Foreign Investment Classified by Types of Business*, 1988-1990



Note: Others cover sectors of mining and quarrying; construction; electricity and water supply; transportation and communication; banking, insurance and real estate; ownership of dwellings; and public administration and defence.

Source: NSO (1990) cited in ONESDB, 1988.

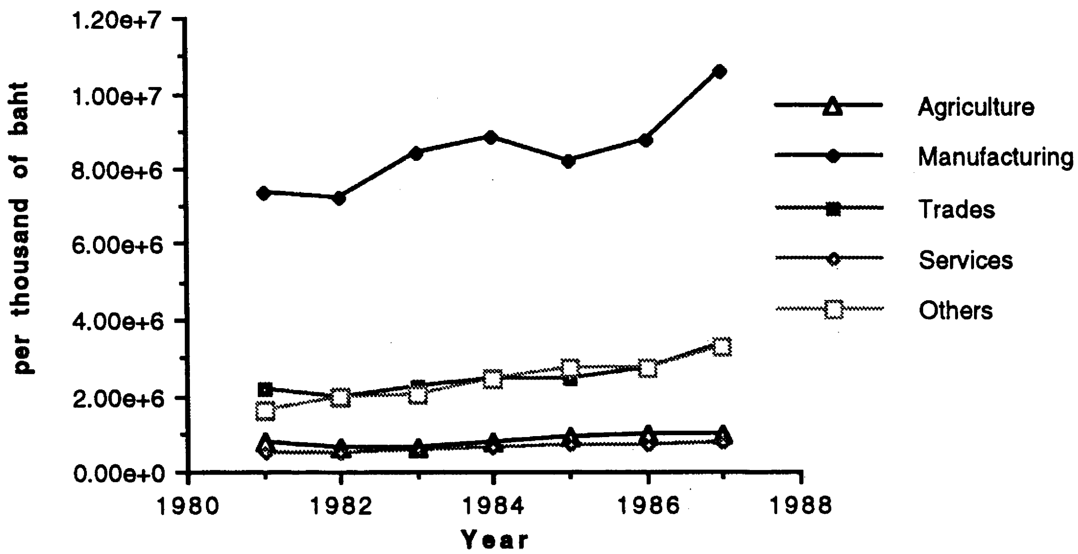
Figure 3.5 Greater Bangkok's Gross Regional Product at Constant 1972 Prices in Five Major Sectors, 1981-1987



Note: Others cover sectors of mining and quarrying; construction; electricity and water supply; transportation and communication; banking, insurance and real estate; ownership of dwellings; and public administration and defence.

Source: NSO (1990) cited in ONESDB, 1988.

Figure 3.6 Bangkok Metropolitan Area's Gross Provincial Product at Constant 1972 Prices in Five Major Sectors, 1981-1987



Note: Others cover sectors of mining and quarrying; construction; electricity and water supply; transportation and communication; banking, insurance and real estate; ownership of dwellings; and public administration and defence.

Source: NSO (1990) cited in ONESDB, 1988.

Figure 3.7 Samut Prakan's Gross Provincial Product at Constant 1972 Prices in Five Major Sectors, 1981-1987

Table 3.1 Factories in Five Major Manufacturing Activities within the Greater Bangkok (GB), Bangkok Metropolitan Area (BMA), Samut Prakan (SP) and the Four Other Provinces (O), 1984-1989

Year	Agricultural products & commodities				Minerals, metals & ceramics				Chemicals & chemical products				Mechanical & electrical equipments				Other products			
	GB	BMA	SP	O	GB	BMA	SP	O	GB	BMA	SP	O	GB	BMA	SP	O	GB	BMA	SP	O
	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.
1984	4,033	2,203	681	1,149	5,890	4,943	529	418	4,809	4,256	311	242	5,008	3,961	543	504	6,851	5,602	581	668
1985	3,395	1,820	487	1,088	4,828	3,982	474	372	3,706	3,243	244	219	3,971	3,143	464	364	6,034	4,983	519	532
1986	3,433	1,784	512	1,137	4,738	3,791	522	425	3,634	3,099	269	266	3,973	3,075	510	388	6,070	4,912	586	572
1987	3,542	1,797	566	1,179	4,877	3,816	582	479	3,710	3,149	294	267	4,051	3,091	554	406	6,490	5,203	635	652
1988	3,667	1,798	638	1,231	5,038	3,870	631	537	3,843	3,226	319	298	4,150	3,126	589	435	6,866	5,445	690	731
1989	3,864	1,863	704	1,297	5,410	4,102	688	620	4,154	3,452	370	332	4,435	3,310	636	489	7,543	5,962	758	823

Year	Agricultural products & commodities				Minerals, metals & ceramics				Chemicals & chemical products				Mechanical & electrical equipments				Other products			
	GB	BMA	SP	O	GB	BMA	SP	O	GB	BMA	SP	O	GB	BMA	SP	O	GB	BMA	SP	O
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1984	100.0	54.6	16.9	28.5	100.0	83.9	9.0	7.1	100.0	88.5	6.5	5.0	100.0	79.1	10.8	10.1	100.0	81.8	8.5	9.7
1985	100.0	53.6	14.3	32.1	100.0	82.5	9.8	7.7	100.0	87.5	6.6	5.9	100.0	79.1	11.7	9.2	100.0	82.6	8.6	8.8
1986	100.0	52.0	14.9	33.1	100.0	80.0	11.0	9.0	100.0	85.3	7.4	7.3	100.0	77.4	12.8	9.8	100.0	80.9	9.7	9.4
1987	100.0	50.7	16.0	33.3	100.0	78.3	11.9	9.8	100.0	84.9	7.9	7.2	100.0	76.3	13.7	10.0	100.0	80.2	9.8	10.0
1988	100.0	49.0	17.4	33.6	100.0	76.8	12.5	10.7	100.0	83.9	8.3	7.8	100.0	75.3	14.2	10.5	100.0	79.3	10.0	10.7
1989	100.0	48.2	18.2	33.6	100.0	75.8	12.7	11.5	100.0	83.1	8.9	8.0	100.0	74.6	14.4	11.0	100.0	79.0	10.1	10.9

Note: The above information does not include number of factories in the industrial estates.

Source: Compiled from data of DIW, 1990.

had the highest growth rate. Compared to the other provinces, it attracted a greater number of factories engaged in producing minerals, metals and ceramics, chemicals and chemical products, mechanical and electrical equipment. It ranked second to the BMA in the number of factories.

Between 1984 and 1989, the number of factories in Samut Prakan had increased from 2,645 to 3,156 and employees from 127,000 to over 261,000 (Table 3.2). In 1984, investment in Samut Prakan's manufacturing sector was almost 39,000 million baht. By 1989, excluding investment in the industrial estates, it was more than 100,000 million baht. The value was much higher than the previous year. While the BMA's share of industry has been declining, Samut Prakan has become more attractive due to its advantageous location close to air- and sea-ports and the Eastern Seaboard in Chonburi.

Table 3.2 Numbers of Factories and Employees and Investment in Manufacturing Industry within Samut Prakan, 1984-1989

Year	Factories[1] no.	Employees[2] no.	Investment[2] mill. baht
1984	2,645	127,286	38,927
1985	2,188	n.a.	n.a.
1986	2,399	159,669	64,796
1987	2,631	n.a.	n.a.
1988	2,867	232,835	70,974
1989	3,156	261,028	102,596

Source: [1] DIW, 1990.
[2] POI, 1990.

In the early 1990s, electronics and electrical goods have become the nation's leading export sector. In 1991, output was around 118 billion baht (US$ 4.6 billion), or 16.5 per cent of all exports — a figure exceeding the total value of both agricultural and commodity exports. This rapid transformation since 1987 has been the result of massive

Japanese investment followed by South Korean, Taiwanese and Singaporean investment during 1988-90 (*Far Eastern Economic Review*, 30 January 1992: 46). This export boom in electronics and electrical goods will transform the industrial structures of the entire Greater Bangkok area and will bring about massive physical restructuring.

3. PHYSICAL RESTRUCTURING

From the BMA to its Vicinity and from its Vicinity to the Extended Metropolitan Region, economic transformation has variably affected land value. In 1989, the average land price in the central area was more than five million baht per rai.[4] It was higher than 50 times those in the radius of 100 kilometres which falls in Petchaburi, Angthong, Saraburi, Chachoengsao and Chonburi (Figure 3.8). It is obvious, however, that high land prices were extended from the BMA to the east within 50 kilometres covering the areas along Bangna-Trat and Ramintra Roads. Apparently, many land development projects especially on Bangna-Trat Road in Samut Prakan, have been constructed such as industrial estates, air- and sea-cargo service centres, condominiums, shopping plazas, golf courses and entertainment theme parks. The high land value reflects the investment of business interest and of the state on a quick return-profit project.

Generally, industrial activity is centred on Greater Bangkok. Between the 1960s and 1980s, the number of factories in Thailand rose more than eighty times. Greater Bangkok alone accounts for one-quarter (DIW, 1990). Almost all factories in Greater Bangkok, however, are located in the BMA and Samut Prakan (Table 3.3). While the growth of factories in Greater Bangkok has differed little from the national pattern, those in Samut Prakan and the other four provinces have increased at a greater rate. Thus, there has been relocation of factories from the BMA to other provinces where land prices are lower. This has been encouraged by government policy promoting industries in other regions outside the BMA. Samut Prakan has been the prime beneficiary given its close proximity to the Eastern Seaboard.

---

[4] One rai is equivalent to 0.4 acre or 0.16 hectare.

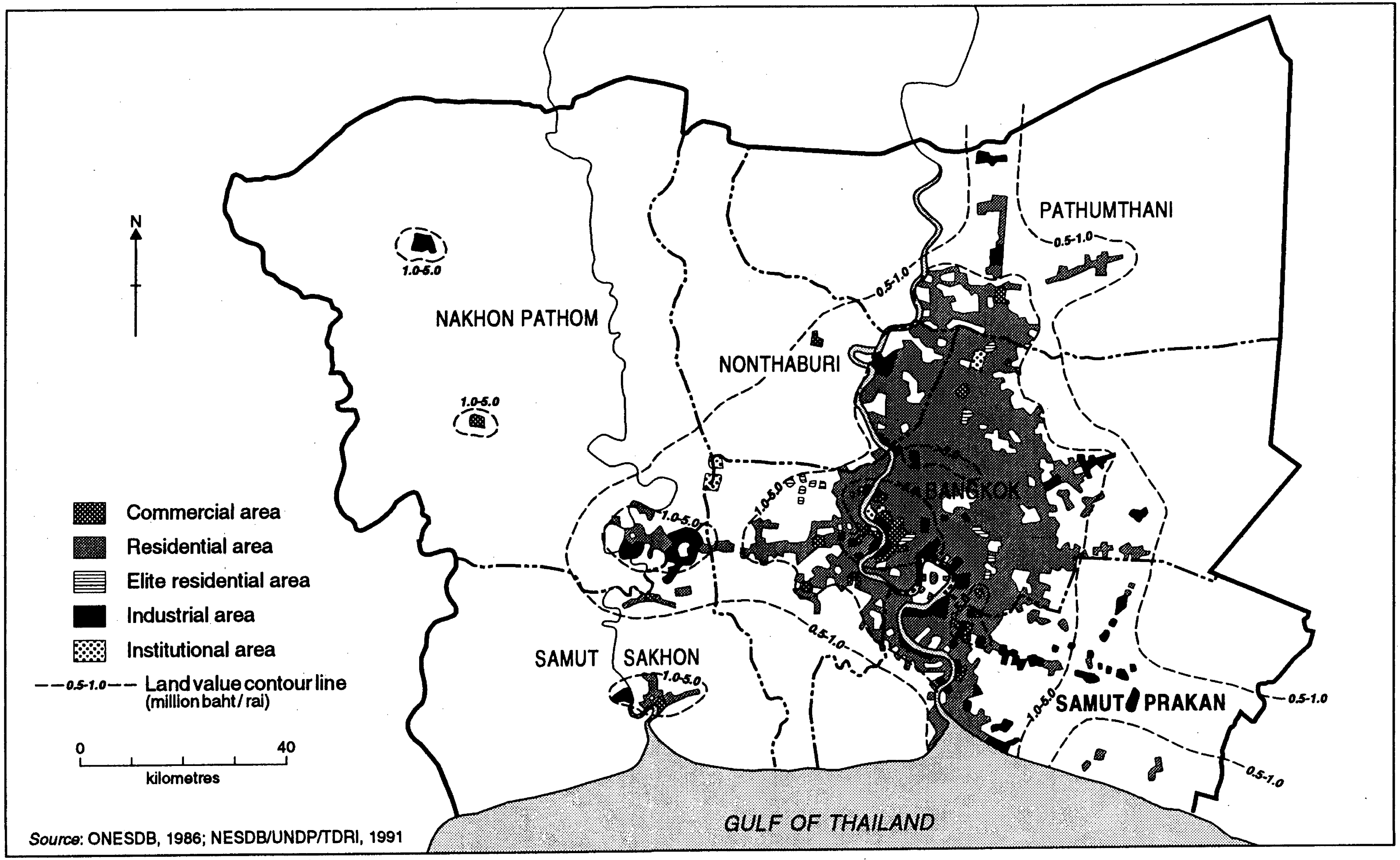


Figure 3.8 Land Use and Land Value of Greater Bangkok, 1989

Table 3.3 Number of Factories in Greater Bangkok, Bangkok Metropolitan Area (BMA), Samut Prakan and the Other Four Provinces in the Region Compared as Percentage to the Total Number of the Whole Kingdom, 1984-1989

Year	Greater Bangkok		BMA		Samut Prakan		Other Four Provinces	
	no.	national %	no.	national %	no.	national %	no.	national %
1984	26,591	27.8	20,965	21.9	**2,645**	**2.8**	2,981	3.1
1985	21,934	25.8	17,171	20.2	**2,188**	**2.6**	2,575	3.0
1986	21,848	25.5	16,661	19.5	**2,399**	**2.8**	2,788	3.2
1987	22,670	26.0	17,056	19.6	**2,631**	**3.0**	2,983	3.4
1988	23,564	25.9	17,465	19.2	**2,867**	**3.1**	3,232	3.6
1989	25,406	26.8	18,689	19.7	**3,156**	**3.3**	3,561	3.8

Note: This table does not include factories which have been established in industrial estates.

Source: Compiled from data of DIW, 1990.

Since the mid-1980s, many new industrial activities have been located in the outlying areas of the BMA, particularly in Thonburi, Bangkoknoi and Bangkhunthien in the west, between Bangkapi and Minburi in the northeast, and at Latkrabang in the east of the city.[5] There are also other new industrial areas in the neighbouring provinces of Nakhon Pathom at Amphoes Sampran and Nakhon Chaisri, Nonthaburi at Amphoes Muang and Pakkret, Pathumthani at Amphoe Muang, Samut Sakhon at Amphoe Muang and Samut Prakan at Amphoes Muang, Phrapradaeng, Phrasamutjedi and Bang Pli. Clearly, most of the high water-consuming industries are located in the southern parts of Greater Bangkok, such as in Nakhon Pathom, Samut Sakhon and Samut Prakan, whereas the low water-consuming ones are situated in Nonthaburi and Pathumthani (Figure 3.8).

[5] This includes five industrial estates that the Industrial Estate Authority of Thailand (IEAT) has responsibility for within Greater Bangkok. Two industrial estates are at Bangchan and Latkrabang in the BMA, another two estates are at Bang Pli and Muang in Samut Prakan and the last one is under construction at Amphoe Muang in Samut Sakhon.

When we investigate the activities on Greater Bangkok's industrial estates, there are only four sites in the BMA and Samut Prakan that are under the responsibility of the Industrial Estate Authority of Thailand (IEAT). The investment in these industrial estates is about 43 per cent of the total investment of the eleven other estates located throughout Thailand (IEAT, 1990). In 1990, IEAT reported that the number of factories in Greater Bangkok was about 600 with a total investment of almost 50,000 million baht and more than 113,000 people employees (Table 3.4). The high investment and number of employees indicate that factories in the industrial estates are mainly capital-intensive and large-scale industries. Clearly, Samut Prakan has a greater number of large-scale factories than has the BMA. Since the mid-1980s, IEAT has stopped promoting industrial estates in Greater Bangkok in response to government policy aimed at easing the congestion of its industrial and residential areas. Nevertheless, the state has never prohibited private enterprises from establishing specialised industrial estates such as gem and jewellery and industrial condominium estates which differ in form and scale from those promoted by IEAT.

Table 3.4 Industrial Activities in Areas Operated by the Industrial Estate Authority of Thailand in Greater Bangkok, 1990

Name of Industrial Estate	Location	Area (rai)	Factories no.	Investment mill. baht	Employees no.
Bangchan	BMA	677	79	4,960	12,284
Latkrabang	BMA	2,533	160	17,082	42,420
Bangpu'	Samut Prakan	3,930	243	18,783	44,617
Bang Pli	Samut Prakan	1,004	117	8,224	13,850
Total		**8,144**	**599**	**49,049**	**113,171**

Source: IEAT, 1990.

Between 1987 and 1991, rapid industrialisation boosted total housing demand in Greater Bangkok. As noted by Rosit (1988), the number of units was increased by about 250,000 — an annual growth rate of 18.9 per cent (Table 3.5). New housing

Table 3.5 Housing Demand in Greater Bangkok, 1987-1991

Residential types	1987 units	1991 units	1987-1991 units	Annual increase units
Housing estates	224,570	368,750	144,180	28,836
Commercial buildings	363,275	369,185	5,910	1,182
Houses constructed by owners	200,792	215,940	15,148	3,029
Houses constructed on allotted land	72,655	78,550	5,895	1,179
Houses constructed by government agencies	116,248	166,248	50,000	10,000
Slum houses	244,385	259,215	14,830	2,966
Houses along canals	33,025	34,562	1,537	307
Others	66,050	78,550	12,500	2,500
Total	**1,321,000**	**1,571,000**	**250,000**	**50,000**

Source: Rosit (1988: 215) cited in ONESDB (n.d.)

developments, owned by the public and private sectors, have been attracted to industrial areas. For example, the National Housing Authority (NHA) constructed low-income apartment blocks and houses at Bangkhen in the north of BMA, at Amphoes Muang and Bang Pli in the east of Samut Prakan and at Amphoe Pakkret in Nonthaburi. Simultaneously, many private developers have created housing estates featuring luxury houses and condominiums for middle- and upper-income people in the BMA. They are located in the inner city at Phayathai and Bangrak, in the eastern suburbs at Bangkapi and Phrakhanong, in the north of the city at Bangkhen and Rangsit, and in the west at Bangkoknoi and Talingchan.[6] Furthermore, the number of squatters has increased in the vicinity of these new industrial sites.

The subsequent economic restructuring of Bangkok has resulted in an expansion of its financial centre. It now includes modern office buildings along Silom Road in Bangrak to Sathon Road in the south and Suriwongse Road in the north. There are also

[6] Between 1985 and 1987, the unprecedented growth of private housing estates (excluding condominium and flat units) occurred to the east and north of the BMA. In Bangkapi, there were 262 housing estate projects, 235 in Phrakhanong and 244 in Bangkhen (Rosit, 1988: 216).

new sub-financial centres on Wireless and Pleonchit Roads in Pathumwan, Sukhumwit Road in Bangkapi, New Petchburi Road in Phayathai, and Ratchadaphisek in Huai Khwang. In addition, huge shopping complexes have been constructed following the diffusion of residential and financial areas throughout the BMA and to some extent at Samrong in Samut Prakan. Other new developments, such as golf courses, multi-purpose precincts comprising offices, shopping malls, condominiums and sport centres, and entertainment theme parks have emerged along inter-provincial highways, particularly Phahonyothin Road in the north and Bangna-Trat Road in the east of Greater Bangkok.

As in Greater Bangkok, physical restructuring of the Samut Prakan Province has been guided mainly by the alignment of public infrastructure, land values and private initiative projects (Figure 3.9). In 1980, Watson Hawksley and SISAT (1987: 2.5-2.6) estimated that agricultural land use occupied 70 per cent of the province. Paddy and fish farming were pronounced in Amphoes Bang Pli and Bang Bo. Residential and industrial activities, however, have largely displaced agricultural areas in Amphoes Muang, Phrapradaeng and Phrasamutjedi and partially in Bang Pli. Industrial activity took over most areas of Amphoe Phrapradaeng covering both banks of the Chao Phraya River and along Puchao Samingprai and Suksawat Roads. There are also many factories and warehouses along the bank of the River in Phrasamutjedi. Two industrial estates owned by the IEAT are located in Amphoes Muang and Bang Pli with a number of small- and medium-scale industries scattered along major roads.

Residential and commercial areas are concentrated in the two municipalities of Amphoes Muang and Phrapradaeng. A medium-size, modern shopping centre is located at Samrongnua in Phrapradaeng while residential-and-commercial units or shop-houses predominate near major roads whereas individual houses and housing estates are formed behind them. In the late 1980s, the expansion housing proceeded apace. Private housing developers proposed thirty-eight housing and condominium projects for middle- and upper-income people all over the province, while the NHA was constructing houses and apartment units for the low-income residents near the Bangpu' Industrial Estate in

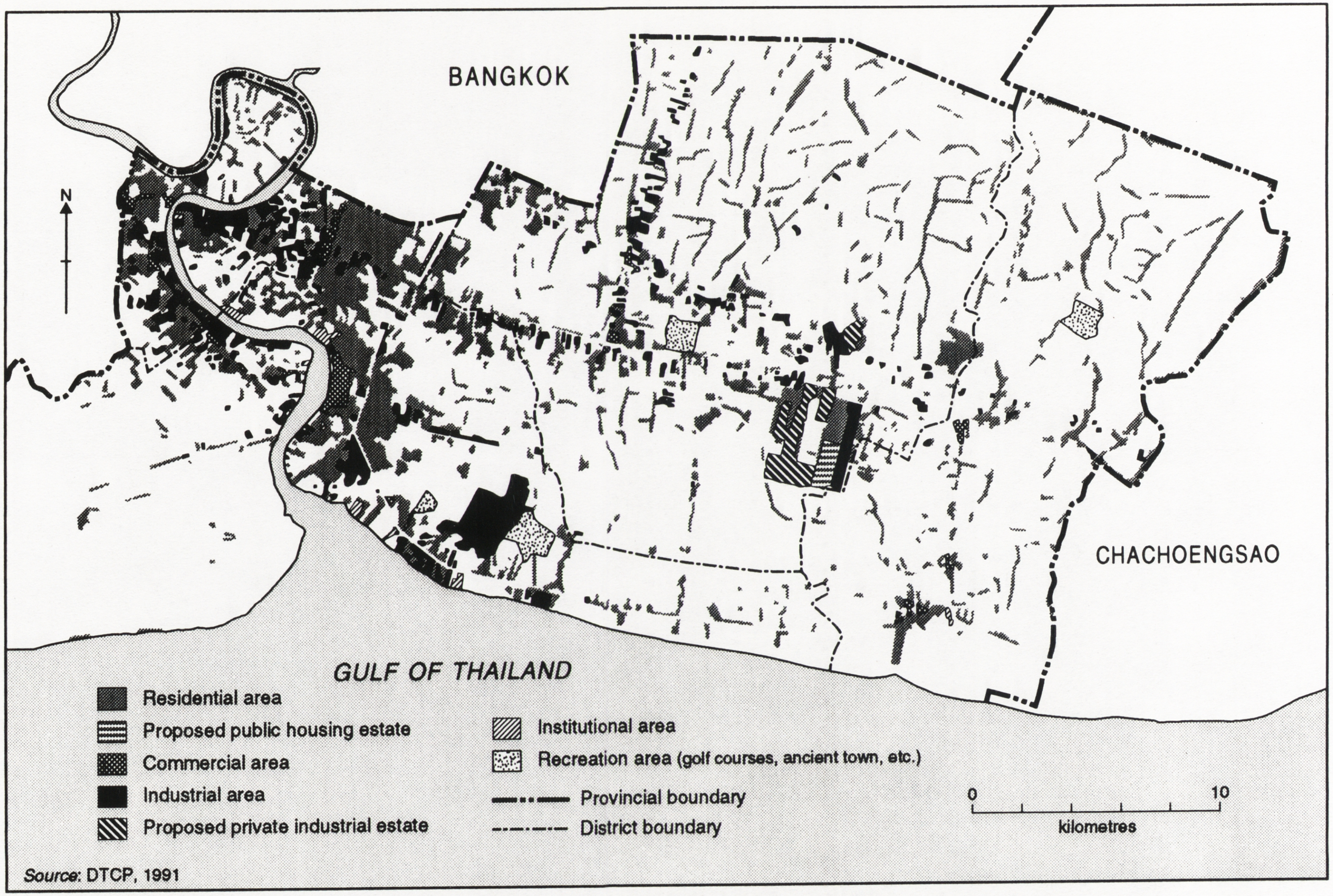


Figure 3.9 Land Use in Samut Prakan, 1989

Amphoe Muang and the Bang Pli Industrial Estate in Amphoe Bang Pli (Table 3.6). In addition, industrial slums have developed near the factories in both Amphoes Muang and Phrapradaeng because of the influx of labour force from the rural areas augmented by people evicted from the BMA's slum areas (Watson Hawksley and SISAT, 1987: 2.9-2.10).

Table 3.6 Housing Development in Samut Prakan, 1989-1990

Types of	Projects no.	Project Area square metres
Residential house	29	778,400
Condominium	9	22,560

Source: Sun Komun Changwat Samut Prakan, 1990.

Generally, rapid urban growth creates an urgent demand for adequate transport systems and other public utilities. Not surprisingly, most new roads and expressways have been constructed in Greater Bangkok, especially the BMA. A second international airport has been proposed for Nongnguhao in Samut Prakan. Telephone, electricity and water supply projects have been proposed to meet the region's increasing demand. Both the local and central governments, however, have never given much importance to environmental awareness and protection. Pollution problems have been disguised by the expanding economy. Yet urban degradation can undermine both Greater Bangkok's economy and society.

4. ENVIRONMENTAL DETERIORATION

Mixed land use within Greater Bangkok's residential, commercial and industrial areas has compounded urban congestion and degradation. Moreover, Bangkok has never had a public waste water treatment plant for its community. The other five provinces around the capital city have no treatment plants. The majority of houses discharge waste water directly into storm drains which in turn release it into nearby waterways. The Chao Phraya River is the main recipient of all wastes. From the mouth to 60 kilometres upstream, it contains very low dissolved oxygen (i.e. the average values in the wet season is 3-4 mg/l and in the dry season is 1-2 mg/l).[7] Most canals inland from the River have become septic tanks, when the BMA blocks them by watergates to control floods. Even in the wet season, the average value of dissolved oxygen in the canal network is almost zero. Unquestionably, the water quality is unfit for human consumption and all waterborne life (Phaithun, 1990: 48).

As noted, domestic waste water is the main source of water pollution in Greater Bangkok. Although industrial pollution has less volume in terms of effluent, its severity is more harmful to the environment because it consists primarily of heavy metals and synthetic organic compounds. Both are toxic. Since the late 1980s, Sarawut (1989: 10) has confirmed changes in the Region's industrial structure, and particularly the shift from light to heavy industries has generated increased hazardous wastes. Although most factories have a water treatment plant, they release waste water illegally into nearby waterways.

Thailand Development Research Institute's (TDRI, 1991) study of polluting industries in Thailand showed their number had increased from 33.4 per cent in 1969 to 50.9 per cent in 1989 with water-polluting industries experiencing the highest growth rate (Table 3.7). Moreover, in the GDP share industries in the Fourth and Sixth National Economic and Social Development Plans, there was a slight decline from 57 per cent in 1979 to 53 per cent in 1989. The water-polluting industries, however, had a much smaller contribution to GDP than the air-polluting industries. The latter provided 42 per cent in 1979 and 39 per cent in 1989 (Table 3.8).

---

[7] Mg/l (milligrams per litre) is equivalent to parts per million.

Table 3.7 Number of Air- and Water-Polluting Industries Licensed by the Department of Industrial Works in the Greater Bangkok, in 1969, 1979 and 1989*

Types of industry	1969 no.	1969 %	1979 no.	1979 %	1989 no.	1989 %
Water-polluting industries	159	25.2	5,393	27.4	20,221	39.3
Air-polluting industries	68	10.8	2,241	11.4	8,120	15.8
Overlapping (Air+water industries)	16	2.5	604	3.1	2,106	4.1
Sum of polluting industries	211	33.4	7,030	35.7	26,235	50.9

Note: * Excluding a number of licensed factories under the Authority of Industrial Estates and Provincial Office of Industry.

Source: Recalculated TDRI's information (1991) which cited data in the Department of Industrial Works, Ministry of Industry, 1990.

Table 3.8 Contribution of Air- and Water-Polluting Industries to Gross Domestic Product at 1972 Prices, 1979 and 1989*

Types of industry	1979 Value mill. baht	1979 GDP per cent	1989 Value mill. baht	1989 GDP per cent
Water-polluting industries	65,177	15.2	125,108	13.6
Air-polluting industries	180,648	42.0	362,242	39.4
Sum of polluting industries	245,825	57.2	487,350	53.1

Note: * Excluding a number of factories under the Authority of Industrial Estates and Provincial Office of Industry.

Source: Recalculated TDRI's information, 1991.

In 1990, waste water from all sources in Samut Prakan was estimated at 42,000 cubic metres per day. Domestic effluent supplied more than half of the total. Highly contaminated, industrial waste water, especially from food processing, textile, chemicals and tanneries in the canal network on the left bank of Chao Phraya River, provided a further 25 per cent of waste water flowing into the lower River (*Phuchatkan*, 2-8 July 1990: 59). The impact of water pollution caused by industrial and domestic waste in Samut Prakan, however, is more serious to the local people than those in the BMA. Whereas Bangkokians rely on piped services, most residents in Samut Prakan depend upon natural water bodies.

Water pollution has not only damaged fish farming and living organisms in natural water bodies but has also brought infectious diseases to people. Samut Prakan's Provincial Office of Public Health (1991) reported that water-borne diseases (e.g. diarrhoea and dysentery) were a leading health hazard. Between 1986 and 1990, diarrhoea was a cause of death (Table 3.9). Apparently, diarrhoea and dysentery were found mainly in the industrial areas of Muang and Phrapradaeng districts, and ninety-seven per cent of the patients were migrant labourers. This phenomenon is less harmful in BMA because of access to piped water.

Table 3.9 Number of Patients Who Were Sick with Diarrhoea and Dysentery in Samut Prakan, 1986-1990

Year	Diarrhoea Illness (no. per 10 thousand)	Diarrhoea Death (no. per 10 thousand)	Dysentery Illness (no. per 10 thousand)	Dysentery Death (no. per 10 thousand)
1986	908.77	0.14	40.34	0
1987	1,113.20	0.13	60.73	0
1988	1,129.62	0.12	60.43	0
1989	953.83	0	65.55	0
1990	1,090.83	0	69.67	0

Source: POPH, 1991

The economic and physical restructuring in Greater Bangkok led to the uncontrolled establishment of an increasing number of factories. It not only compounded the severity of pollution problem, but resulted in its spread. Given the absence of effective state regulation, the entrepreneur sought to lower the costs of production either by not treating their waste or by transferring the factory to the outlying area of the city. Certainly, environmental degradation is widespread and is now harming suburban communities. The negative effects of the economic restructuring of the BMA and its vicinity has ruined agricultural activity and worsened the quality of life. The transition has also had an impact on the structure of Greater Bangkok's society.

5. SOCIAL RESTRUCTURING

In 1988, there were 8.5 million people in Greater Bangkok. The rate of increase between 1985 and 1988 averaged 223,190 people or three per cent a year. Bangkok Metropolitan Area gained more population than the five adjacent provinces. It acquired almost seventy per cent of Greater Bangkok's total population whereas Samut Sakhon, the smallest number of population, had four per cent. Between 1985 and 1988, Nakhon Pathom had the lowest rate of increase (1.4 per cent per annum) whereas Samut Prakan had the highest rate (5.4 per cent) to become the second largest province in Greater Bangkok (Table 3.10). Over the same period, the BMA was the only province that lost population. In contrast, Samut Prakan had the highest rate of immigration (Table 3.11).

The above trends partially reflected shifts in labour within the manufacturing sector induced by the economic restructuring of the 1980s. As shown in Table 3.12, the total number of employees in Greater Bangkok declined from 909,000 in 1984 to 707,871 in 1987. During this period, the BMA lost around 29 per cent of its employees while the number of blue collar workers in the four provinces of Nonthaburi, Pathumthani, Samut Sakhon and Nakhon Pathom declined by 42 per cent. On the contrary, Samut Prakan gained 35 per cent or over 46,000 manufacturing employees.

Table 3.10 **Number of Population and Growth Rate in Bangkok Metropolitan Area (BMA) and Vicinity, 1985-1988**

Province	1985 Population no.	1985 Growth rate	1986 Population no.	1986 Growth rate	1987 Population no.	1987 Growth rate	1988 Population no.	1988 Growth rate
BMA	5,363,378	3.65	5,468,915	1.97	5,609,352	2.57	5,716,779	1.92
Samut Prakarn	**662,612**	**3.48**	**689,631**	**4.08**	**741,905**	**7.58**	**789,060**	**6.36**
Pathumthani	384,713	4.89	402,080	4.51	415,193	3.26	435,409	4.87
Nonthaburi	504,424	5.48	525,475	4.17	571,871	8.83	596,381	4.29
Samut Sakhon	315,373	4.56	327,677	3.90	334,170	1.98	340,952	2.03
Nakorn Pathom	609,316	2.19	617,596	1.36	619,518	0.31	630,805	1.82
Total	**7,839,816**	**3.73**	**8,031,374**	**2.44**	**8,292,009**	**3.25**	**8,509,386**	**2.62**

Source: NSO (1990) cited in Registration Division, Local Administration Department, Ministry of Interior.

Table 3.11 Components of Population Change in Bangkok Metropolitan Area (BMA) and Vicinity, 1987-1988

Province	1987 no.	1988 no.	Change no.	Change %	Components of change Births no.	Deaths no.	Net migration no.	Net migration %
BMA	5,609,352	5,716,779	107,427	1.92	136,962	23,440	-6,095	-0.11
Samut Prakan	**741,905**	**789,060**	**47,155**	**6.36**	**7,716**	**3,509**	**42,948**	**5.44**
Pathumthani	415,193	435,409	20,216	4.87	3,517	3,135	19,834	4.56
Nonthaburi	571,871	596,381	24,510	4.29	5,381	2,363	21,492	3.60
Samut Sakhon	334,170	340,259	6,782	2.03	4,768	1,084	3,098	0.91
Nakhon Pathom	619,518	630,805	11,287	1.82	9,267	3,162	5,182	0.82
Total	**8,292,009**	**8,509,386**	**217,377**	**2.62**	**167,611**	**36,693**	**86,459**	**1.02**

Source: NSO (1990) cited in Registration Division, Local Administration Department, Ministry of Interior.

Table 3.12 Employment in Manufacturing Sector in Greater Bangkok, 1984 and 1987

Province	Manufacturing employment 1984[a] number	per cent	1987 number	per cent
BMA	610,000	67.1	433,883	61.3[b]
Samut Prakan	**131,000**	**14.4**	**177,386**	**25.1[c]**
Nonthaburi	13,000	1.5		
Pathumthani	113,000	12.4		
			96,602*	13.6*
Samut Sakhon	12,000	1.3		
Nakhon Pathom	30,000	3.3		
Greater Bangkok	**909,000**	**100.0**	**707,871**	**100.0**

Note: * This number is sub-total factories of Nonthaburi, Pathumthani, Samut Sakhon and Nakhon Pathom.

Source: a) ONESDB, 1986.
b) DL, 1990.
c) POI, 1988.

Unquestionably, Samut Prakan during the late 1980s, was not only Greater Bangkok's leading industrial city but of the entire country. In 1987, there is significant evidence in Tables 3.11 and 3.12 that Samut Prakan had the highest proportion of employees in manufacturing — 24 per cent of its total population. Although the BMA had more than 430,000 employees in manufacturing, they contributed less than 8 per cent of its workforce. Collectively, the other four provinces in Greater Bangkok did not have more than five per cent in manufacturing. If present trends continue in Samut Prakan, blue collar workers will comprise the largest class of residents.

As Harvey (1985: 26) highlighted: 'The greater the labour surplus and the more rapid its rate of expansion, the easier it is for capital to control the struggle in the workplace'. The sudden influx of manufacturing employees in Samut Prakan and other parts of Greater Bangkok can create major social problems. In particular, there was a shortage of accommodation. If the state and the business desire to have a legitimised and skilled work force, they have to bear the costs of the reproduction of labour power at a standard of living which reflects a whole host of cultural, historical, moral and environmental considerations (Harvey, 1985). In Greater Bangkok, the National Housing Authority is the only agency that provides housing for low-income people. As the housing supply is inadequate, there is an increasing number of slum areas around the industrial zones. Farmers, who were once the dominant class in the neighbouring provinces of BMA have been supplanted by a new working class. Thus, the continuing influx of labour force in industrial sector possibly has created both of a social gap and cultural conflict between newcomers and life-time residents.

6. POLITICAL CONFLICTS

The rapid economic, physical and social restructuring of Greater Bangkok and the severity of its pollution have created urban management problems. As the latter have affected the wider community, attention is focused on the 'actors' in the restructuring process. Clearly, public and private sectors are the main actors (Table 3.13). They form

Table 3.13 Main Actors in Greater Bangkok's Restructuring Process

Actors	Main Goals
Public sector	
National government	Transformation of industrial structures (OPM, MOI, MF, MC); Infrastructure construction and maintenance (MI, MOI, MTC); Environmental control and monitoring (MPH, MOI, MSTE)
Provincial government	Transformation of industrial structures (BMA, PAO); Infrastructure construction and maintenance (BMA, PAO); Environmental control and monitoring (PAO)
Municipality and Sanitary Administration	Public hygiene
Private sector	
Manufacturing firms	Factory establishment and expansion
Developers and housing and industrial estate firms	Land and space for sale and rent
Landowners	Land and space for sale and rent

Note: OPM: Office of the Prime Ministers; MOI: Ministry of Industry; MC: Ministry of Commerce; MF: Ministry of Finance; MI: Ministry of Interior; MTC: Ministry of Transportation and Communications; MPH: Ministry of Public Health; MSTE: Ministry of Sciences, Technology and Environment; BMA: Bangkok Metropolitan Administration. PAO: Provincial Administration Organisation;

themselves as Machimura (1992: 120) called 'the coalition for urban restructuring'. The state accommodates business interests and helps them to alter the urban landscape to accomplish their economic objectives. This conduct raises two issues: how do they take good care of Greater Bangkok's urban environment and are they working in harmony?

Supposedly, the state is the major actor in urban management, together with the main objective of achieving prosperity. There has been, however, a conflict between different government instrumentalities because the national government, the provincial governments and public enterprises have their own interests in urban development. During the late 1980s, for instance, the RTG sought to, in principle, decentralise industrial activities from Greater Bangkok. Generally, the Board of Investment under the umbrella of the Office of the Prime Minister (OPM) adhered to government policy though it permitted an annual growth rate of over eight per cent between 1987 and 1989 compared with 5.4 per cent over the past decade (TDRI, 1991: 77-91). Further, both the Department of Industrial Works under the Ministry of Industry (MOI) and the Provincial Office of Industry under the Provincial Governments still permit new establishments to locate in the five provinces adjacent to the BMA.

In practice, all government agencies at the national level often interfere with the administration of the provincial and local governments. In addition, all local governments have limited responsibility. For example, when there is a need to improve public utilities, local government cannot propose any development plan outside its municipality or sanitary districts without the central government's approval. Water supply, telecommunications, electricity or all major roads are also under control of public enterprises in Bangkok. Although the province earns a large sum of revenue, particularly in terms of taxes, it has to send its income to the central government. If the Provincial Government intends to spend capital for any purpose, it has to ask for an approval through its five-year development plan from the central government.[8] Furthermore, the provincial governor is not a local person. He is a public servant appointed by the Ministry of Interior in Bangkok. In practice, he works for a four-year term and does not respond to the community's needs.[9] In contrast to the BMA, the central government lets Bangkokians elect their governor. Thus, the Provincial Government can manage the city with little intervention from the RTG.[10]

---

[8] In 1989, Samut Prakan collected taxes of around 13,000 million baht. When the Provincial Government launched proposed projects to solve environmental problems, the central government approved only three projects which was equivalent to 4.48 million baht or 0.0003 per cent of the total revenue sent to the RTG (*Phuchatkan*, 2-8 July 1990: 67).

[9] The central government has never trusted the local government's administration. The Ministry of Interior (MI) directly controls the provincial government through its governorship; even the lower level of local government, especially town municipality can be inspected by the Provincial Governor who is appointed by the MI. In practice, the Governor can withdraw the Lord Mayor from his position, if his work does not satisfy the provincial government or the RTG (Prayat, 1976: 60).

[10] Before 1975, the local government of the Bangkok Metropolitan Area was entirely under the control of the Ministry of Interior. On 20 February 1975, the central government let the Bangkok Metropolitan Authority have its own elected governor and deputy governors for four-year term. Seemingly, the administration of the local authority is independent. However, the Minister of Interior inspects the Bangkok Metropolitan Authority's policies and intervenes in all important issues or projects. Moreover, the revenue of the Bangkok Metropolitan Authority comes from two main sources: first, from collected

Since the mid-1980s, local businessmen have gradually taken a role in economic development through the provincial chamber of commerce or the Joint Public and Private Sector Consultative Committee (JPPCC) (Anek, 1992).[11] Their roles have influenced the decision making of provincial government. Pressure from domestic and overseas enterprises has resulted in the launching of many new development projects. Without land zoning, private enterprises are able to invest their capital at any location. Landowners also make profits by selling or renting land. With the support of both central and provincial governments, entrepreneurs can shape the urban landscape to their specific needs. During the rapid growth of the late 1980s, they sought speculative gains, and with government connivance, have proposed many land development projects. In 1990, the Chamber of Commerce in Samut Prakan attempted to cooperate with the Provincial Government in order to resolve the pollution problem by persuading all industrial entrepreneurs to treat their waste. However, the President of the Chamber admitted some entrepreneurs were unwilling to participate (*Phuchatkan*, 2-8 July 1990: 67).

The community has been the principal victim of the city's transformation. Soaring land prices, urban congestion and environmental degradation are new problems to local inhabitants within the Vicinity of the BMA. Some farmers have been evicted by landlords. Although protests have been made to both government and enterprises, little has been achieved because of the difficulties in contacting the appropriate government agency. For example, pollution problems and control are the responsibility of the Office of National Environment Board, the Department of Public Health, the Department of Industrial Works, the Provincial Office of Industry and the Provincial Office of Public Health. When any group has problems, these departments just record the complaints. Overlapping responsibility results in little effective action.

---

taxes and all forms of fees, and the other from the central government. This condition lets the Ministry of Interior have a claim to revoke projects requiring large sum of capital (Son and Witthaya, 1983: 335-359).

[11] In 1981, the RTG created the central JPPCC. This Committee gives advice on national economic development and government-business policy. Since 1984, the RTG had encouraged all provinces in Thailand to develop provincial equivalence. In 1985, Samut Prakan established its own JPPCC (OBSCSP, 1991; Anek, 1992).

In the 'Privatised City', the coalition of bureaucrats and entrepreneurs has exploited society's resources with little attention to the adverse effects. If these are ignored, the city cannot be sustained. Greater Bangkok will have reached the extremity of its life at the privatised city. No one can benefit from the resultant anarchy.

RESUME

Chapter III has provided information on the privatised city at macro and micro scales by examining both Greater Bangkok and Samut Prakan. Since the 1980s, the economic, physical and social restructuring of the Bangkok Metropolitan Area has resulted in its influence extending to neighbouring provinces. Although social upheaval and global economic instability terminated Bangkok's growth in the 1970s, the subsequent inflow of capital from overseas has transformed the Privatised City.

The availability of foreign capital has enabled the private sector to exploit urban resources, particularly land, labour and public utilities. With state assistance, entrepreneurs have behaved like the profit maximisers of classical location theory. In short, the city is being transformed to meet short-term business needs and the public sector is left to cope with the social and environmental fall-out. Both the state and the entrepreneur put profit before social needs and environmental protection (Tabb and Sawers, 1978: 15; Douglas, 1983: 7). In the case of Greater Bangkok, when the private sector harms the urban environment, local, provincial and central governments do not seriously intervene.

Under the existing situation, the coalition for urban restructuring in the privatised city of Greater Bangkok have to face a trade-off between a good economy and a bad environment. How can this balance be transformed? These broad views of Greater Bangkok and Samut Prakan, however, cannot establish a clear connection between the industrial production process, urban environment and community. There is a need for a detailed study at a smaller scale than Greater Bangkok. This could explore a series of critical issues: how does the production process generate both goods and waste, how severe is the pollution problem and what is its distribution; and how do the negative environmental impacts affect the community? Part II addresses these issues in a micro-study of Amphoes Bang Pli and Bang Bo within Samut Prakan. It provides the basis for discussing good urban management in Part III.

PART II

ENVIRONMENTAL ISSUES IN SAMUT PRAKAN

CHAPTER IV

THE PRODUCTION PROCESSES OF FOUR MAJOR INDUSTRIAL WASTE GENERATORS

Rising land prices, inadequate infrastructure and the desire of local people for a better environment have forced industries from the Bangkok Metropolitan Area (BMA) and the inner city of Samut Prakan to the outlying areas of Greater Bangkok. Many of them have been attracted to greenfield areas in Samut Prakan's Bang Pli and Bang Bo districts. In particular, their industrial estates offer reasonable land prices, adequate infrastructure and good access to the Eastern Seaboard and BMA. A disproportionate number of the new industries, however, are large generators of hazardous waste — tanneries, slaughter houses, metal-plating and chemical manufacturers. Yet there has been little effort to detail the nature and extent of their waste output.

In seeking to analyse waste generation in Amphoes Bang Pli and Bang Bo a number of issues are raised. Given that one cannot study all types of industries, how can we categorise them in terms of waste generation? Once the key waste generators are identified, how can we make an in-depth study of their production processes? Finally, how do the industries control their unwanted outputs, particularly waste water?

As all industries cannot be studied, they are ranked in terms of waste generation using Watson Hawksley and SISAT's (1987) survey methods (Section 1). On this basis, major waste generators in Amphoes Bang Pli and Bang Bo are identified. Four selected production processes are also examined in detail — chemicals and chemical products, fabricated metal products, plastic and allied products, and food industries — to highlight the complex nature of waste disposal (Section 2). Their production processes are considered according to the degree of investment, derived technology, inputs in forms of energy and raw materials, and outputs in terms of goods and waste. Finally, responsibility for treatment and waste water control are discussed (Section 3).

1. INDUSTRIAL WASTE GENERATORS

Before identifying major industrial waste generators, we have to understand the term of 'water pollution'. Gilpin (1976: 171) has defined it as 'substances, bacteria or virus present in such concentrations or numbers as to impair the quality of the water rendering it less suitable or unsuitable for its intended use and presenting a hazard to man or to his environment'. Similarly, Holum (1977: 654-655) has described it as 'the addition to water of an excess of material (or heat) that is harmful to humans, animals, or desirable aquatic life, or otherwise causes significant departures from the normal activities of various living communities in or near bodies of water'.

The above definitions suggest water pollution has many sources. The composition of industrial waste water, however, may be different from other effluents such as those from domestic and agricultural sources. According to Nemerow and Dasgupta (1991: 3), it may have one or more of the following elements:

Inorganic salts	Heated water
Acids and/or alkalis	Colour
Organic matter	Toxic chemicals
Suspended solids	Micro-organisms
Floating solids and liquids	Radioactive materials
Foam-producing matter	

Generally, industrial waste is considered more dangerous than other sources because it generates hazardous wastes.[1] Industries with a high potential for generating hazardous

---

[1] If we define the term of 'hazardous waste', it can be described as:

> 'A substance or mixture of substances which has no further economic use and which if disposed of untreated to land, water or air will be potentially harmful to man or his environment, by reason of its chemical, biological or physical properties' (Australian Environment Council, 1983).

Therefore, some substances may be hazardous on more than one count as follows (Gilpin, 1976: 71-71; Australian Environment Council, 1983):

wastes are mainly: inorganic and organic chemicals, petroleum refining, iron and steel, nonferrous metals (smelting and refining), leather tanning and finishing, paint and coatings, electroplating and metal finishing (Sutter: 1989: 3). Although other industries such as paper and food processing have a lower potential for generating similar wastes, their effluents are still critical. For instance, organic wastes are considered less harmful because they are easily degraded by natural processes. Toxic chemicals and acids are considered more hazardous. Nevertheless, the large amount of organic waste from slaughter houses and fish canneries may be comparable to smaller quantities of heavy metals and acids from chemical products and metal finishing that severely affect aquatic life and natural water supplies. Therefore, industrial pollution hazards depend upon the quantity and quality of waste.

Watson Hawksley and SISAT (1987: 2.139-2.148) classified industrial waste generators in Samut Prakan according to the probable degree of hazardous waste quantities generated. Their classification was based on typical waste generation rates for the similar industrial types in industrialised countries especially Hong Kong. Drawing on their fieldwork in Amphoes Muang and Phrapradaeng, they recognised four classes based on the content of inorganic and toxic substances:

Class 1: high

Class 2: moderate

Class 3: low

Class 4: very low to zero

As no quantitative information was given on class characteristics, the distinctions are arbitrary.

- Toxic (e.g. most pesticides, lead salts, arsenic compounds, cadmium compounds);
- Reactive (e.g. radioactivity)
- Flammable (e.g. oil or hydrocarbons);
- Corrosive (e.g. acids or alkalies);
- Oxidizing (e.g. nitrates or chromates).

Normally, the estimation of hazardous waste quantities is derived from employee figures or production rates. In Watson Hawksley and SISAT's (1987) study, the hazardous waste generation rates were estimated on the basis of the number of employees working within a specific industry category because data on load factors per employee was available from site visits. This methodology, however, cannot be used in this study because there is no data on load factors per employee and no information on production rates for many industrial activities. In identifying the sources and generation of waste, the nature of the four different classes, therefore, has to be demonstrated by a thorough examination of specific production processes. While this may be a tedious procedure it does underline the complexity of studying waste quality in Samut Prakan.

Class 1 covers those industries with the highest incidence of hazardous waste. They include sectors of chemicals and chemical products, metal finishing, tanning and leather finishing, textile finishing and electrical equipment and machinery (Table 4.1a). These Class 1 industries have a greater potential to generate waste than other classes because of the presence of one or more of the following elements (see Tables 4.1b, 4.1c and 4.1d):

Acids (e.g. from the mixing procedure in the chemicals and chemical products, and from the surface cleaning in metal finishing);

Alkalies (e.g. from the skinning and lime fleshing process in the tanning and leather finishing industries);

Oily wastes (e.g. from the vehicle assembly and the oil refinery process);

Solvents (e.g. from the mixing procedure in paint, lacquer and varnish products, and from the dry cleaning process);

Pesticides (e.g. from the production of chemicals used to make insecticides, herbicides, and pesticides);

Heavy metals (e.g. lead and mercury from the production of electric lamps/ tubes, electric appliances and batteries, and chromium in the tanning and metal plating processes)

Table 4.1a Number of Class 1 Factories in Amphoes Bang Pli and Bang Bo, Samut Prakan, 1986 and 1990

Incidence of Hazardous Waste Class 1	Bang Pli 1986	Bang Pli * 1990**	Bang Bo 1986	Bang Bo *1990**
Chemicals and chemical products				
- Basic chemicals (excluding fertilisers)	3	4	-	-
- Paints, varnishes & lacquers	3	7	-	1
- Drugs & medicines	7	6	-	-
Metal finishing (galvanising, electroplating, etc.)	8	9	-	-
Tanning/leather finishing & fur dressing	2	3	-	-
Textile finishing				
- Textile cloths	6	7	-	-
- Knitted goods	-	4	-	-
Electrical equipment/machinery				
- Electrical industry, machinery & apparatus	4	5	-	-
- Radio, TV & communications equipment	6	5	-	1
- Electric appliances & houseware	2	3	-	-
- Electric lamps/tubes	-	2	-	-
- Batteries	2	1	-	-
- Other electrical industries	2	4	-	-
Total	**45**	**60**	**-**	**2**

Source: *Watson Hawksley and SISAT, 1987.
** POI, 1991a.

(Continued next page)

Table 4.1b Number of Class 2 Factories in Amphoes Bang Pli and Bang Bo, Samut Prakan, 1986 and 1990 (Continued)

Incidence of Hazardous Waste Class 2	Bang Pli		Bang Bo	
	1986 *	1990**	1986	*1990**
Basic metal industries				
- Iron & steel	4	7	-	-
- Non-ferrous metals	3	4	-	1
Fabricated metal products				
- Cutlery, hand tools & general hardware	2	2	1	1
- Furniture & fixings (primarily of metal)	3	3	1	-
- Structural metal products	8	9	-	-
- Other fabricated metal products	17	39	2	2
Machinery (except electrical)				
- Engines & turbines	6	5	5	5
- Metal & wood working machinery	1	1	-	-
- Special machinery	1	4	-	-
- Machinery & equipment (except electrical)	6	9	-	-
Transport and agricultural equipment				
- Agricultural equipment	3	4	-	-
- Motor vehicle assembly	5	4	-	-
- Specialist vehicles & equipment	8	11	1	1
- Bicycles & motorcycles	2	3	-	-
- Specialist cycle parts	8	7	-	-
Total	**77**	**112**	**10**	**10**

Source: *Watson Hawksley and SISAT, 1987.
** POI, 1991a.

(Continued next page)

Table 4.1c Number of Class 3 Factories in Amphoes Bang Pli and Bang Bo, Samut Prakan, 1986 and 1990 (Continued)

Incidence of Hazardous Waste Class 3	Bang Pli 1986 *	Bang Pli 1990**	Bang Bo 1986 *	Bang Bo 1990**
Paper & allied products				
- Manufacture of paper & paperboard	-	-	-	-
- Paper & paperboard boxes & containers	1	2	-	-
- Other paper/paperboard articles	-	2	-	-
- Printing, publishing & allied products	1	2	-	-
Plastic & allied products				
- Synthetic resins & plastics	-	4	-	-
- Other plastic products	11	27	2	5
Rubber products	4	5	-	-
Footwear (except rubber & plastic)	2	10	-	1
Wood products (except furniture)	3	10	29	10
Other manufacturing industries				
- Fertilisers & pesticides	-	2	-	-
- Soaps, cleaners, perfumes & cosmetics, etc.	3	5	-	-
- Miscellaneous chemicals	4	4	-	-
- Miscellaneous products of petroleum & coal	-	-	-	-
- Office computing & accounting machinery	-	1	-	-
- Professional scientific measuring & control equipment	1	-	-	-
- Watches & clocks	-	-	-	-
Total	**30**	**74**	**31**	**16**

Source: *Watson Hawksley and SISAT, 1987.
** POI, 1991a.

(Continued next page)

Table 4.1d Number of Class 4 Factories in Amphoes Bang Pli and Bang Bo, Samut Prakan, 1986 and 1990 (Continued)

Incidence of Hazardous Waste Class 4	Bang Pli 1986 *	Bang Pli 1990**	Bang Bo 1986 *	Bang Bo 1990**
Food industries				
- Slaughtering, preparing & preserving meat	3	6	1	-
- Dairy products	-	-	-	-
- Fruit & vegetable canning	2	3	-	-
- Fish canning	2	3	1	5
- Vegetable & animal oils/fats	1	3	-	-
- Grain products	18	9	25	19
- Bakery products	3	2	-	-
- Sugar	-	1	-	-
- Tea, coffee, cocoa, etc.	1	1	-	1
- Other food products	2	2	-	2
- Ice making	-	2	2	2
- Animal feeds	2	2	2	2
Tobacco	-	-	-	-
Textile goods				
- Make-up textile goods	2	3	-	-
- Carpets & rugs	2	-	-	-
- Other textiles	-	8	-	-
Wearing apparel	6	9	1	1
Furniture & fixtures (except primarily of metal)	3	8	1	1
Non-metallic mineral products (except those of petroleum & coal)	12	18	-	2
Total	**59**	**80**	**33**	**35**

Source: *Watson Hawksley and SISAT, 1987.
** POI, 1991a.

If we want to reclaim the above ingredients, they require special treatment before flushing them into the environment. Unquestionably, if the untreated hazardous waste is released into the streams, it presents a danger to the life or health of living organisms in water and to people who use it as a water supply.

Class 2 comprises industrial sectors with a moderate incidence of hazardous waste (Table 4.1b). They cover significant activities in basic metal industries, fabricated metal products, machinery (except electrical), and transport and agricultural equipment. The industrial types in this class generate a smaller volume of waste compared with Class 1. Class 3 consists of the industries with a low incidence of hazardous waste (Table 4.1c). It includes paper and allied products, plastic and allied products, rubber products, footwear (except rubber and plastic), wood products (except furniture), other manufacturing industries such as cosmetics, petroleum and coal products, fertilisers, pesticides and miscellaneous chemicals. These industries generate less hazardous waste than Class 2. Finally, Class 4 covers industrial types with the lowest incidence of hazardous waste (Table 4.1d). It comprises food industries, tobacco, textile goods, wearing apparel, furniture & fixtures (except primarily of metal) and non-metallic mineral products (except those of petroleum & coal). Industries in this class generate little or no hazardous waste. Thus, it follows that a small quantity of waste water generated by industries in Class 1 will be more harmful than a large amount derived from industries in Class 4.

A survey undertaken by Watson Hawksley and SISAT (1987) and the Provincial Office of Industry (1991a) in both 1986 and 1990 shows changes in the number of industries in these classes in both Amphoes Bang Pli and Bang Bo (though some activities were omitted such as breweries, sporting and athletic goods and jewellery manufacturers). During this period, the total number of factories in Amphoe Bang Pli increased dramatically. The addition of plastic and allied products boosted the third category by more than 50 per cent. In contrast, the total number of factories in Amphoe Bang Bo decreased by 15 per cent in the same period, particularly in the third category.

This is due to the closure of nineteen saw mills. There was, however, a slight increase in Class 1 and Class 4 factories in Amphoe Bang Bo (Table 4.1a-4.1d). During fieldwork between April and September 1991, there were a number of medium- and large-scale industries under construction on seven new private and public industrial estates in both districts. Therefore, the number of factories in all four classes is likely to increase over the next five years.

These changes confirm the findings of TDRI's investigation in 1991 that industrial activities generating hazardous waste will increase in the suburban provinces of Greater Bangkok. As industries in the BMA face additional pressure from new laws and regulations prohibiting environmentally sensitive industrial activities in high density urban areas, and high land prices, they are moving to suburban areas. Among these Amphoes Bang Pli and Bang Bo are prime target areas. During the 1990s, the number of factories in these areas will increase both inside and outside public and private industrial estates. All wastes in the industrial estates are, at least in theory, controlled.

Nevertheless, there are many cases in which the industry makes the proper decision concerning waste treatment and the consultant provides a reasonably adequately designed waste treatment plant, and yet the treatment plant does not provide proper protection for the surrounding environment. The problem is due to the lack of coordination between production by industry and either the operation of its waste treatment facilities, the improper interpretation of production process by consulting engineers, or little or no interest by entrepreneurs in managing the operation of waste treatment units. For these reasons, it is necessary to understand the cause of waste generation by exploring production processes in order to determine an appropriate level of waste control. Thus the case studies in the next section are selected from firms located outside the industrial estates to illustrate the techniques used in producing goods and the four different types of waste. The in-depth studies on production processes will provide information on the interrelationship between goods production and waste generation.

2. FOUR CASE STUDIES ON PRODUCTION PROCESSES

As it is not possible to discuss all industries the strategy is to select a case study from each category — a representative of the largest sector in each group being chosen. In Class 1, chemicals and chemical products are chosen for examination with a particular emphasis on the paints, varnishes and lacquers sub-sector. In Class 2, fabricated metal products are selected and specific attention paid to the other fabricated metal products sub-sector which uses galvanising or electroplating techniques for surface coating. In Class 3, interest is concentrated on the plastic and allied products sectors with specific consideration being given to the synthetic resins and plastics sub-sector. In Class 4, food industries are selected as representative. Although the grain production sub-sector, particularly rice milling has the largest number of factories in Bang Pli and Bang Bo, its production process does not generate waste water. Thus the slaughter, preparing and preserving meat sub-sector was substituted because it creates a significant amount of waste water.

The volume and toxicity of waste in each case study, however, cannot be supplied because of variable outputs of waste. On one day the plant could be closed and on another it could be operating at two or three times its normal capacity to fill an urgent order. For this reason, it is impossible to obtain accurate data on volume of waste. Moreover, each industrial type such as metal finishing employs different methods to process goods. This is due to contracts requiring different input materials such as zinc, aluminium and brass. Thus, it is difficult to determine an average outflow.

In discussing production processes with industrial firms, some were reluctant to discuss their waste generation and disposal activities. They only cooperated when anonymity was guaranteed. Nevertheless, others provided information on both production processes and waste control. Missing information, such as derived technology, industrial inputs in terms of energy and materials and outputs in forms of goods and waste (except waste flow), and the waste handling of most firms in the study areas, was supplied by the Provincial Office of Industry (POI) and the Department of Industrial Works (DIW).

CLASS 1: CHEMICALS AND CHEMICAL PRODUCTS

The chemicals and chemical products sector represents as a major industry in Class 1 with a high potential to generate hazardous waste. Its number of factories in Amphoes Bang Pli and Bang Bo increased from thirteen to eighteen between 1986 and 1990 (Table 4.1a). As shown in Figure 4.1, a number of these industries were located along Watkingkaeo-Latkrabang/Pracharat-Utit Roads and Bangna-Trat Road. When we concentrate on the paints, varnishes and lacquers sub-sector as a case study, it is evident that the scale of activity is quite small with an average investment of less than 10 million baht. Employees do not exceed ten per plant. Yet, one plant produces a variety of products such as enamels, lacquers, varnishes, undercoats surfacers, primers, sealers and fillers.

As shown in Figure 4.2, the production process is simple, especially in the manufacture of emulsion and gloss finished enamel paints. It involves mixing pigments and grinding them to a satisfactory fineness, colour and consistency. Both emulsion and enamel paints contain pigments and a second ingredient, a binder. Pigments have decorative and protective properties, while the binder (a resin or polymer) holds the pigment particles together and binds them to the surface (Nemerow and Dasgupta, 1991: 538).

Electricity is the main source of energy used to drive the mixing and grinding machines. A bore is the prime source of water supply to the factory. Around 10 to 20 cubic metres per day are used (Groundwater Division, 1991). Although water is used as solvent in the mixing process, most of the waste water is from washing machines and equipments. As shown in Table 4.2, the sampled firm used 24,150 kilogrammes of solid inputs and 16,600 litres of liquid raw materials to produce about 10,000 gallons of gloss

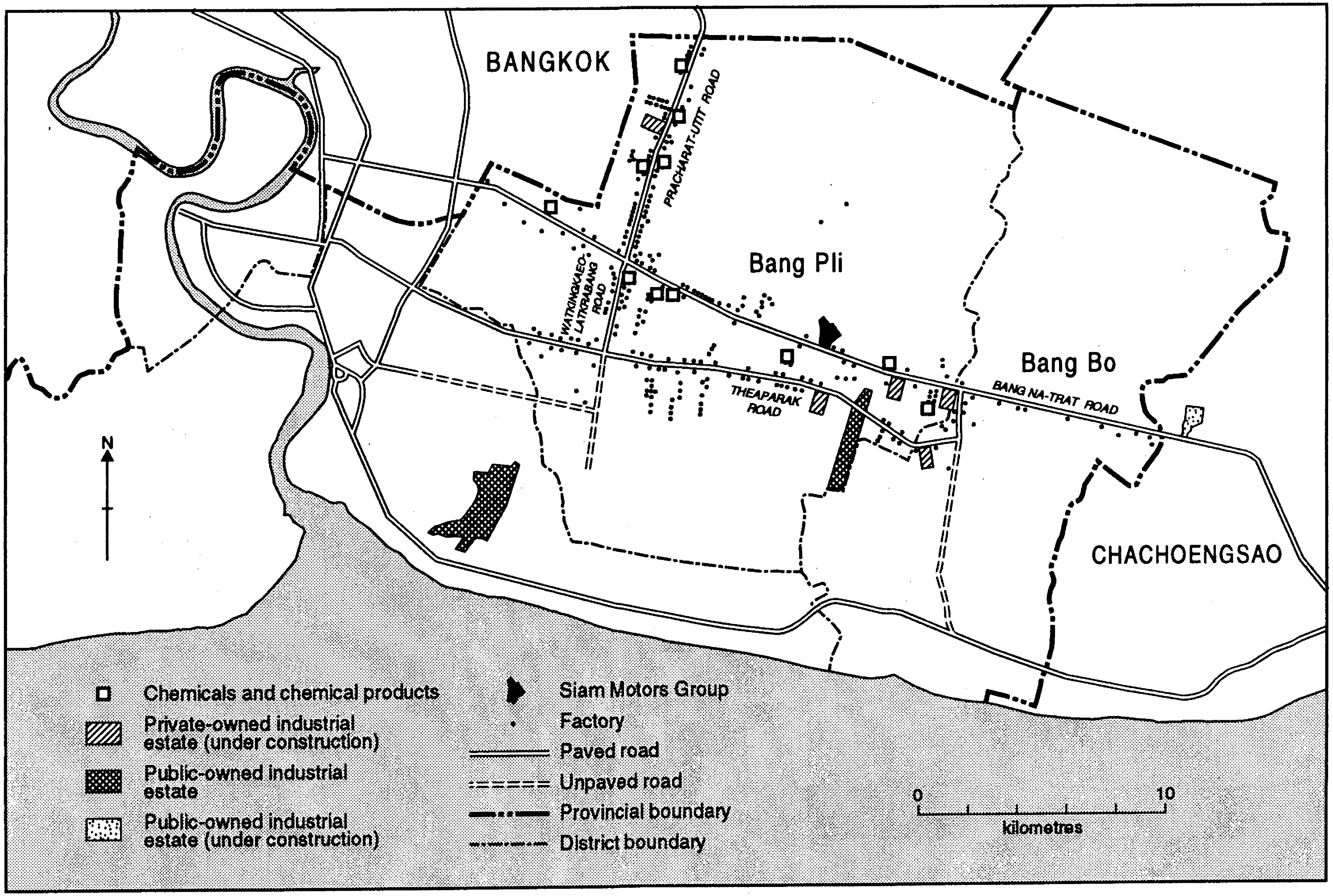
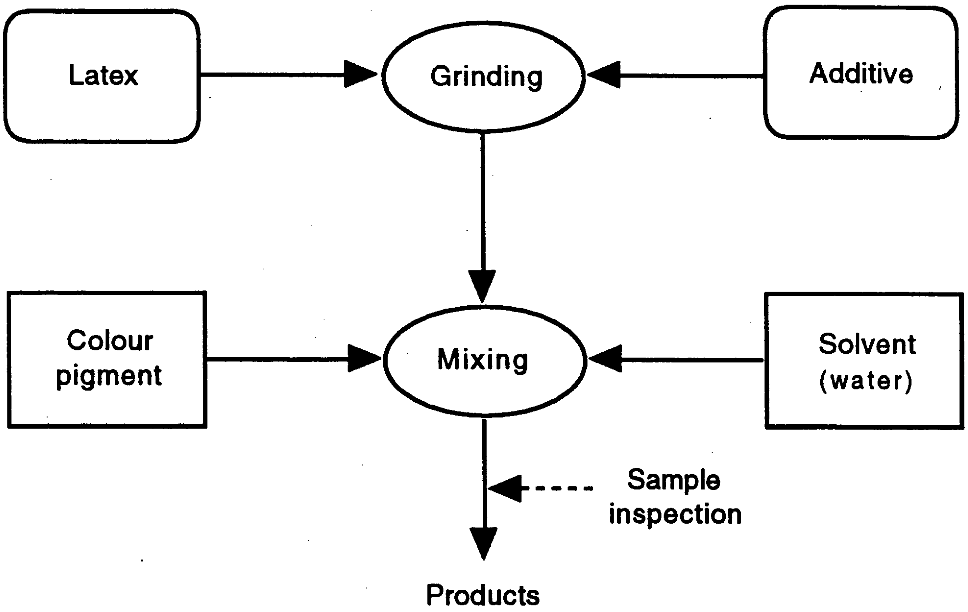


Figure 4.1 Location of Factories Producing Chemicals and Chemical Products in Amphoes Bang Pli and Bang Bo, Samut Prakan 1991

Emulsion Paint



Gloss finished enamel paint

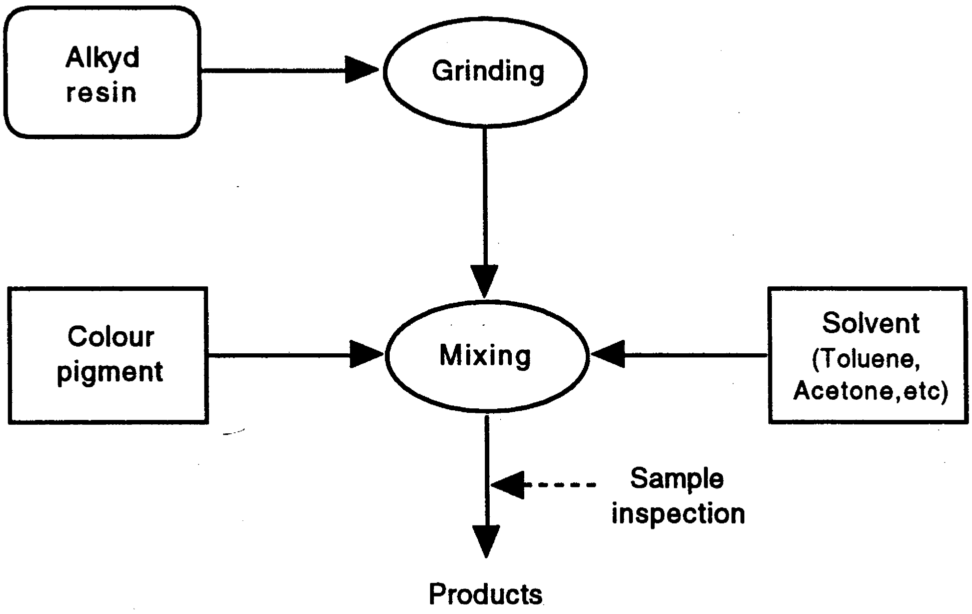


Figure 4.2 Flow Chart of Paint Products

Table 4.2 Raw Materials Used to Produce the End Products of Paints, Varnishes and Lacquers*

Raw materials	Unit/annum	Products	Unit/annum
Alkyd resins	14,000 kg	Gloss finished enamel paint	5,015 gal
Colour pigments	3,700 kg	Undercoats	650 gal
Ketone	2,100 kg	Vanishes and surfacers	750 gal
Additives and driers	1,100 kg	Other products	3,700 gal
Acetone	900 kg		
Alcohols	900 kg		
Acetate	750 kg		
Inerts	700 kg		
Mineral spirits	10,600 L		
Toluene	6,000 L		

Note : *Data from an anonymous firm at the eleventh kilometre on Bangna-Trat Road.

Source: POI, 1991b.

finished enamel paint, undercoats, varnishes and surfacers and other related products. The leftover oils, resins, solvents, plasticizers, pigments, extenders, and dyes are washed and mixed together as waste water. Other liquid wastes are also generated by the reactor condenser using by-products, caustic and other water-based washes, solvent-based washes, solvent-based rejected material, water-based rejected material, and washes containing heavy metals. The waste water is stored in the pond and later is flushed into a nearby canal (Nemerow and Dasgupta, 1991: 538; pers. comm. DIW official, 8 July 1991).

CLASS 2 : FABRICATED METAL PRODUCTS

The fabricated metal products sector falls in Class 2 of moderate potential to generate hazardous waste. Its number of factories in Amphoes Bang Pli and Bang Bo rose from thirty-four to fifty-six between 1986 and 1990 (Table 4.1b). Most activity in this sector is located along Theparak, Pracharat-Utit, Watkingkaeo-Latkrabang Roads in Bang Pli. As shown in Figure 4.3, few are sited on Bangna-Trat Roads. When we

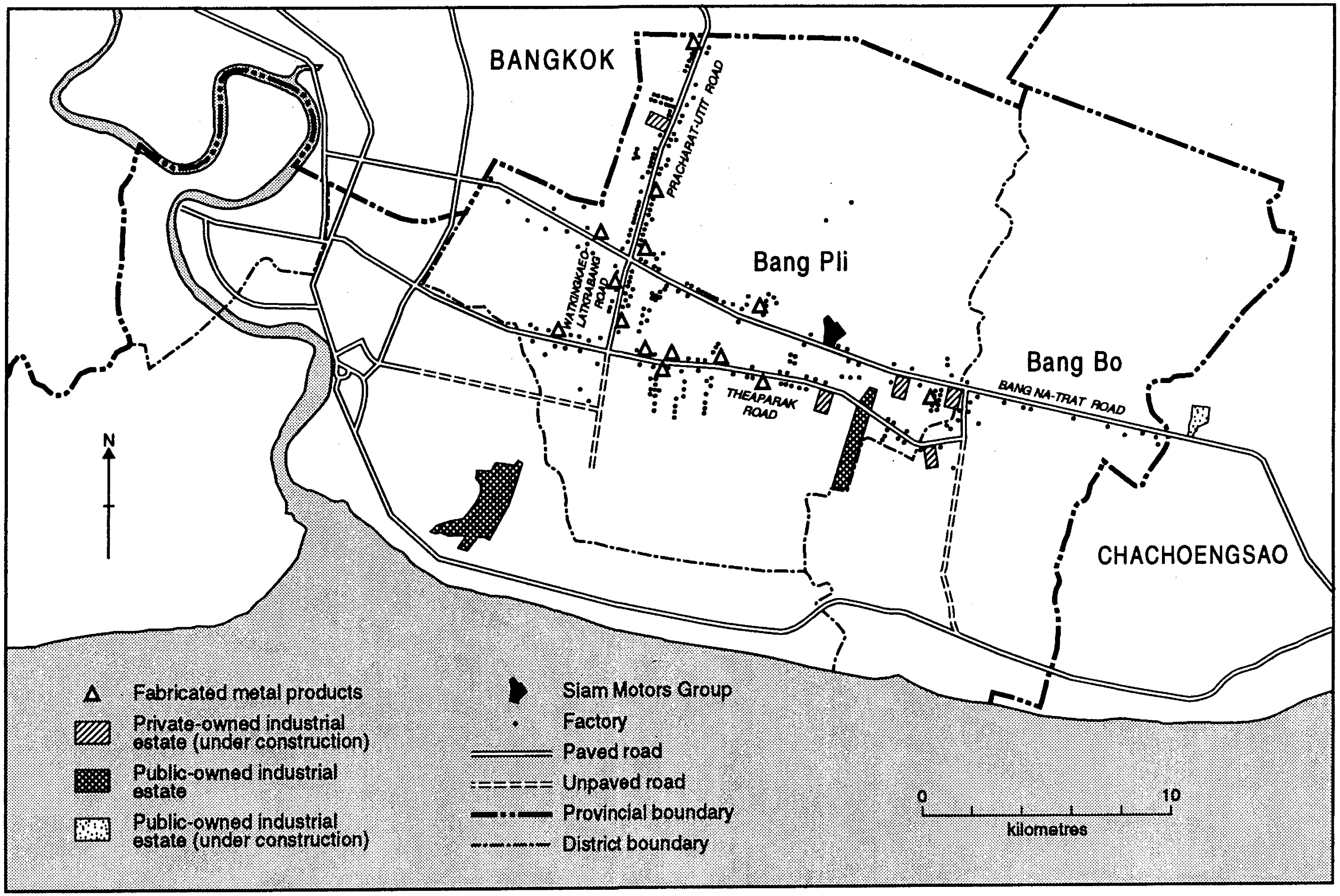


Figure 4.3 Location of Factories Producing Fabricated Metal Products in Amphoes Bang Pli and Bang Bo, Samut Prakan 1991

investigate the miscellaneous or other fabricated metal products sub-sector, attention is concentrated on metal fabrication. It encompasses ferrous and nonferrous metals undergoing a wide variety of operations and treatments affecting the basic size, shape, and configuration of the material as well as surface preparation and finish to best suit the product or assembly. Metal finishing embraces any metalwork which concerns itself with the following functions (Baskin, Giffels and Willoughby, 1971: 13.1-13.2):

- metal removal, such as in a machining plant
- metal forming, such as in a stamping plant
- metal joining, such as welding, brazing, and soldering
- metal finishing such as solvent degreasing, priming, painting and plating.

All the above processes, covering a very broad spectrum of products and materials, may generate a single contaminant or combination of contaminants. The metal finishing sub-procedure, however, is the prime source of hazardous waste water.

A field survey of the metal fabricating industries revealed a range of different sized factories with investments varying between less than 1 and 86 million baht and workforces ranging between less than 10 and to 140 employees. Although the entrepreneurs were mainly Thai, their production process was based upon imported technology. Some had bought an overseas patent or hired a foreign technician to help upgrade their production. Few had formed joint ventures because the overseas co-partner is required to transfer technology to the Thai entrepreneur. In contrast, the multinational enterprises (MNEs) applied the technology provided by the overseas-based mother firm.

Metal finishing, especially by electroplating, generates more harmful waste than priming or painting.[2] It is illustrated here by reference to chrome plating (Figure 4.4). In

[2] Electroplating has long served as a means of applying decorative and protective coatings to metals. Most metals can be electroplated, but the common metals deposited in this way are nickel, chromium, cadmium, copper, silver, zinc, gold and tin. In commercial plating, the object to be plated is placed in a tank containing a suitable electrolyte. The anode consists of a plate of pure metal; the object to be plated is the cathode. The tank contains a solution of salts of the metal to be applied. A D-C current, having a density of 6 to 24 volts, is required for the plating operation. When the current is flowing, metal from the anode replenishes the electrolyte solution while ions of the dissolved metal are deposited on the workpiece in a solid state. The properties of the plated material and rate of deposition depend upon such factors as current density, temperature of electrolyte, condition of surface, and properties of workpiece material (Amstead, Ostwald and Begeman, 1979: 714).

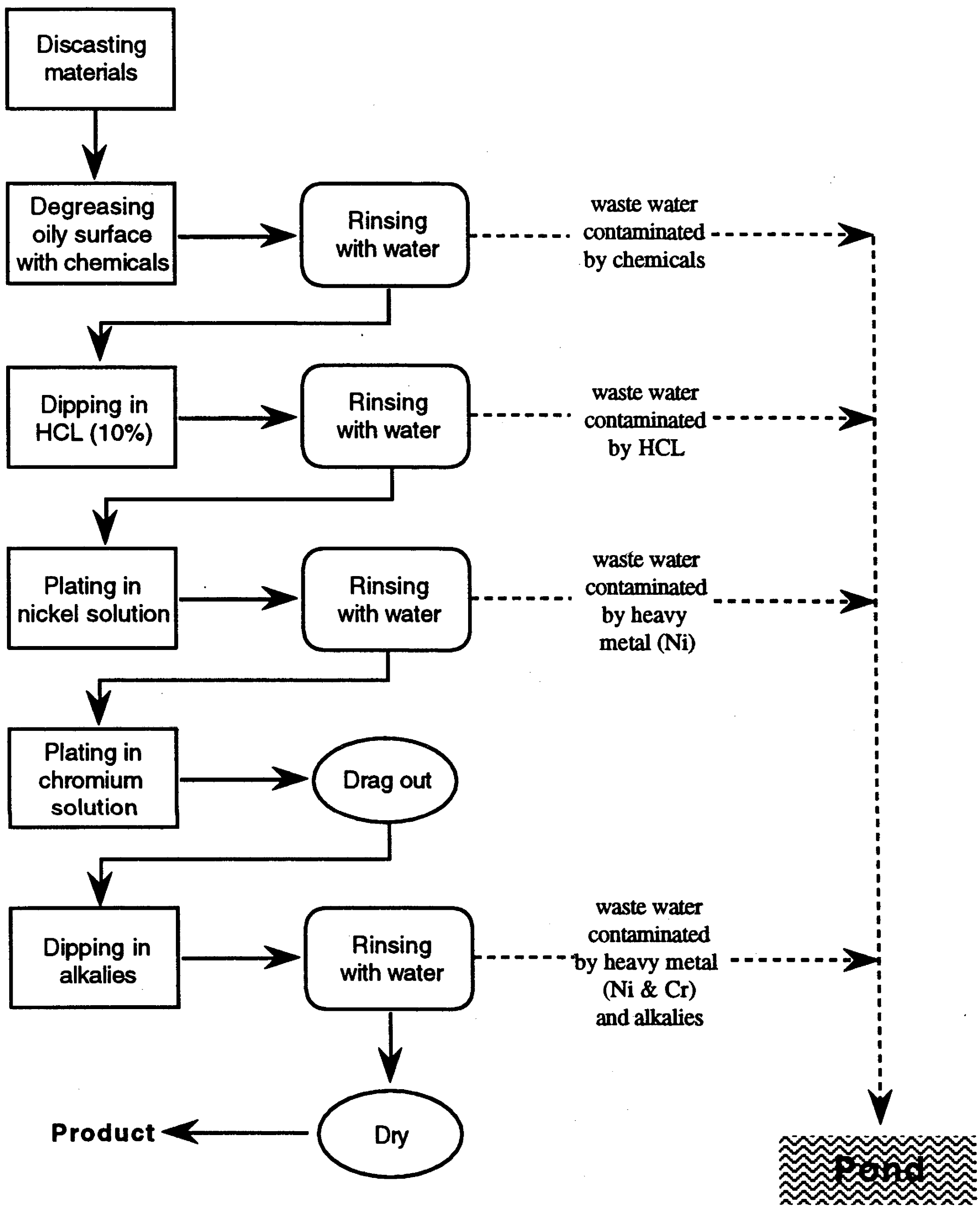


Figure 4.4 Flow Chart of Metal-Plated Product (Chromium)

this process, the metal's surface must be thoroughly polished and cleaned by sulphuric and hydrochloric acids and rinsed with water before operations commence. Before applying a chromium solution, the cleaned materials have to be plated with a nickel solution using an electrolytic process. It proceeds by passing an electric current from an anode to a cathode (the cathode being the object on which the metal is deposited) through a suitable nickel- or chromium-carrying electrolytic solution in the presence of a catalyst. The catalyst does not enter into electro-chemical decomposition. A solution of chromic acid or of nickel sulphate with a high degree of saturation is used as the electrolyte. Since the rate of deposition is fairly slow, the work must remain in the tanks several hours for heavy plating particularly when chrome coating is used. Later the plated materials will be polished and cleaned once again by alkalies and water before drying the end products (Amstead, Ostwald and Begeman, 1979: 714; pers. comm. DIW official, 8 July 1991).

Electricity is the main power source used in metal plating. Bore water is the only source used in rinsing procedures. Water consumption ranges from between 15 and 300 cubic metres depending upon the scale of productivity and water recycling (Groundwater Division, 1991). In the chrome plating process, a sampled firm used 21,700 kilogrammes of solid raw materials to produce 1,300,900 pieces of plated suspension's cover and spring coil, plated hydraulic and plated axle (Table 4.3). Seventy per cent of the raw materials in this particular case were imported. Most of the end products are intermediate goods used in fabricated spare parts for the manufacture of bicycles, buses and cars. Three sections in the production process generate waste water — rinsing, fluid replenishment and washing.

A large proportion of the water used in electroplating is for rinsing. This water is used to remove the film (fluids and solids) that is deposited on the surfaces of the metal. As a result of this rinsing, the water becomes contaminated with the constituents of the film. Rinsing is used at different stages of production. As process fluids are exhausted or spent, new solutions have to be made up, with water a major constituent of these

Table 4.3 Raw Materials Used to Produce the End Products of Chrome Plating

Raw materials	Unit/annum	Products	Unit/annum
Chromic acid	5,000 kg	Plated suspension's cover	800,000 pieces
Ferrous sulphate	3,000 kg	Plated suspension's spring coil	500,000 pieces
Caustic soda	2,000 kg		
Hydrochloric acid	1,500 kg	Plated hydraulic	600 pieces
Sulfuric acid	1,000 kg	Plated axle	300 pieces
Nickel sulphate	1,000 kg		
Metal pieces	6,000 kg		
Copper sheet	1,000 kg		
Nickel bullion	600 kg		
Lead bullion	500 kg		
Tin bullion	100 kg		

Note : *Data from an anonymous firm on Watkingkaeo-Latkrabang Road.

Source: POI, 1991b.

solutions. When a fluid is used at high temperature, water must be added periodically to make up for evaporative losses. Exhausted or spent process solutions are dumped and either collected in sumps for batch processing or are slowly metered into discharged rinse water prior to treatment. In addition, water used for washing machinery or equipment, such as filters, pumps and tanks, picks up residues of concentrated process solutions, salts or oils and is routed to an appropriate waste water stream for treatment (Cherry, 1982: 9-10).

CLASS 3 : PLASTIC AND ALLIED PRODUCTS

Between 1986 and 1990, the number of factories in plastic and allied products sector increased from thirteen to thirty-six in Amphoes Bang Pli and Bang Bo (Table 4.1c). Most manufacturers in this sector are found along Theparak and Bangna-Trat Roads. As shown in Figure 4.5, few are located on Pracharat-Utit and Watkingkaeo-Latkrabang Roads. The manufacture of synthetic resins and plastics is a recent

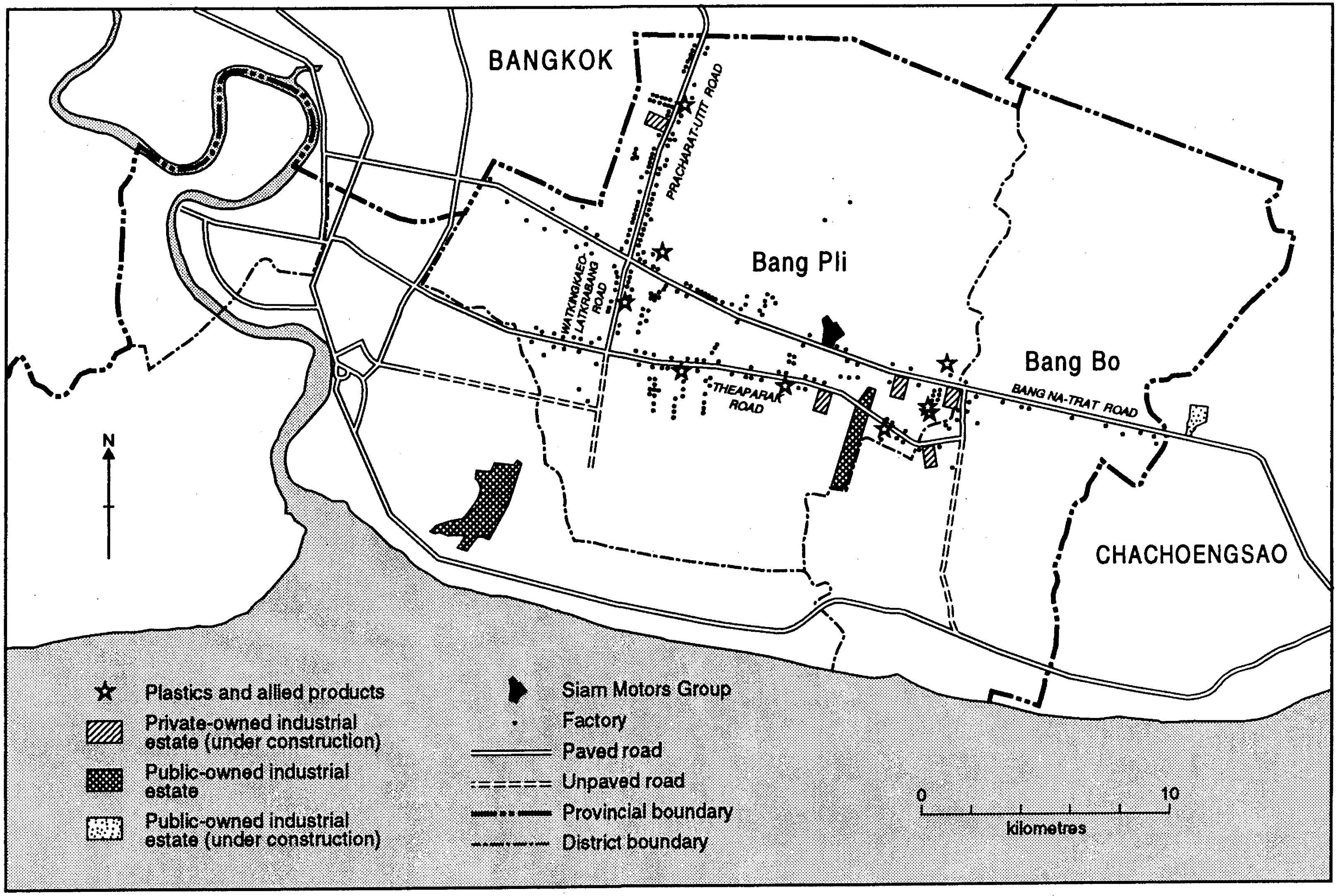


Figure 4.5 Location of Factories Producing Plastics and Allied Products in Amphoes Bang Pli and Bang Bo, Samut Prakan 1991

phenomena in both districts. Its output consists of intermediate goods for other industries such as packaging, television cabinets and appliance parts. Individual factories are large industry with the investment of 100 million baht. Shareholders were Thai with overseas associates; generally Taiwanese and/or Japanese, because of the technological dependency involved.

Attention here is focused on polystyrene plant which is a large-scale, capital intensive industry employing only fifteen workers.[3] Certainly, the production process is fully automated and controlled by a computer. Electricity is the prime source of energy for driving the machines. Bore water is mainly used for cooling purposes. One thousand cubic metres is the average water intake (Groundwater Division, 1991; pers comm., 18 July 1991). The polystyrene process requires around 12,320 tonnes of raw materials to produce 12,000 tonnes of polystyrene HI and GP (Table 4.4). A Thai entrepreneur summarised the process as follows (Figure 4.6):

> Styrene monomer containing a measured quantity of specific additions is polymerized at controlled temperature with or without catalyst or solvent to form solid pellets of polystyrene polymer product. This process for the continuous mass polymerisation of styrene may be divided conveniently into 4 major areas.
>
> a. Feed preparation - mixing tank
> b. Polymerisation - heat reaction
> c. Polymer devolatilisation - stop reaction and evaporation
> d. Extrusion and product finishing - cut and pellet mixing

As described by Nemerow and Dasgupta (1991: 569-570) the fundamental manufacturing process for polystyrene resins is a batch process which uses a combination of both bulk (mass polymerisation) and suspension methods. The styrene monomer, or mixtures of monomers, is purified by distillation or caustic washing to remove inhibitors. The purified raw materials, together with an initiator, are charged into

[3] Polystyrene is a thermoplastic material especially adapted for injection molding and extrusion. Outstanding characteristics are low specific gravity (1.07), availability in colours from clear to opaque, resistance to water and most chemicals, dimensional stability, and insulating ability. It is an excellent rubber substitute for electrical insulation. Styrene resin is molded into such products as battery boxes, dishes, radio parts, lenses, flotation gears, foundry patterns, ice chests, packaging insulated disposable cups, and wall tile. It can be injection-molded, extruded, or formed in dies (Amstead, Ostwald and Begeman, 1979: 262).

Table 4.4 Raw Materials Used to Produce the End Products of Polystyrene

Raw materials	Unit/annum	Products	Unit/annum
Styrene monomer	11,500.0 tonnes	Polystyrene HI	6,000 tonnes
FBR	180.0 tonnes	Polystyrene GP	6,000 tonnes
White oil	370.0 tonnes		
LX-1076	1.8 tonnes		
TNPP	1.8 tonnes		
EBA	24.0 tonnes		
HTP	4.2 tonnes		
HST	4.5 tonnes		
UVTEX-OB	180.0 tonnes		
VIOLET	18.0 tonnes		
Calcium Stearate	6.0 tonnes		
Zinc Stearate	1.8 tonnes		
Ethyl Benzene	30.1 tonnes		

Note : *Date of an anonymous firm at the twenty-fifth kilometre of Bangna-Trat Road.

Source: POI, 1991b.

stainless-steel or aluminium polymerisation vessels, which are jacketed for heating and cooling and contain agitators. Polymerisation of the monomer is carried out at about 90°C to approximately 30 per cent conversion, at which stage the reaction mass is syrupy. During this prepolymerisation step, water is used only as a heat-exchange medium. Since it does not come into contact with the product, it is not contaminated and can be recirculated. The prepolymer, or partially polymerised mass, is then transferred to suspension-polymerisation reactors containing water and proprietary suspending and dispersing agents. The reactors are usually jacketed, and the contents stirred in stainless-steel vessels. The syrupy mass is broken up into droplets by means of the stirrer and held in suspension in the aqueous phase. Temperature is a critical variable in the further polymerisation of the product. After completion of polymerisation, the polymer suspension is stripped. The stripped batch is centrifuged, and the polymer product is filtered, washed and dewatered.

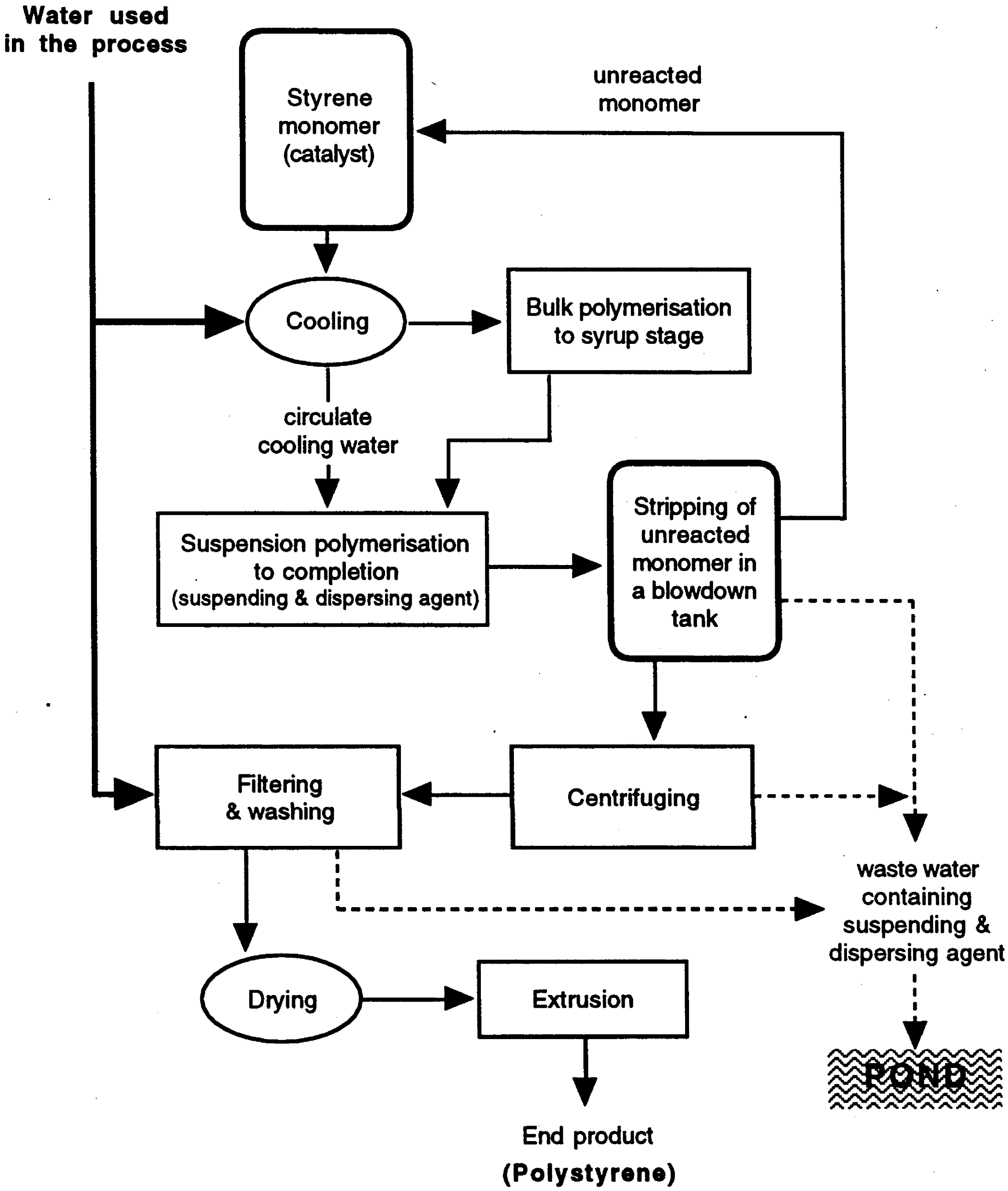


Figure 4.6 Flow Chart of Polystyrene Product

Reaction water (suspension medium) and wash water are the two significant sources of waste water in the production of polystyrene. Some cooling water is lost through evaporation but the amount lost is insignificant. Approximately 1.5 gallons of water, other than cooling water, is used for each pound of polymer product. The pollutant character of the effluent is slight, because of the small quantities of additives (catalyst and suspending agents) used in suspension polymerization; and the low reaction-medium temperatures required (120 to 180°F). The catalysts are generally of the peroxide type; the suspending agents may be methyl or ethyl cellulose, polyacrylic acids, polyvinyl alcohol, and numerous other naturally occurring materials such as gelatine, starches, gums, casein, zein and alginates. Inorganic materials such as calcium carbonate, calcium phosphate, talc, clays and silicates may also be present in effluent reaction water (Nemerow and Dasgupta, 1991: 570).

CLASS 4: FOOD INDUSTRIES

Between 1986 and 1990, there were sixty-five food industries in Amphoes Bang Pli and Bang Bo. Although there was no change in the sub-total number, food industries still remained the largest group of factories in Class 4 (Table 4.1d). As shown in Figure 4.7, several food industrial activities were located along Pracharat-Utit/Watkingkaeo-Latkrabang Road and Theparak Road. Few are located along Bangna-Trat Road. All rice mills were situated along the canals. As mentioned, grain products do not create waste water. Hence, attention is found on the slaughter, preparing and preserving of meat, particularly frozen chicken processing.

Poultry is a large-scale industry which is locally-owned. With an average investment of more than 100 million baht and around 200 employees, its products, especially frozen chicken are sold both within the country and overseas. Imported technology is used in the chicken manufacturing process (Figure 4.8). Electricity is the main source of power and bores are the sole source of water. Around 1,000-1,500 cubic metres of water per day is required. Based on the Provincial Office of Industry's record

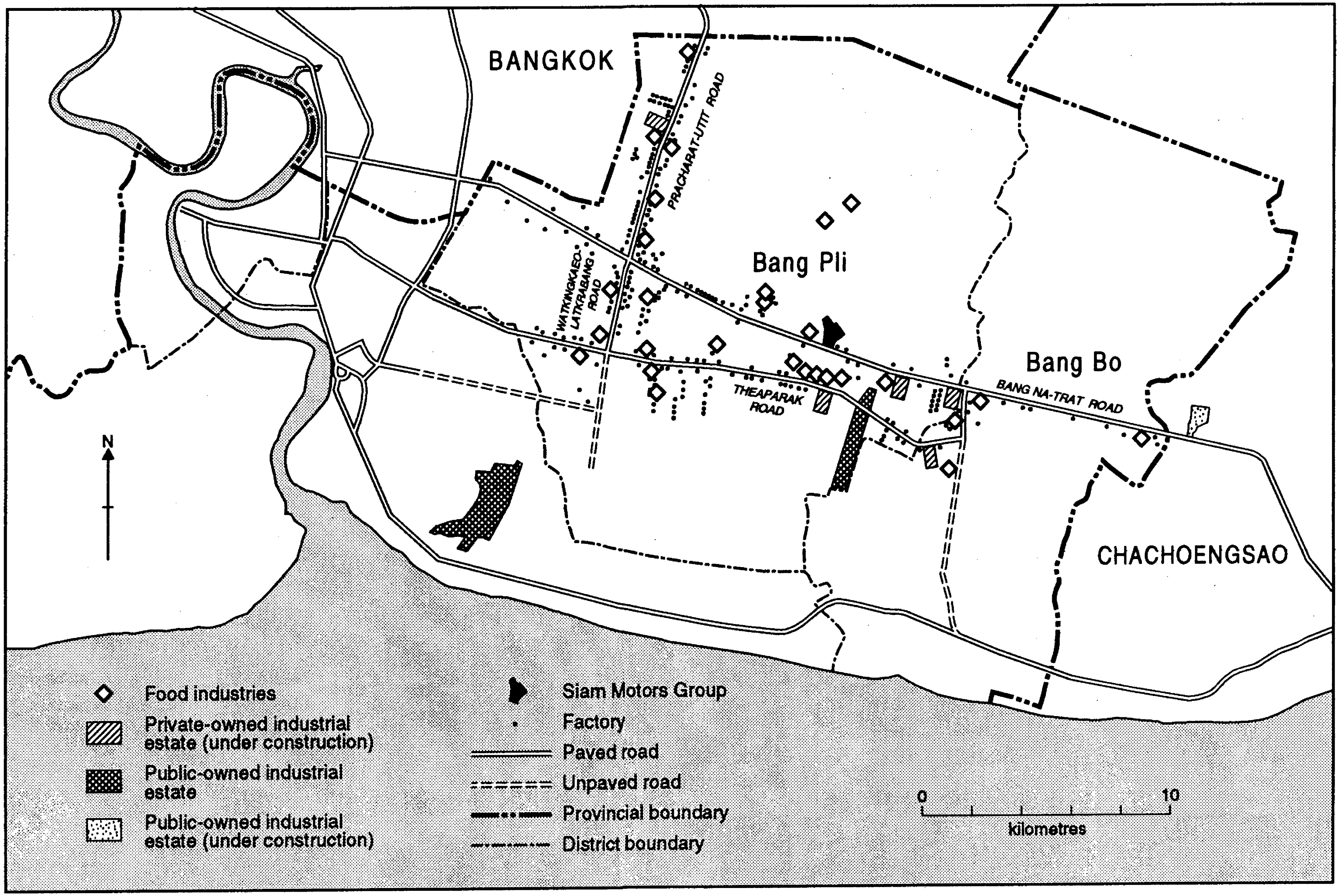


Figure 4.7 Location of Food Industries in Amphoes Bang Pli and Bang Bo, Samut Prakan 1991

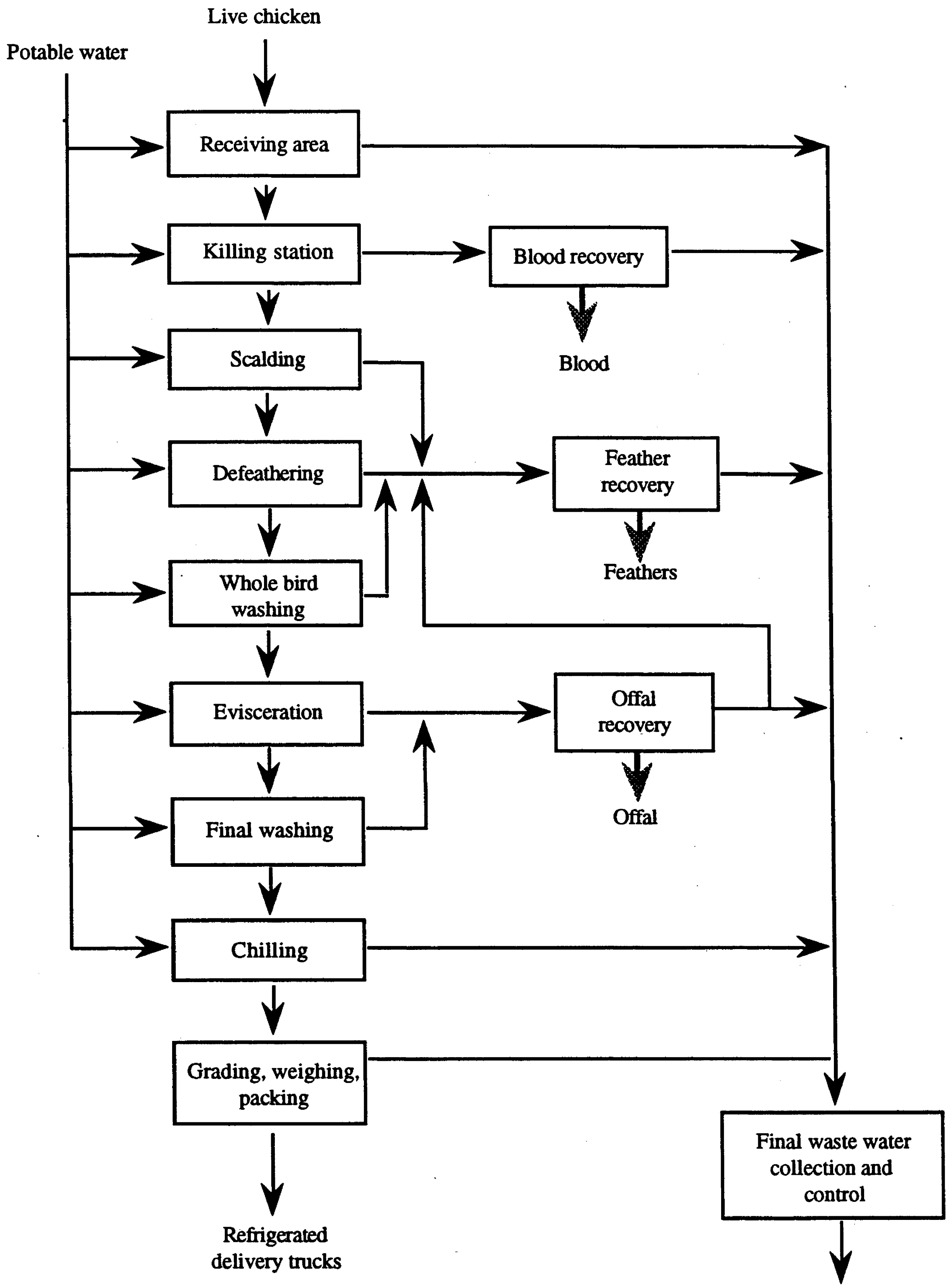


Figure 4.8 Flow Chart of Poultry Processing Plant

(1991b), one firm used 14,400,000 live chickens as raw materials to produce 9,720 tonnes of frozen chicken and 21,864 tonnes of skin, bone and feathers (Table 4.5).

As mentioned, the production process is based on imported techniques. Middlebrooks (1979: 265-267) highlights that live poultry are held for only a short period prior to slaughter and processing. Very little feeding or fattening of the poultry is practised at processing plants. A certain amount of waste material, however, is deposited in the receiving area of the poultry processing plant. This material is usually flushed into the sewer system which transports the waste water to a treatment system. Birds are usually fastened by their feet to a moving conveyor which transports them to a room where they are slaughtered by cutting the jugular vein. Blood is usually trapped and may be discharged directly to a sewer or recovered.

Table 4.5 Raw Materials Used to Produce the End Products of Poultry Industry

Raw materials	Unit/annum	Products	Unit/annum
Live chicken	14,400,000	Frozen chicken	9,720 tonnes
		Skin, bone and feathers	21, 864 tonnes

Note : *Data from an anonymous firm on Pracharat-Utit Road.

Source: POI, 1991b.

After the blood is drained from the carcass, the feathers are removed by scalding with hot water. Feathers are removed from the carcass by a mechanical process, and the feathers are washed from the bird and transferred to a collection site. Pin feathers are removed by manual labour or by wax dipping. A gas flame is also used to singe hair and odd pin feathers. The cleaned birds are then washed with a fine spray.

The poultry is eviscerated in an area separated from the remainder of the plant to prevent contamination. Manual operations are normally used to remove the inner organs and separate edible parts such as hearts and livers. Continuous washing is used to remove offal to the waste water system. Poultry to be prepared for distribution as parts are processed immediately following evisceration and washing.

Final processing in the preparation of poultry is the chilling of the carcasses to prevent bacterial decomposition. A countercurrent chilling process is normally employed. The first chill tank lowers the carcass temperature to about 18°C, and the second and third chilling tanks eventually lower the carcass to a temperature of approximately 2°C. After the carcass is cooled, it is drained on a conveyor belt and then sized, graded and packaged. Many poultry products are frozen after packaging. Therefore, blood, offal and dirt from the washing processes are the main waste flowing into the sewer or the sedimentation tank. All organic wastes will later be reclaimed by biological treatment method.

WASTE RE-EVALUATION

As highlighted, the volume of waste water depends upon bore water intake. The high water intake usually generates large quantity of liquid waste. In Class 4, poultry processing consumes a large amount of water. Although this process generates least hazardous waste, it tends to produce high volume of waste water typically organic in character with a higher biochemical oxygen demand (BOD) than normally found in domestic waste water, high suspended solids concentrations, and large quantities of floating material such as grease. BOD, suspended solids, oil and grease are the most important control parameters. The other three categories consume less bore water, though they generate low volume of waste water with high contents of acids and heavy metals. These pollutants need to be treated differently.

As mentioned in the first section, estimates of hazardous waste quantities are difficult to derive because all industries cannot be investigated. Even if they could be estimated, waste flow cannot be obtained. At least, examination of an individual plant allows the identification of the source and nature of waste water. Clearly, there are two main sources of waste from the production process. First, it is the process itself that generates waste. Second, it is from the washdown of machine, equipment or even the factory floor. The waste from these sources can technically be prevented in several ways (Langeweg, 1989: 124):

1. In-process recycling of (potential) waste products at the site of their generation;

2. Improvements in the process-technical sense in the manufacturing process, thereby altering the primary source of waste products;

3. Improvements in plant operations such as good housekeeping, preventative maintenance and better monitoring systems;

4. Replacing raw materials by less harmful ones or using smaller quantities of such substances; and

5. Redesign or reformulation of end products.

The above preventative approaches not only lessen hazardous waste but they also help reduce the cost of treatment. Improvements in plant operations may be the best alternative to Thai entrepreneurs because it does not depend on purchasing technological know-how from overseas. In waste handling, most water is only kept in the storage pond or sedimentation tank. Once the untreated waste, however, has been flushed into the water system, it is difficult to distinguish precise sources because firms do not necessarily use the nearest outlet. This condition raises two questions: how much attention do entrepreneurs pay to waste water control, and how does the Department of Industrial Works (DIW), the Industrial Estate Authority of Thailand (IEAT) and other concerned organisations monitor industrial waste treatment?

3. INDUSTRIAL WASTE CONTROLLERS

In practice, when an entrepreneur asks permission to establish a new factory, a satisfactory waste water treatment system has to be approved by the Department of Industrial Works. If the agency finds the treatment plant inefficient, it would give advice on improving the system. If the entrepreneur will not deal with the problem, an order is issued to close the factory. In contrast, the IEAT requests entrepreneurs on public industrial estates to detail their primary waste treatment requirements including their production processes, before permitting the discharge of waste water to the central treatment plant for secondary processing.[4] Between 1989 and 1991, the DIW gave notices to many firms in Amphoes Bang Pli and Bang Bo requesting improved water treatment operations. For example, the POI's record showed most food industries on Theparak Road and Pracharat-Utit Road had been warned frequently to operate their waste treatment systems properly.

An entrepreneur's primary objective is to produce the best possible product at the lowest possible cost. Having to install waste treatment devices contravenes this goal. Moreover, operating schedules are variable because of fluctuations in demand. For these reasons, an entrepreneur views waste water treatment as an imposed necessity which is only employed when directed or when public approval and acclaim can be gained for expenditure and effort in resolving the problem. This compulsion is necessary when the effect of waste water is readily visible (Nemerow and Dasgupta, 1991: 10).

---

[4] Normally, there are three types of waste water treatment (Krenkel, 1974b: 221; Ramalho, 1983: 7). Primary treatment consists of the pre-treatment processes plus tank sedimentation and usually chlorination prior to discharge into a receiving water. A primary treatment plant will often include a sludge digester, in which the solids removed from the sedimentation tank are subjected to anaerobic fermentation (i.e. stabilisation in the absence of free oxygen).

Secondary treatment may be defined as a biological process following primary treatment. There are many forms of secondary biological processes, including activated sludge, trickling filtration, contact stabilisation, and lagoons of various types. The most common biological process in use is probably either the activated sludge process or an aerated lagoon.

Tertiary treatment may be required, if the effluent from a secondary treatment plant is not considered satisfactory. This may consist of many different processes including precipitation, filtration, coagulation, membrane separation processes, adsorption, ion exchange, reverse osmosis, electrodialysis, sonozone process, etc.

When a business is investing in a waste treatment system, decisions are based on engineering and economic considerations. In engineering terms, the degree of a waste water treatment depends mainly on discharge the requirements for the effluent. Despite a conventional classification of waste water treatment processes, primary treatment is employed for removing suspended solids and floating materials. It is also used for conditioning the waste water for discharge to either a receiving body of water or to a secondary treatment facility for neutralisation and/or equalisation. Secondary treatment comprises conventional biological treatment processes. Tertiary treatment is intended primarily for elimination of pollutants not removed by conventional biological treatment (Ramalho, 1983: 7). From an economic viewpoint, however, the primary treatment is cheapest while the secondary and tertiary systems are more expensive. In addition, there are three more components that have to be considered — size of land area, fixed and operating costs, and technological know-how.

Generally, economic costs influence the selection of treatment systems. Most firms choose the cheapest method to control their waste. Primary waste treatment systems are usually employed. Few industries invest in secondary or tertiary systems without having knowledge of sanitary engineering. As confirmed by the Hawksley and SISAT's (1987) study, food industries in Samut Prakan generated a high rate of waste water flow, and a high BOD concentration due to organic waste. Biological or secondary treatment methods were exclusively employed. The facilities, however, were designed with no clear concept of basic sanitary engineering principles. In most cases, aerated lagoons were used, with both inadequate basin volume and aeration capacity. Underdesigned settling tanks were also observed. Some categories generating a low rate of waste water flow but more hazardous waste content employed mixed treatment techniques.

From interviews with entrepreneurs and the DIW's officials, a small-scale or undercapitalised firm cannot afford a proper water treatment plant. Most have primary treatment systems because of lack of space and capital. For example, a paint industry on Bangna-Trat Road has only a sedimentation pond or ditch storing waste water. After suspension, solids are deposited and liquid waste will be directly released to the waterways. A worker in nearby factory, however, estimated that:

> The firm washes the grinding and mixing machines every two or three days. Waste water sometimes is stored in the pond, but it sometimes is released directly to the canal besides the factory.

A larger-scale or more capital-intensive operation, however, can have a better treatment system. Not all do so. Some have primary treatment systems like their smaller-scale counterparts. An interview with a metal plating firm on Watkingkaeo-Latkrabang Road revealed the treatment was limited to a pH adjusting or neutralisation process before the waste was passed it to a public treatment plant for heavy metals at Samaedum, Samut Sakhon Province. Generally, larger industries prefer to buy more land for larger sedimentation ponds for primary treatment rather than invest in secondary and tertiary treatment systems. During the past few years, the DIW has served these firms notices requiring an improvement in the treatment process.

As the DIW has only 699 officials for more than 50,000 factories in Thailand thorough inspecting is impossible (Theera, Panu and Krikpong, 1990: 68). An interview with the DIW's officials revealed their investigations are confined to the operation of treatment systems and measurement of effluent parameters. No assessment is made of heavy metals, however, because it is time consuming and budgets are inadequate. Moreover, the DIW has no authority over the Industrial Estate Authority of Thailand (IEAT). The IEAT has its own waste organisation for water treatment plant but it has no special section to treat heavy metals.

RESUME

Chapter IV has examined aspects of industrial waste generation in Amphoes Bang Pli and Bang Bo, Samut Prakan. After identifying four types of waste generators, they were illustrated by case studies of different processes. The categorisation of waste generation, however, does not imply that representatives of Class 1 are the worst polluters. Class 4 industry can be equally damaging. Much depends upon the quantity and quality of waste generated.

A firm may employ one or more techniques to satisfy the market. As a result, a variety of wastes can be generated. It is not difficult at this stage to identify type of wastes from different effluents. When all industrial waste is flushed into the streams, however, the identification of industrial generators of specific waste is rather obscure. Moreover, domestic waste intensifies the stream pollution.

Pollution control, therefore, is a difficult task. It is doubtful, however, that firms really intend to treat their waste because the cost of pollution control generally lessens profit. If an entrepreneur marks up the price of goods to cover costs, competitiveness in the market may be lost. For this reason, the cheapest waste treatment system, the primary treatment plant is usually chosen. Sometimes, firms do not operate the treatment system at all. Often pollution control is not achieved because government monitoring techniques are inefficient. Prevention of waste during the production processes, then, may help lessen the volume of waste and the cost of pollution control.

Whenever an entrepreneur does not control waste water properly and ignores regulations, the effluents affect water quality. Two major issues are raised — how are the characteristics of the streams changed, and how does the polluted water affect the aquatic life? The next chapter addresses these questions by examining the extent of the water pollution problem and its severity on flora and fauna.

CHAPTER V

QUALITY OF SURFACE WATER

Effluent from industrial and domestic services has polluted the quality of water in the canal network of Amphoes Bang Pli and Bang Bo, Samut Prakan. Basically, industrial effluent is considered more hazardous than other kinds of waste water. It affects the self-purification of streams.[1] Since this phenomenon is largely dependent upon the activities of bacteria and other micro-organisms, the presence of any toxic substances (e.g. acids, alkalis, metallic contaminants, and phenols) will reduce the rate of a stream's self-purification by killing organisms or arresting their development. The extent to which this natural self-purification process is inhibited depends upon the nature, degree of toxicity, and concentration of the chemical pollutants (Klein *et al.*, 1962: 220). Consequently, the direct impact of industrial pollution not only results in the deterioration of water quality but also harms aquatic life.

As noted in the preceding Chapter, it is hard to identify the precise source of pollutants when industries flush untreated waste water into the canal network because they do not necessarily use the nearest outlet. Given this problem, the best research strategy is to monitor the impact of industrial waste on canal water — its quality and living organisms. The critical issues are: how can we investigate water quality throughout the year; what are the key indicators reflecting the changing physical, chemical and biological conditions of the streams; and how have they affected flora and fauna?

In assessing the canal network's water quality in Amphoes Bang Pli and Bang Bo, a sample design and collection points are specified together with measurements of

[1] Self-purification of streams is dependent to a large extent on biochemical reactions brought about by the activities of micro-organisms (especially bacteria) which, given sufficient dissolved oxygen utilise the organic matter as food and break down compounds to simpler and comparatively harmless end-products (Klein *et al.*, 1962: 216).

water parameters (Section 1). Results from the latter process help explain the severity and distribution or pollution within both districts (Section 2). Finally, we investigate the effects of water pollution on living organisms (Section 3).

1. WATER SAMPLING AND ANALYSIS

Before concentrating on water sampling, it is necessary to gain an insight into the physical condition of the canal network in Amphoes Bang Pli and Bang Bo. There are eleven main canals and a number of small tributaries which traverse Amphoes Bang Pli and Bang Bo, Samut Prakan. Originally, these canals were constructed for irrigation and transportation purposes over 100 years ago. They are still important both for local transportation and as a major source of water supply for paddy and fish farming. On the eastern bank of Chao Phraya River, Samut Prakan the canal network has a grid pattern. There are three main canals that almost parallel the coast of the Gulf of Thailand — Khlong Chaithale, Khlong Samrong and Khlong Prawetburirom. These canals serve as connection routes between the Chao Phraya River in Samut Prakan and Bang Pakong River in Chacheongsao Province (Figure 5.1). They also separate Amphoes Bang Pli and Bang Bo into two sections — the upper zone between Khlong Prawetburirom and Khlong Samrong and the lower zone between Khlong Samrong and Khlong Chaithale. Other smaller tributaries run in a north-south direction. The average length of the canals in the upper area is fourteen kilometres, whereas those in the lower section are about twelve kilometres long. The width of all canals ranges from 5 to 20 metres and the depth is between 0.5 metre and 2.5 metres in the dry season and between 1.5 metres and 3.0 metres in the wet season.

The stream flow of all canals is variable. It depends upon tides in the Gulf of Thailand and fluctuation in the water level of the two major rivers. Some canals, however, have become septic tanks in the dry season whereas many places are flooded in the wet season because of the flood protection scheme designed to protect the Bangkok Metropolitan Area (BMA). This scheme has many gates to control water levels on major

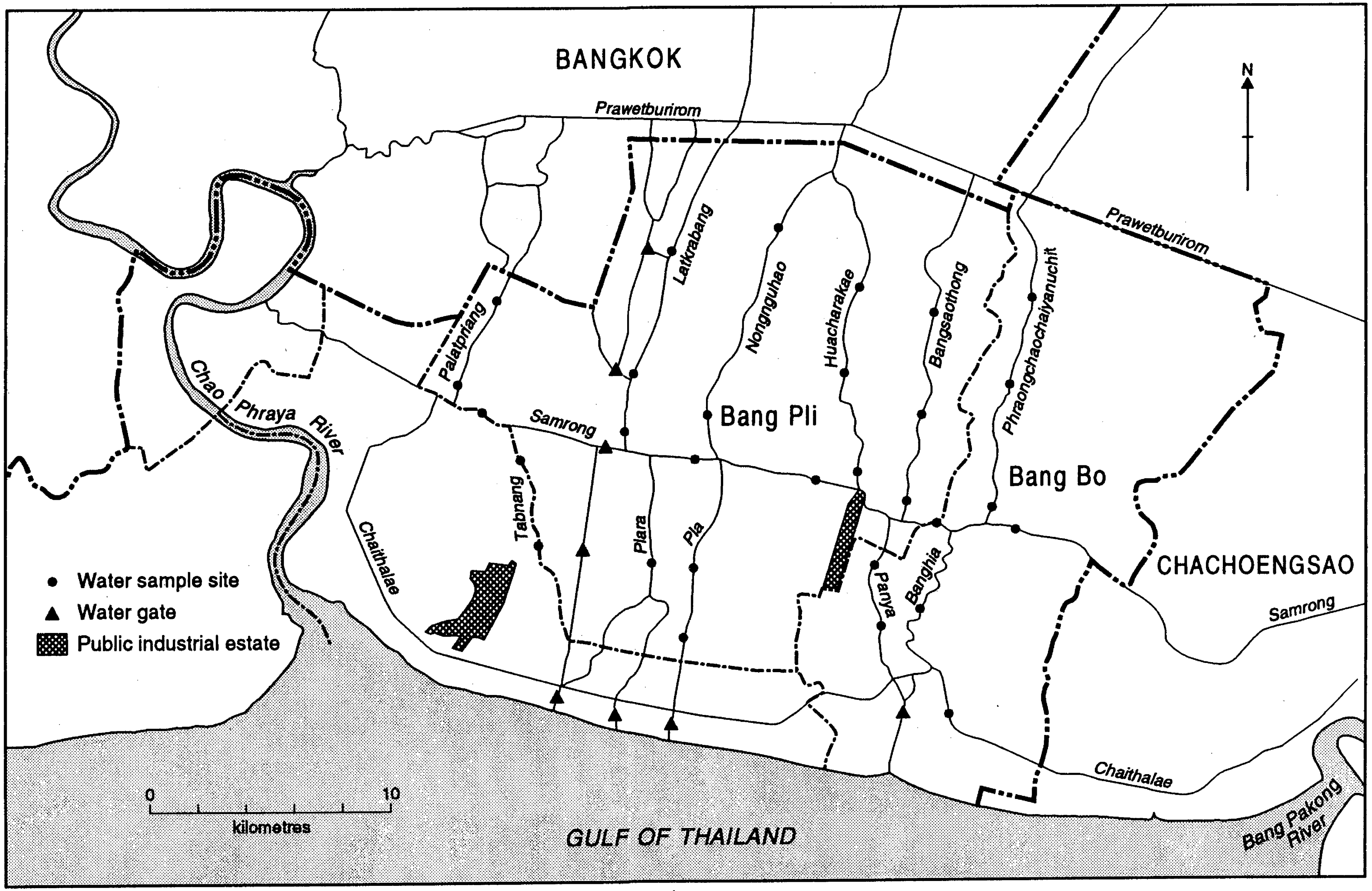


Figure 5.1 Water Sample Sites along Major Canals in Amphoes Bang Pli and Bang Bo, Samut Prakan

canals in Amphoes Muang, Phrapradaeng and Bang Pli. As each water gate is controlled independently the flow of water on the whole network is variable. Water flow on some canals has been reversed. Others are subject to daily fluctuation. These physical constraints have affected the water sample design.[2] The design has also been influenced by the time and financial constraints imposed on this study.[3]

Following Nemerow and Dasgupta's approach (1991: 75-79), however, there are nine factors to be considered in water sampling and analysis. They are:

(1) The overall objectives of the programme
(2) Total number of samples
(3) Points of collection
(4) Method of collection
(5) Data to be obtained
(6) Frequency of sample collection
(7) Time of year for sampling
(8) Statistical handling of data
(9) Care of samples prior to analysis

Some of the above factors can be amalgamated for discussion.

This study of the existing water quality of the canal network in Amphoes Bang Pli and Bang Bo had two main objectives. First, it sought to measure water quality. Second it was designed to reflect the distribution of water pollution in both districts. Generally, data collection is supposed to represent the water condition for one year. The

---

[2] In Samut Prakan Province, there are thirty-one water gates on the eastern bank of Chao Phraya River that help protect flood for Bangkok Metropolitan Area during the wet season. Although there are five gates in Amphoes Bang Pli and Bang Bo (including three more gates along the coast in Amphoe Muang), they greatly affect the water flow and level throughout the year (TISTR, 1988; Field survey in 1991).

[3] Within a six-month period of fieldwork, time for other activities such as interviews with local people, industrial entrepreneurs and government officials together with data collection from documents had been shared. Moreover, the low budget available for water sample collection and analysis could not provide a good representation of water quality throughout the year.

six-month period time for fieldwork, however, precluded frequent collection. Therefore, two sequences of water sampling were conducted — one in the dry season (April, 1991) and the other in the wet season (June-July, 1991).

Normally, a minimum of four stream stations (sampling points) is recommended (Nemerow and Dasgupta, 1991: 75-79):

(a) an upstream site, where the water is uncontaminated;

(b) just below the source of pollution or dilution;

(c) where the stream is in the worst condition due to a specific source of pollution (bottom of oxygen sag);[4]

(d) a point midway between bottom of oxygen sag and recovery of oxygen level.

The canal network examined in the field survey is on the coastal plain where there are many gates controlling the water level inland. As noted, their operation changes the direction of flow at different times of the year. In addition, there are many factories and a number of households alongside the canals. All tributaries are also short, ranging from eight to fifteen kilometres long. As a result, it is hard to find an upstream site where water is uncontaminated. Moreover, there are many sources of industrial and domestic pollution, together with the non-harmonised control of water gates which distort the natural flow and the oxygen sag. The industrial processes are varied and the processing time is unpredictable. Therefore, there is no specific time when industrial effluent is released into the canal. Thus, the best strategy for evaluating the distribution of pollution is to design all sampling points evenly — every four kilometres. Thirty sample sites covered the whole study area (Figure 5.1).

---

[4] Basically, the point of maximum deoxygenation of the stream usually occurs a considerable distance below the point of industrial or domestic discharge, being determined by such local factors as: the dilution; the biochemical oxygen demand (BOD) of the discharge and of the stream water; the nature of the organic matter; the total organic load on the stream; the physical characteristics of the stream; the extent to which re-aeration from the air occurs; the dissolved oxygen content of the stream; the temperature; and the kind and numbers of micro-organisms present in the discharge. The combined influence of deoxygenation and re-aeration in a polluted stream causes progressive changes in the dissolved oxygen (DO) content of the stream. If the DO content is plotted against the time of flow downstream, a characteristic curve is an inverted bow with an extended limb reversing its curvature in a downstream direction and approaching an asymptote represented by complete oxygen saturation. This curve is called as the 'oxygen sag' curve (Klein, *et al.*, 1962: 218).

Theoretically, samples should be taken from a three-fifth depth in shallow streams (i.e. less than fifty centimetres deep). In deeper streams, the samples should comprise composite portions taken from depths of one-fifth and four-fifth (Nemerow and Dasgupta, 1991: 76). In practice, grab samples were taken from one metre deep by a sample collector because of the changeable water flow and level. Temperature, pH value and dissolved oxygen were measured at the collection sites by portable testing equipment. Samples for coliform bacteria, heavy metals and other chemical analysis were collected in different containers. Polyethylene containers were used to collect samples for chemical analysis while special sterile bottles were required for biological examination in the laboratory.[5] All samples were stored at the temperature of 0°C to 4°C until analyses are carried out. Despite the two water samplings, the analytical results given as arithmetic mean, trim mean and standard deviation were not considered to be a good statistical sample. Nevertheless, it does broadly show the condition of canals during two different seasons.

In analysing physical, chemical and biological properties of water samples, water indices that indicate surface water quality were compared with standard values established by the Office of National Environment Board (ONEB).[6] The water parameters considered were:

Temperature	Copper
pH value	Nickel
Dissolved oxygen	Manganese
BOD_5	Zinc
Nitrate-Nitrogen	Cadmium
Ammonia-Nitrogen	Chromium (hexavalent)

[5] Despite budget constraint, water samples for faecal coliform and heavy metals analysis were collected only near the outlet of subsequent tributaries that join Samrong Canal and some spots along Samrong Canal. Notably, most of the canal intersections are crowded by houses, shops and factories. In some places, there is also a market.

[6] This standard values of surface water quality is in the notification of the Ministry of Science, Technology and Energy [B.E. 2528 (1985)], published in the Royal Government Gazette, Vol. 103, Part 60, dated April 15, B.E. 2529 (1986).

Phenols	Lead
Cyanide	Mercury (Total)
Radioactivity	Arsenic
Coliform bacteria (Total and faecal coliforms)	Pesticides (Total)

As mentioned time and financial constraints prevented all parameters being assessed. Some parameters were ignored, especially radioactivity, pesticides, cyanide, phenols and total coliform. The examination techniques employed in this study for assessing water quality followed the recommendations of the Office of National Environment Board (ONEB) and the Department of Industrial Works (DIW). However, their recommendations are based on standard methods for examining of water and waste water approved by the American Public Health Association (APHA), the American Water Works Association (AWWA) and the Water Pollution Control Federation (WPCF). As the analytical methods are universal, only the types and coding number of water analysis are used in this study (Table 5.1).

As noted, not all water indices were examined in the laboratory. There were three parameters that were measured at sample sites. Temperature, pH value and dissolved oxygen (DO) were analysed by portable equipment. Temperature and pH value were measured using a thermometer and electrometric pH meter respectively (Table 5.1). Although the DO value was analysed differently employing the membrane electrode method, it is, however, one of the standard methods in coding number 421 F. As indicated in Table 5.1, other water indicators were examined in the laboratory following standard procedures. Biochemical oxygen demand within five days is based on the measurement of DO by membrane electrode method and the calculation of the difference between initial and final DO. Coliform bacteria, particularly faecal coliform, is tested using the multiple tube fermentation technique. The cadmium reduction method assessed nitrate levels whereas Nesslerization method was used to evaluate the ammonia value of the water samples. All metals were examined by direct aspiration atomic absorption spectrophotometric method, except mercury and hexavalent chromium which were

Table 5.1 Standard Methods for Examining Water and Waste Water Recommended by the ONEB, APHA, AWWA and WPCF

Water Parameters	Methodology
Temperature	Thermometer used at sites (212)
pH value	pH meter examined by electrometric (423)
Dissolved oxygen	Membrane electrode method (421 F)
BOD_5	Biochemical oxygen demand (507)
Coliform bacteria	Multiple tube fermentation technique (908 C)
Nitrate-nitrogen	Cadmium reduction (418 C)
Ammonia-nitrogen	Nesslerization - Direct and following distillation (417 B)
Arsemic	Atomic absorption gaseous hydrede (307 A)
Copper	Atomic absorption - Direct aspiration (313 A)
Nickel	Atomic absorption - Direct aspiration (321 A)
Manganese	Atomic absorption - Direct aspiration (319 A)
Zinc	Atomic absorption - Direct aspiration (328 A)
Total mercury	Atomic absorption - Cold vapour technique (320 A)
Cadmium	Atomic absorption - Direct aspiration (310 A)
Chromium (hexavalent)	Colourimetric (312 B)
Lead	Atomic absorption - Direct aspiration (316 A)

Note: Coding numbers in parentheses are based on *Standard Methods for the Examination of Water and Wastewater (16th ed.).*

Source: ONEB, 1991; APHA, AWWA and WPCF, 1985.

determined respectively by cold vapour atomic absorption and colourimetric methods. Lastly, arsenic was traced using atomic absorption gaseous hydrede (see Appendix 1.1).

2. WATER QUALITY

After examining all samples the results are interpreted to meet the study's overall objectives. Water sampling was designed to measure the canal network's water quality and to identify the distribution of water pollution. In assessing the samples, the average value of all water indices are collated against ONEB's standard values of surface water. Then Bang Pli and Bang Bo are segmented to identify the causes and outcomes of the distribution of particular types of pollution.

2.1 Degradable levels of the canal network

Usually, the value of biochemical oxygen demand (BOD) is used as the primary indicator of water quality. If the BOD is above the optimum level, it means that the water is either unclean or unsuitable for aquatic life and human use. Based on the TDRI's study for the BMA and its vicinity in 1988, domestic waste water accounted for about 75 per cent of the total biochemical oxygen demand (BOD) load, while factories accounted for the remainder. Given Samut Prakan's greater share of industrial land use, a BOD load higher than 25 per cent is anticipated.

Before classifying the environmental condition of streams in Amphoes Bang Pli and Bang Bo, the BOD and other water parameters need to be evaluated. However, there is a need for further consideration of water indices. Despite time and budget constraints and unavailability of some equipment, it was possible to identify critical physical, biological and chemical conditions of surface water in dry and wet seasons as follows:

- Physical indices:	temperature
- Biological indices:	faecal coliform bacteria
- Chemical indices:	pH value, dissolved oxygen, biochemical oxygen demand, ammonia-nitrogen, nitrate-nitrogen, arsenic, copper, nickel, manganese, zinc, cadmium, chromium (hexavalent), lead, and mercury (total).

Table 5.2 shows the average value of these water indices in Amphoes Bang Pli and Bang Bo during the wet and dry seasons. All values are discussed and compared to standard values which classify the condition of surface water in Table 5.3. Initially, attention is focused on physical and biological indices before examining chemical parameters.

a) Physical and biological conditions

During the 1991 field study, the average value of temperature was about 31°C in the dry season and 30°C in the wet season. Its standard deviation values for both seasons were very low reflecting little variable results of temperature in all canals. The temperature of surface water in Amphoes Bang Pli and Bang Bo was considered 'normal'. No factory or household caused thermal pollution in the canals. As no standard values were available, colour, turbidity and other physical parameters were not analysed. To compensate, total suspended solids (TSS) was measured. Its values in dry and wet seasons were on average 268.8 and 54.8 mg/l respectively. The canals in the 1991 dry season were considered less clear than in the wet season. However, the TSS's standard deviation for both seasons were 326.6 and 40.6 respectively. This condition represented high variable values in all canals. Some canals had a TSS as low as 18.0 mg/l in the dry season and 3.0 mg/l in the wet season. Whereas others had a different TSS as high as 1,226.0 and 163.5 mg/l respectively. Indeed, the water level was so low that motor boats (*rua hangyao*) easily stirred up sediment at the canal's bottom. Throughout the year, the dredging operation of some canals also caused turbidity. There is no standard value for TSS of surface water quality that can be used for collation. However, if we consider it from the standard value for industrial effluent set by the ONEB, its first, second and third limits were not more than 30, 60 and 150 mg/l respectively. The average TSS exceeded these limits in both the 1991 dry and wet seasons (see Appendix 1.2 and 1.3).

Table 5.2 Average Values of Specific Surface Water Quality Index of Wet and Dry Seasons Comparing to Water Quality Standard in Amphoes Bang Pli and Bang Bo, Samut Prakan, 1991

Water Indicators	Unit	Dry season Mean	Dry season S.D.	Wet season Mean	Wet season S.D.	Standard of Water Quality
Temperature	°C	30.9	1.8	30.0	0.6	natural
pH value		7.5	0.6	6.6	1.0	Class 1: natural Class 2-4: 5.0-9.0 Class 5: -
Dissolved Oxygen	mg/l	3.19	1.49	1.99	1.2	Class 1: >6 Class 2: 6 Class 3: 4 Class 4: 2 Class 5: <2
BOD_5	mg/l	13.90	7.97	10.58	5.57	Class 1: <1.5 Class 2: 1.5 Class 3: 2.0 Class 4: 4.0 Class 5: >4
Coliform bacteria: Total coliform	MPN/100 ml	n.a.	n.a.	n.a.	n.a.	Class 1: <5,000 Class 2: 5,000 Class 3: 20,000 Class 4-5: >20,000
Faecal Coliform	MPN/100 ml	9,605⁺	8,296	9,522⁺	8,109	Class 1: <1,000 Class 2: 1,000 Class 3: 4,000 Class 4-5: >4,000
Nitrate (NO_3-N)	mg/l	0.4	0.9	4.6	1.3	Class 1: <5.0 Class 2-4: 5.0 Class 5: >5.0
Ammonia (NH_3-N)	mg/l	0.4	0.8	0.2	0.2	Class 1: <0.5 Class 2-4: 0.5 Class 5 >0.5
Phenols	mg/l	n.a.	n.a.	n.a.	n.a.	Class 1: <0.005 Class 2-4: 0.005 Class 5: >0.005
Copper	mg/l	nil	-	nil	-	Class 1: <0.1 Class 2-4: 0.1 Class 5: >0.1
Nickel	mg/l	n.a.	n.a.	0.10	0.08	Class 1: <0.1 Class 2-4: 0.1 Class 5: >0.1

Source: The 1991 Field Study; ONEB, 1991.

(Continued next page)

Table 5.2 (Continued)

Water Indicators	Unit	Dry season Mean	Dry season S.D.	Wet season Mean	Wet season S.D.	Standard of Water Quality
Manganese	mg/l	n.a.	n.a.	nil	-	Class 1: <1.0 Class 2-4: 1.0 Class 5: >1.0
Zinc	mg/l	nil	-	nil	-	Class 1: <1.0 Class 2-4: 1.0 Class 5: >1.0
Mercury (total)	mg/l	0.003^{+}	0.007	0.006^{+}	0.004	Class 1: <0.002 Class 2-4: 0.002 Class 5: >0.002
Cadmium*	mg/l	nil	-	nil	-	Class 1: <0.05 Class 2-4: 0.05 Class 5: >0.05
Chromium (hexavalent)	mg/l	nil	-	nil	-	Class 1: <0.05 Class 2-4: 0.05 Class 5: >0.05
Lead	mg/l	0.010	0.010	0.050^{+}	0.020	Class 1: <0.05 Class 2-4: 0.05 Class 5: >0.05
Arsenic	mg/l	nil	-	nil	-	Class 1: <0.01 Class 2-4: 0.01 Class 5: >0.01
Cyanide	mg/l	n.a.	n.a.	n.a.	n.a.	Class 1: <0.005 Class 2-4: 0.005 Class 5: >0.005
Radioactivity: Gross a	Becquerel/l	n.a.	n.a.	n.a.	n.a.	Class 1: <0.1 Class 2-4: 0.1 Class 5: >0.1
Gross b	Becquerel/l	n.a.	n.a.	n.a.	n.a.	Class 1: <1.0 Class 2-4: 1.0 Class 5: >1.0
Pesticides (total)	mg/l	n.a.	n.a.	n.a.	n.a.	Class 1: <0.05 Class 2-4: 0.05 Class 5: >0.05

Source: The 1991 Field Study; ONEB, 1991.

(Continued next page)

Table 5.2 (Continued)

Water Indicators	Unit	Dry season Mean	S.D.	Wet season Mean	S.D.	Standard of Water Quality
Specific pesticides:						
DDT	μg/l	n.a.	n.a.	n.a.	n.a.	Class 1: <1.0 Class 2-4: 1.0 Class 5: >1.0
a BHC	μg/l	n.a.	n.a.	n.a.	n.a.	Class 1: <0.02 Class 2-4: 0.02 Class 5: >0.02
Dieldrin	μg/l	n.a.	n.a.	n.a.	n.a.	Class 1: <0.1 Class 2-4: 0.1 Class 5: >0.1
Aldrin	μg/l	n.a.	n.a.	n.a.	n.a.	Class 1: <0.1 Class 2-4: 0.1 Class 5: >0.1
Heptachlor & Heptachlor epoxide	μg/l	n.a.	n.a.	n.a.	n.a.	Class 1: <0.2 Class 2-4: 0.2 Class 5: >0.2
Endrin	μg/l	n.a.	n.a.	n.a.	n.a.	Class 1-5: none

Note: All the above classification of water quality standard are announced in *Laws and Standards on Pollution Control in Thailand, 1989.*

S.D. - Standard deviation
MPN/100 ml - most probable number per 100 millilitres
mg/l - milligramme per litre
μg/l - microgramme per litre
n.a. - not available
nil - very low or almost undetectable
+ Trim mean

* The condition of water samples from the canals has value of hardness as $CaCO_3$ more than 100 mg/l so that its standard value of cadmium is classified by 0.05 mg/l. If the value of hardness is less than 100 mg/l, the standard values of cadmium is set by 0.005 mg/l.

Source: The 1991 Field Study; ONEB, 1991.

Table 5.3 Classification of the surface water on condition and beneficial usages

Class 1	Extra clean fresh surface water resources used for: (1) conservation, not necessary to pass through water treatment processes, require only ordinary process for pathogenic destruction; and (2) ecosystem conservation which basic living organisms can spread breeding naturally.
Class 2	Very clean fresh surface water resource used for: (1) consumption which requires the ordinary water treatment process before use; (2) aquatic organism conservation for living and assisting for fishery; (3) fishery; (4) recreation.
Class 3	Medium clean fresh surface water resources used for: (1) consumption but has to pass through an ordinary treatment process before use; (2) agriculture.
Class 4	Fairly clean fresh surface water resources used for: (1) consumption but requires special water treatment process before use; (2) industry; (3) other activities.
Class 5	The resources which are not classified in Class 1-4 and used for: (1) navigation.

Source: ONEB, 1991.

In assessing the biological condition of the canal network, only faecal coliform bacteria was considered because it is more significant than total coliform bacteria. It is restricted to the intestinal tract of warm blooded animals. Using *Escherichia coli* to indicate fresh faecal pollution, the average dry season value derived from fieldwork was 9,600 MPN/100 ml while the rainy season value was about 9,520 MPN/100 ml (Train, 1979: 43-48).[7] Both values are double the maximum value analysed to the highest (fifth) class of surface water (Table 5.3). When we determine faecal coliform's standard deviation for both seasons, they were as great as 8,296 and 8,109. Since some canals where paddy and fish farming were dominant, faecal coliform values were in the range of less than 1,000 to 7,000 MPN/100 ml. Conversely, some canals where residences and factories were crowded, the values were in the range of 10,000-24,000 MPN/100 ml. Sources of faecal coliform bacteria were derived largely from household, slaughter house, and other food processing industries. Thus, most canals are unsuitable for any human activity because bacteria cause pathogenic diseases (see Appendix 1.2 and 1.3).

b) Chemical condition

The key indicators used in this study are dissolved oxygen (DO), biochemical oxygen demand within five days (BOD_5), pH value, nitrate-nitrogen, ammonia-nitrogen, arsenic and heavy metals. The average value of dissolved oxygen during the 1991 wet and dry seasons was quite low. In the wet season, the average DO of streams was less than 2 mg/l, while in the dry season it was around 3 mg/l. The DO's standard deviation in the wet and dry seasons were 1.2 and 1.5 respectively. There was considerable seasonal variation in dissolved oxygen within all canals. In the wet season, the DO in all canals was in the range of 0.3 to 5.1 mg/l. While in the dry season, it was between 0.8 and 8.0 mg/l (see Appendix 1.2 and 1.3).

---

7 The value of faecal coliform in the dry and wet seasons were presented in trim mean. Some values were ignored because there were extraordinary values in some canals which were very low or less than 1,000 MPN/100 ml. However, some canals especially where residences, markets and factories were crowded had a very high value of 24,000 MPN/100 ml. They were included in the calculation.

Generally, the low average DO reflected the high BOD_5 of the canal network. From the field survey, the BOD_5 value was 10.58 mg/l in the wet season and 13.90 mg/l in the dry season — three times higher than the average standard value of the fifth Class. Its standard deviation for both seasons were moderate — 5.57 and 7.97 respectively. This indicated a fluctuation of BOD_5 in all canals. Its ranges in the wet and dry seasons were 4.00-26.00 and 3.00-31.00 mg/l respectively. However, the average BOD_5 revealed that the amount of oxygen in the water was insufficient for self-purification. Not surprisingly, the canals were odoriferous.

In 1991, the average pH values for all canals were normal. In summer, the pH value was about 7.5 whereas it was 6.6 in the rainy season. The pH value in all canals exhibited little variation since its standard deviation for both seasons were very low — 0.6 and 1.0 respectively. The average values of nitrate, ammonia and arsenic in the canal network were very low for both seasons. Particularly, arsenic was virtually absent. This was due to the absence of many fertiliser-related industries generating these chemicals. Another major source of these chemicals was the use of rodenticides on paddy farms. The standard deviations of nitrate and ammonia for both seasons were high. It reflected their variable values in all canals (0.9 and 0.8 in the dry season and 1.3 and 0.2 in the wet season respectively). However, the results of pH, nitrate, ammonia and arsenic did not reveal any environmental damage. If we considered the average values of these four parameters in Amphoes Bang Pli and Bang Bo surface water would be grouped in Class 1.

Nickel was within moderate limits, especially in the wet season. The average value was 0.10 mg/l when its standard deviation was 0.08. This condition showed nickel in the canal network varied widely between 0.01 to 0.25 mg/l. Conversely, other heavy metals such as copper, zinc, manganese, cadmium and chromium were rarely detected. During the 1991 dry season, the quantity of copper, zinc, cadmium and chromium were insignificant though technical problems prevented the derivation of nickel and manganese. During the wet season, the amount of these heavy metals, in the canal network was minimal.

Mercury and lead within streams, however, exceeded harmful limits for both seasons in 1991. In the dry season, the average level of mercury was 0.003 mg/l — a figure higher than the maximum level in the fifth Class. Its standard deviation was very high or about 0.007 revealing a wide range of mercury in the canal network between almost zero and 0.025 mg/l. In the wet season, the average value of mercury was 0.006 mg/l which was also above the highest limit. Its standard deviation in this season was high or around 0.004 indicating a broad range in all canals of almost zero to 0,015 mg/l.[8] Although lead in the 1991 dry season was insignificant, its standard deviation was remarkably high or 0.010 which was equal to its average value. All canals in this season had a contamination of lead in the range of 0.002 to 0.047 mg/l which was considered lower than the minimum limit in the first class. In the wet season, its average value was 0.050 mg/l where the standard deviation was as high as 0.020.[9] The range of lead of the canal network was between 0.016 and 0.055 mg/l. This high level of mercury and lead was derived from industrial waste such as the manufactures of electric lamps, electric appliances, batteries, fungicide, paints and basic chemicals.

In 1991, the condition of the canal network in Amphoes Bang Pli and Bang Bo was suitable only for navigation. Although the average nitrate, ammonia and arsenic components were very low in the streams, the results of DO, BOD_5 and heavy metals underlined the surface water was degraded. If we restricted our attention to the five-day BOD, its average values highlighted the canal network was already polluted. Heavy metals further compounded the problem. The presence of certain metals (e.g. lead,

---

[8] The value of mercury in the 1991 dry and wet seasons was calculated in trim mean. There were some canals which had unusually higher values than the harmful limit in the fifth class (68-925 times in the dry season and 26-78 times in the wet season). No clear explanation of this cause could be traced. Some local people advised the water gates may have been opened or some industries located outside the area illegally dumped their waste by trucks during the night time. As they caused errors, these values were, therefore, ignored in the calculation.

[9] Only the average value of lead in the wet season was interpreted in trim mean. There were some canals that had a high value of about 3 to 10 times the highest limit in the fifth class. These values were excluded in the calculation.

copper, mercury and chromium) are toxic to micro-organisms, especially bacteria, even in low concentrations (Klein, 1959: 131). Without bacteria, there is no self-purification of the streams. Moreover, the standard deviation of many water indices showed some canals had a serious pollution problem. The distribution of specific pollutants of the canal network can be further described in the next sub-section.

2.2 Distribution of water pollution

The above average readings of critical water parameters have stressed the severity of environmental deterioration of the canal network in Amphoes Bang Pli and Bang Bo. No indication, however, is given to the distribution of specific problems, such as oxygen depletion or heavy metals contamination. A substantial volume of waste water flowing into the canal network stemmed from two large public industrial estates outside Amphoes Bang Pli and Bang Bo and another one within their confines. Although these industrial estates have waste treatment plants, untreated water is sometimes flushed into the waterways. Obviously, effluent from the Bangpu' Industrial Estate in Amphoe Muang, in the southwest of the area affects Tabnang, Palatpriang and the west-Samrong Canals. While the Latkrabang Industrial Estate in the BMA is more than five kilometres distant from the areas under review, its effluent has had a significant environmental impact on Khlongs Prawetburirom and upstream of Huacharakae and Nongnguhao Canals. Effluent from the Bang Pli Industrial Estate also affects both the mid-Samrong and Panya Canals. This distribution does not include waste from individual factories scattered along major roads and canals in Amphoes Bang Pli and Bang Bo.

An examination of the distribution of water pollution shows that some streams could be categorised in Classes 3 or 4. These would be clean enough for the survival of aquatic organisms and fit for human consumption. As noted, those canals grouped in Class 5 were suitable for navigation. In this investigation, some significant water indices have been discussed, particularly dissolved oxygen, five-day biochemical oxygen demand, faecal coliform, lead and mercury because their values exceeded standard limits.

Basically, dissolved oxygen is significant to all forms of aquatic life. The content of oxygen as well as the biochemical oxygen demand are the primary indicators reflecting the degree of degradable water. Figure 5.2 shows the distribution of dissolved oxygen (DO) in the canal network during two seasons. Generally, the DO values of canals in the western part of Watkingkaeo-Latkrabang and Pracharat-Utit Roads (i.e. Khlong Palatpriang, Khlong Tabnang and the west of Khlong Samrong) were very low or negligible (the average value was 1.2 mg/l in both seasons). In the wet season, all canals in this section had a very low DO value ranging from 0.3 to 1.1 mg/l. As many eyewitnesses reported many factories including the Bangpu' Industrial Estate frequently flushed waste water when it was raining in order to easily and invisibly dilute the concentrated waste. In the dry season, the DO value in this part became moderate. It was between 0.8 and 3.4 mg/l because of less industrial waste.

Conversely, canals on the eastern side of the Roads had higher DO in both seasons (the average value was 2.9 mg/l). The reason for the difference was because the four gates blocked the water flow from the small tributaries flowing into Khlong Latkrabang, Khlong Plara and the eastern part of Samrong Canal (Figure 5.1). In the dry season, these canals had a high DO value ranging from 1.1 to 8.0 mg/l. Some canals had a low value because dredging was in progress, stirring up sediment from the canal's bottom. This caused the oxygen depletion. Khlongs Latkrabang, Plara, Pla, Huacharakae, Phraonkchaochaiyanuchit and Banghia had moderate to high DO values as they were used as major transportation routes. In the wet season, the DO value in most canals was low, ranging from 0.8 to 5.1 mg/l. Only Khlong Phraonkchaochaiyanuchit, Khlong Banghia and the eastern Samrong Canal showed high DO values because they were surrounded by paddy and fish farms. The lower DO content in the western part of Watkingkaeo-Latkrabang and Pracharat-Utit Roads reflected the high density of households and factories generating large volumes of waste water, and lack of use as transport arteries. Conversely, the canals on the eastern side are frequently used by motor boats and, therefore, the oxygen content is high.

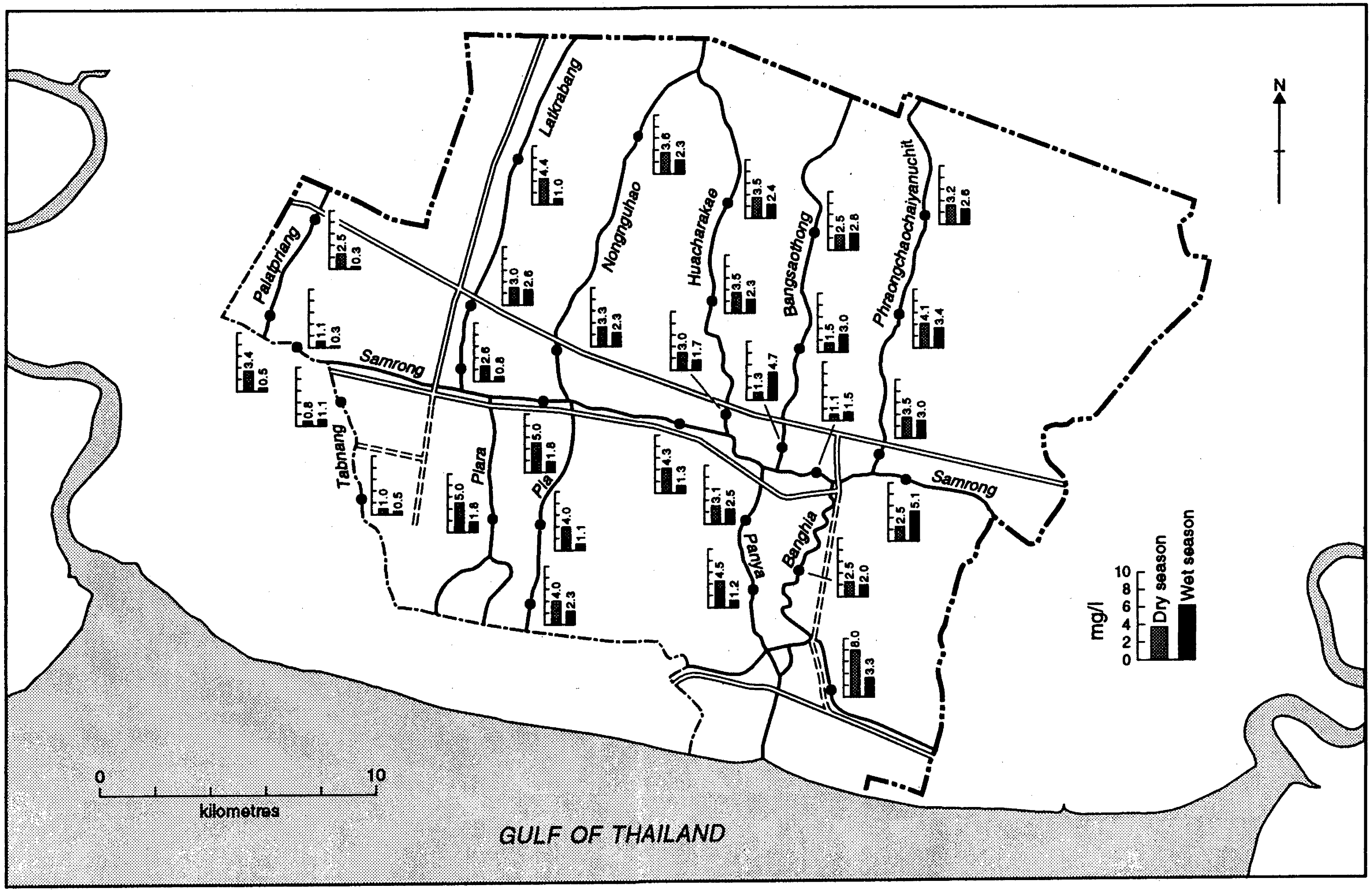


Figure 5.2 Dissolved Oxygen in the Canal Network in Dry and Wet Seasons (April and June/July 1991), Amphoes Bang Pli and Bang Bo, Samut Prakan

The five-day biochemical oxygen demand (BOD_5) value reflects the cleanliness of the water. Figure 5.3 showed that the values of BOD_5 on the western side of Watkingkaeo-Latkrabang and Pracharat-Utit Roads and the lower part of Samrong Canal were higher than others. In both seasons, all canals on the western part had an average BOD_5 of 17.0 mg/l while those in the eastern section had a lower average BOD_5 of 10.9 mg/l. As noted, some canals on the western side had become virtual septic tanks because the gates prevented the flow of water. In the dry season, the canal network on the western part had a BOD_5 between 11.0-24.0 mg/l; whereas in the wet season it became a little higher ranging from 10.0 to 26.0 mg/l. Unquestionably, the flow of waste water from the crowded residential and industrial areas was responsible for the differences.

In contrast, water flowing in a north-south direction within the eastern part of Watkingkaeo-Latkrabang and Pracharat-Utit Roads recorded low BOD_5 in the upper zone of Khlong Samrong (i.e. between 3.0 and 16.0 mg/l in both seasons). Here fresh water from Khlong Prawetburirom helped increase the oxygen content. However, the canals in the southern section had a high BOD_5 (i.e. between 8.0 and 31.0 mg/l in both seasons) since there were at least five water gates along the coast — three in Amphoe Muang and two in Amphoe Bang Bo which blocked water outflow to the sea. During the 1991 field survey Khlongs Pla, Panya and Banghia which were connected to the mid-Samrong Canal had a high BOD_5. This was due to some food processing industries, especially poultry, flushing organic waste, such as blood and fat, into the waterways. The condition of canals in the upper area seemed to be less polluted. The overall BOD_5 in the eastern part, however, was higher than the maximum level of Class 5 which was considered dirty.

When faecal coliform on the western side of Watkingkaeo-Latkrabang and Pracharat-Utit Roads is considered, Figure 5.4 shows that its values were very high in both seasons (the average value being than 13,700 MPN/100ml). This reflected the area's densely developed character and absence of waste water treatment plants for all householders and failure of industrial enterprises to use their facilities. Although faecal

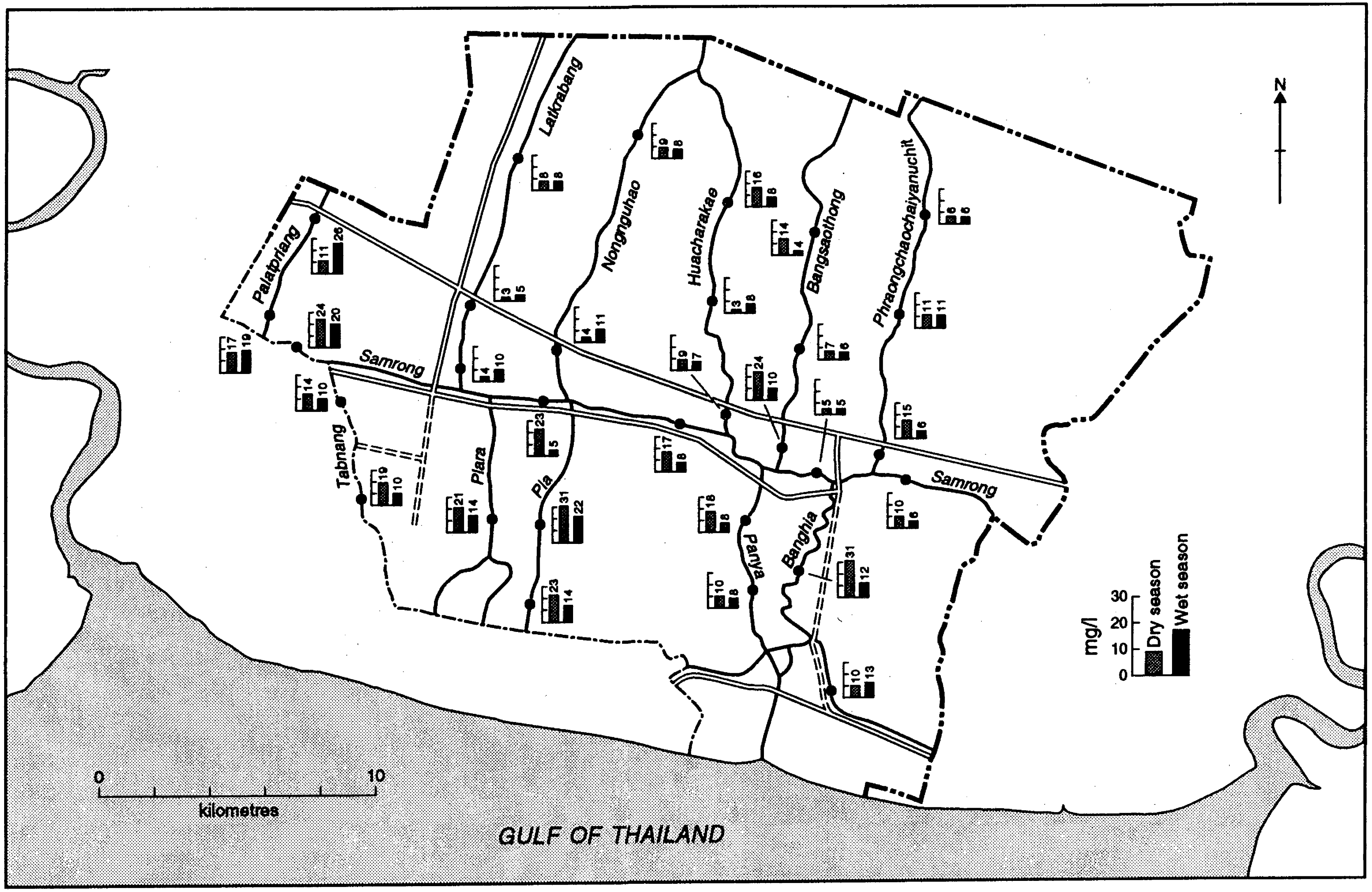


Figure 5.3 Five-day Biochemical Oxygen Demand in the Canal Network in Dry and Wet Seasons (April and June/July 1991), Amphoes Bang Pli and Bang Bo, Samut Prakan

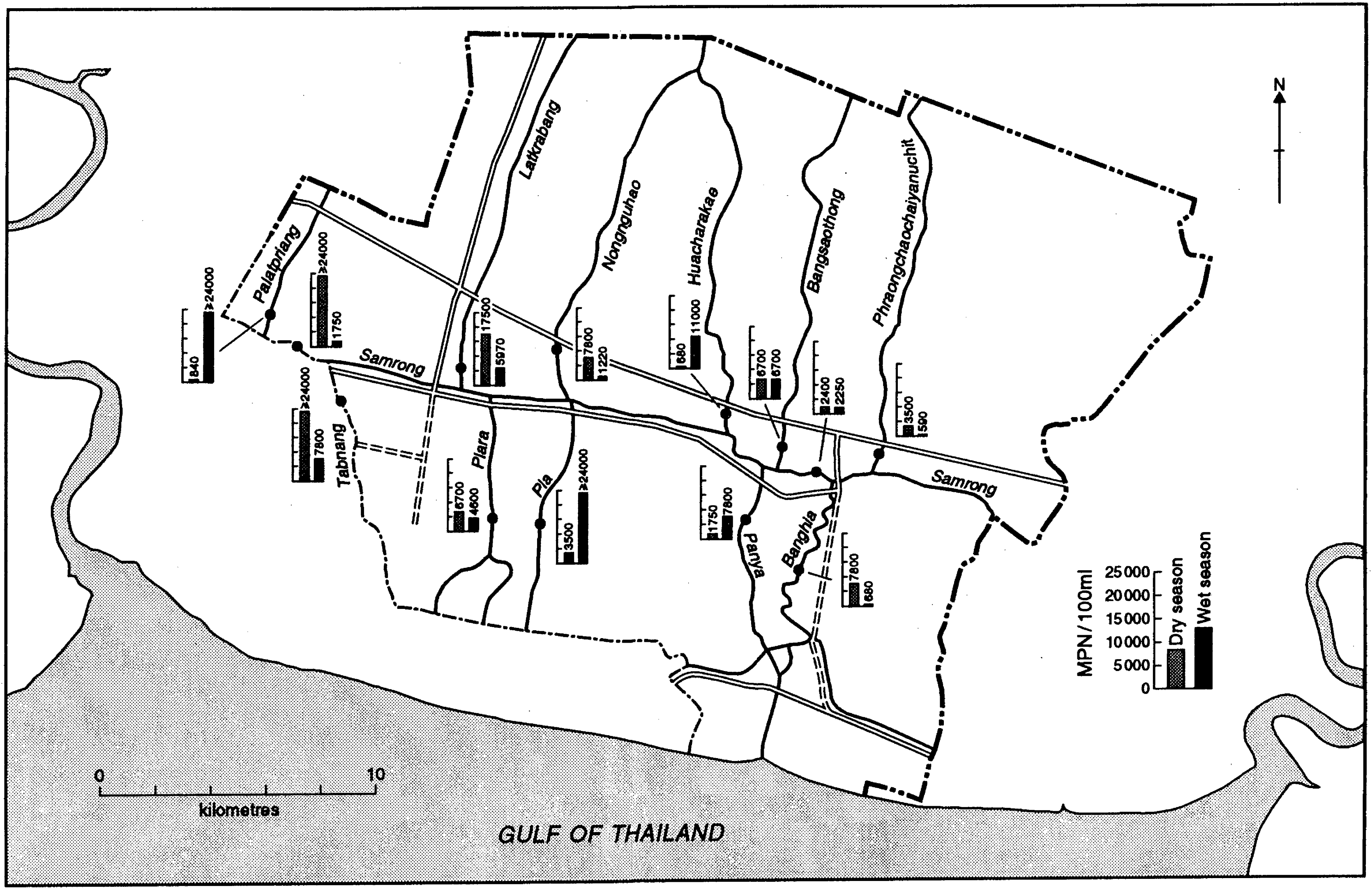


Figure 5.4 Faecal Coliform in the Canal Network in Dry and Wet Seasons (April and June/July 1991), Amphoes Bang Pli and Bang Bo, Samut Prakan

coliform in Palatpriang Canal showed a low value of 840 MPN/100 ml in the dry season, its value was over 24,000 MPN/100 ml in the wet season. Conversely, faecal coliform in the western section of Samrong and Tabnang Canals reached 17,500 and 7,800 MPN/100 ml respectively in the wet season, their values were over 24,000 MPN/100 ml in the dry seasons. This situation reflected the gate controls in Amphoes Muang, Phrapradaeng and Bang Pli which affected water flow in the western Amphoe Bang Pli. Streams in this section were, therefore, very dirty and exceeded the maximum limit of 4,000 MPN/100 ml.

Certainly, these results indicated higher average values than the rest of the area. In the 1991 dry and wet seasons, the average value of faecal coliform in the eastern part of Watkingkaeo-Latkrabang and Pracharat-Utit Roads was about 6,150 MPN/100 ml, though its urban areas were less densely populated. This value was also considered higher than the maximum limit for the fifth class. When we concentrated on specific canals during the dry season — Khlongs Latkrabang, Nongnguhao, Banghia, Plara and Bangsaothong — they reached values of 17,500, 7,800, 7,800, 6,700, and 6,700 MPN/100 ml respectively. It reflected the concentration of food processing industries and densely populated settlements along these canals. In the wet season, they recorded lower values because of the high levels of precipitation. Nevertheless, Khlongs Pla, Huacharakae and Panya connected to the mid-Samrong Canal still had high faecal coliform levels because of the higher-than-usual levels of waste water.

Heavy metals, notably lead, were low in most canals during the dry season (Figure 5.5). Khlong Pla, for instance, had the lowest level of 0.002 mg/l and Khlong Bangsaothong the highest of 0.047 or 0.05 mg/l. These values were still lower than the maximum limit of 0.05 mg/l. The water gates, therefore, were not responsible for different lead levels in the canals on both sides of Watkingkaeo-Latkrabang and Pracharat-Utit Roads. During the rainy season, the lead level in many canals increased dramatically. Lead levels in Khlongs Nongnguhao, Pla, Palatpriang and mid-Samrong were 0.217, 0.205, 0.154 and 0.150 mg/l respectively. They were three to four times

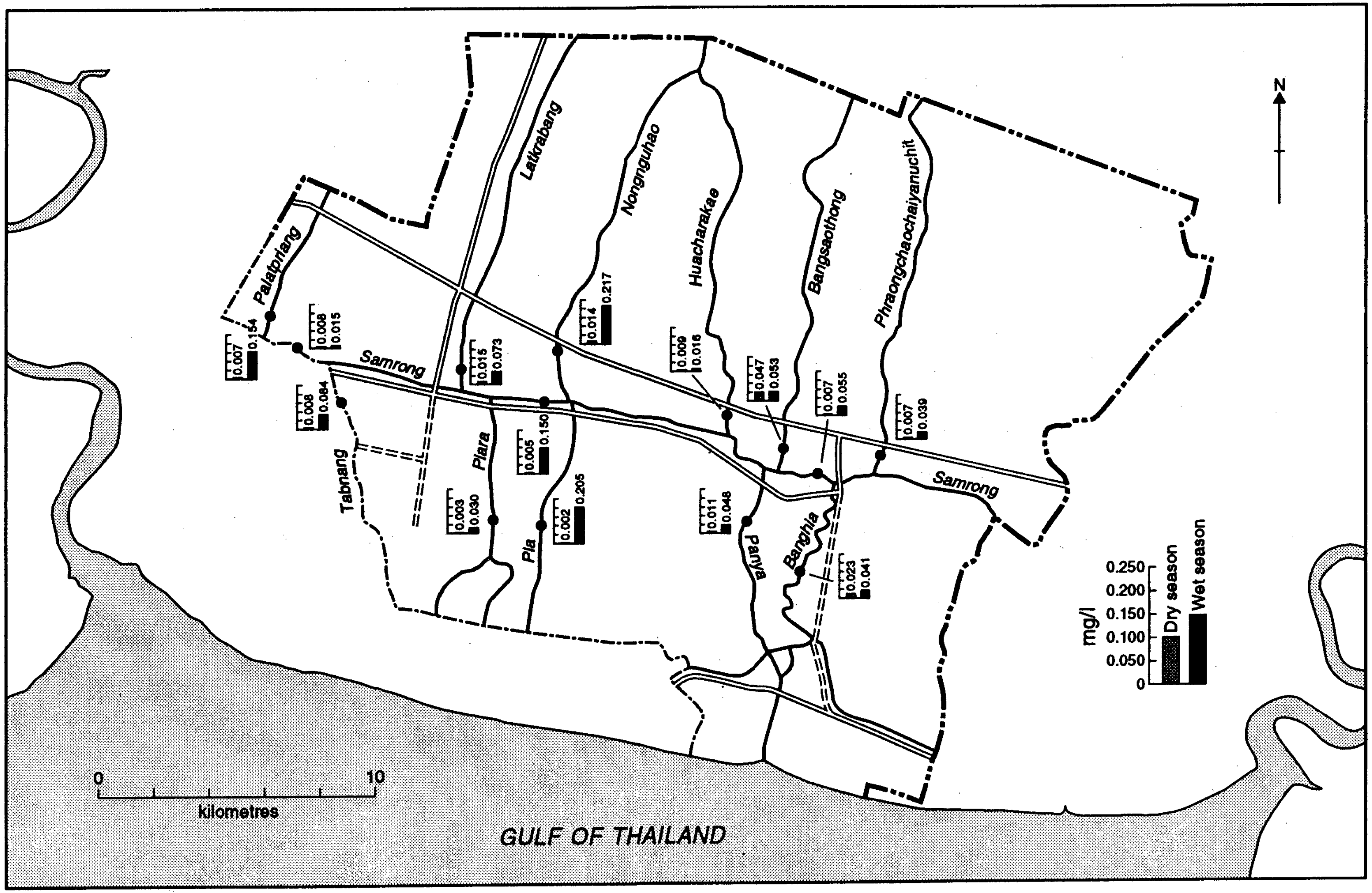


Figure 5.5 Lead in the Canal Network in Dry and Wet Seasons (April and June/July 1991), Amphoes Bang Pli and Bang Bo, Samut Prakan

higher than the maximum permitted limit. These canals and the surrounding areas had many metal welding and steel industries along their banks which caused lead contamination in the waterways. Other canals had lower lead levels ranging from 0.084 to 0.002 mg/l. Nevertheless, these levels exceeded the permitted maximum.

Mercury is another important heavy metal which indicates high levels of water contamination. Again, the water gates were not a significant factor for the different mercury values in surface water of both sides on Watkingkaeo-Latkrabang and Pracharat-Utit Roads. In the dry season, more than half of the sample sites concentrated in the west and the north of Amphoes Bang Pli and Bang Bo had very low or undetectable levels of mercury (Figure 5.6). Conversely, Khlongs Bangsaothong, Banghia, Plara and the mid stream of Samrong presented the highest values. They were 925, 100, 68 and 13 times respectively the maximum limit of Class 5, 0.002 mg/l. Many sample sites which had very low levels of mercury in the wet season, however, recorded increased values. Khlongs Banghia, Nongnguhao, Plara, the west of Samrong, Latkrabang and the mid-Samrong had the highest levels. Their values were 78, 42, 32, 31, 26 and 13 times respectively exceeded the maximum limit of Class 5. There were electric light and assembly works and a few pharmaceutical plants located near these canals. These industries could have released waste water contaminated by mercury. As a result, all canals were unsuitable for aquatic life or human consumption.

The concentration of other heavy metals in most canals (i.e. chromium, copper, nickel, manganese, zinc and cadmium) was very low. This may be due to metal finishing industries sending their waste to Samaedum in Samut Sakhon Province for special treatment. There is, therefore, no further discussion on these heavy metals in this section. Their environmental effects, however, are presented in the next section.

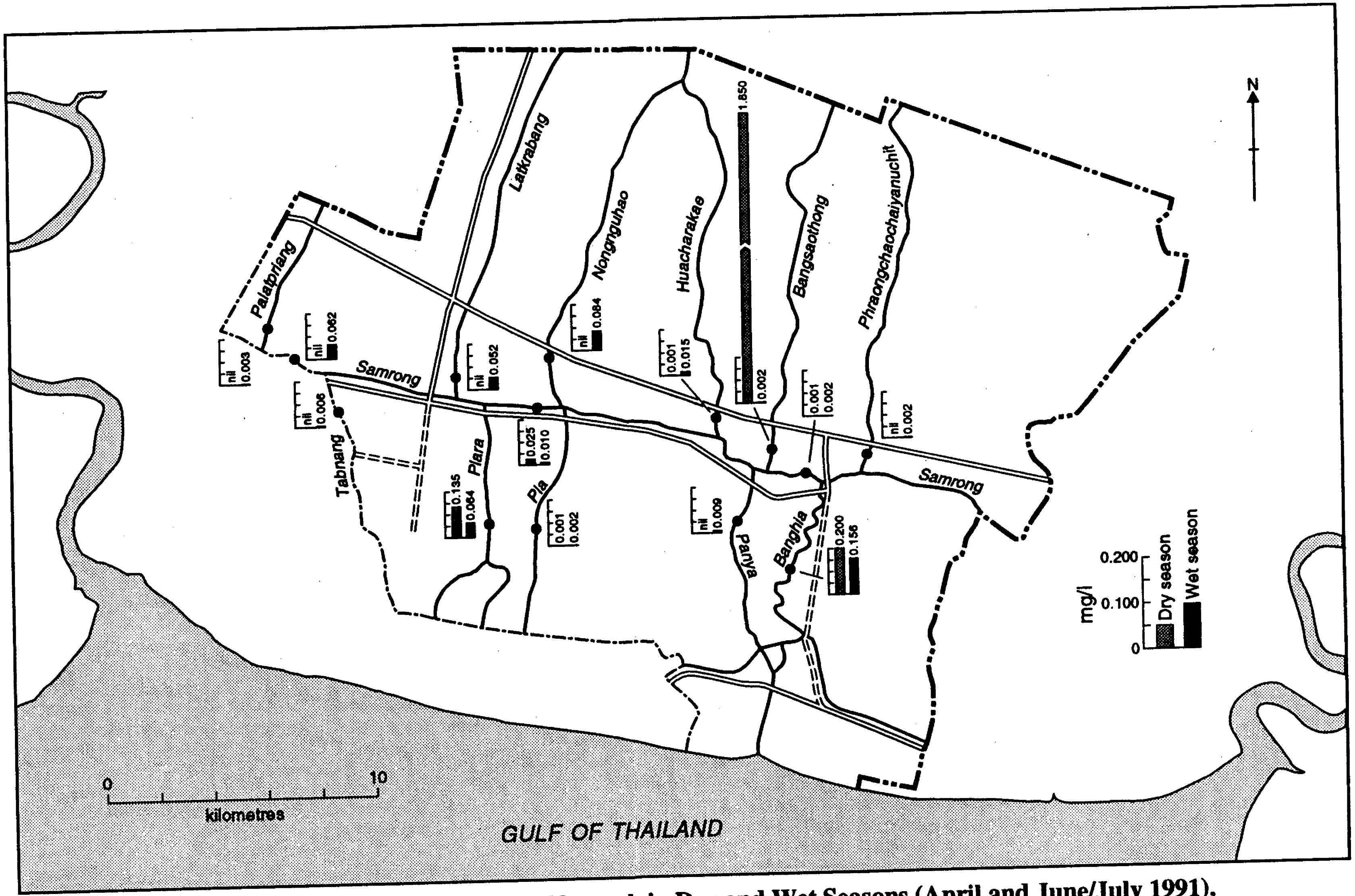


Figure 5.6 Mercury in the Canal Network in Dry and Wet Seasons (April and June/July 1991), Amphoes Bang Pli and Bang Bo, Samut Prakan

3. IMPACTS ON AQUATIC LIFE

Polluted water is harmful to all forms of aquatic life and to human consumption. Naturally, clean surface water is composed of chemical substances. Oxygen is certainly an important element to all living organisms and some heavy metals such as manganese and zinc are essential as nutrients to flora and fauna. However, if the oxygen is inadequate or any metals exceed a tolerable limit of specific species, significant environmental damage is presented.

Normally, minimum dissolved oxygen concentration of 5 mg/l or less are required for fish survival. The exact level depends not only upon the type of fish, but also upon the environment conditions such as pH, temperature, and stress. As Nemerow (1974: 197) has observed:

> Most harmful effects of pollution on fish life pass unnoticed or are attributed to other causes than pollution when the fish are slowly killed off. The sewage may change conditions so that only the small ones may be killed, and the dead may not even be seen. The spawn may be prevented from hatching, or the development may be made abnormal, so that malformed fish result. Or the natural spawning beds may be covered by a deposit of septic sludge, in which the eggs cannot hatch. The pollution may kill the animal life on which the fish normally live, thus depriving them of nourishment. Fish then tend to become dwarfed in polluted waters. Extremely small concentrations of certain chemicals have been found to make fish very nervous, rendering them an easy prey for other aquatic life or driving them away from the waters ... In addition, the incidence of disease increases among fish in polluted waters. Parasitic worms produce little black cysts on the skin of the fish in polluted waters more commonly that in most unpolluted water. Another bacterial disease causing the fish to be eaten away, called saprollignia or fin and tail rot, has been observed.

Between 1982 and 1983, a great number of fish were found dead in many regions of Thailand exhibiting the characteristics observed by Nemerow. Simultaneously, the Department of Medical Sciences under the Ministry of Public Health reported high levels of *Aeromonas Hydrophila* and mercury in fresh water fishes (Kana Kammakan Chapokit Kaekaipanha Rokrabat Satnam, 1983). Boonyaratpalin *et al.* (1983: 6) also confirmed fish, shrimp and snails from natural waters and culture operations were found to be infected. A total of 42 species of fish from 25 provinces typically had necrotic lesions on the upper and lower jaws and other parts of the body. Moreover, many fish had patches of fungus on the skin and fins. Some fish had whitish eyes and ulcers. Most research conducted during this period considered the fresh water environment had been changed causing stress to fauna. Accelerated levels of heavy metals and other toxic substances in the water resources have also reduced the immunity of fauna and the number of flora. This was due to the excessive use of pesticides and fertilisers on farms. Also, it reflected the rapid transformation of land from agricultural to residential and industrial uses in the 1980s, especially in Greater Bangkok (Sem, 1983: 6). Indeed, the expanding metropolitan area has generated a variety of pollutants which have degraded the natural water system.

A field survey in 1991 revealed this situation remained unchanged. The degree of damage was especially severe to the west of Amphoe Bang Pli where factories and households were concentrated. Conversely, the problem was less critical in Amphoe Bang Bo where they were diffused. As confirmed by three residents who were living in 1991 along Tabnang Canal to the west of the study area:

> Our canal sometimes is red or murky. Water lily and weeds have disappeared since the Bangpu' Industrial Estate has been established. Small fish such as *Pla Kradi* [Blue gourami or *Trichogaster trichopterus* (Pallas)] and *Pla Sui* (Red-tail rasbora or *Rasbora borapetensis* H. M. Smith) have also gone. *Pla Chorn* [Stripped snakehead fish or *Channa striata* (Bloch)] was badly injured — rotten fin and many big red dots on the skin. Sometimes it swam madly — hurling on the water's surface and hitting the stream's bank as it needed air to breath.

Farmers in the far east of the area, especially along Phraongchaochaiyanuchit Canal also reported fish affected by pollution. Small fish still persisted but they were reduced in number. In the dry season, water plants such as lily and weeds were rarely seen. When there was more fresh water from Khlong Prawetburirom in the wet season, such plants bloomed again. Local people in other districts reported similar situations. Clearly, the extent of environmental damage reflects proximity to individual sites.

If we concentrate on individual water indices, each parameter has a varying impact on aquatic life and people (Table 5.4). Although Table 5.4 is not comprehensive in covering the impacts on aquatic fauna and flora, and humans, it gives sufficient information on the tolerable limits and the side-effects of living organisms. Where, for example, the concentration of dissolved oxygen in water is less than 4 mg/l, most fish and invertebrates cannot survive. Faecal coliform bacteria create not only a public health problem for people but they cause diseases in aquatic life. Heavy metal salts dissolved in solution constitute a very serious form of pollution because they are stable compounds, not readily removed by oxidation, precipitation or any other natural process (Klein *et al.*, 1962: 237). Even low concentrations are fatal to aquatic life.

The investigation of water pollutants in this study was restricted to grab samples of surface water. If water samples or sediments are collected from the bottom of the streams, the outcomes would be more critical because of higher accumulation levels. Unquestionably, all benthos or living organisms on the bed stream have mostly suffered from the pollution. Whereas many fauna have disappeared from the canal network, some tolerable flora, particularly water-hyacinth, can survive in this offensive condition. However, this does not mean that new environment of the streams will compensate all losses. It further worsens the recovery of all streams and the economy of the whole province.

RESUME

Chapter V has explored the severity of water pollution and its distribution in the canal network of Amphoes Bang Pli and Bang Bo. It has also revealed the environmental impacts on aquatic flora and fauna. Water quality was sampled during the 1991 field survey held between dry and wet seasons. Although not all water indices were analysed, major indices revealed the unsatisfactory condition of the canal network. Levels of dissolved oxygen, biochemical oxygen demand and faecal coliform were critical. Apart from the presence of lead and mercury, levels of heavy metals were not

Table 5.4 Environmental Effects from Specific Water Indices

Water indices	Possible major sources	Effects to living organisms and human uses
Temperature	Cooling water from iron and steel industries.	In tropical rivers, the maximum temperature may reach 30-35 °C. Above this range, most fish cannot survive.
pH value	Various natural and human activities.	Aquatic life can survive between pH 6 and 9. For primary contact recreation waters, the pH value should not less than 5. If it rises above 9, it affects human eyes.
Oxygen	Various natural and human activities.	The minimum dissolved oxygen concentration for a fresh water biota should be 5 mg/l for warm water species, declining to a lower limit of 4 mg/l for short periods of time, provided that the water quality is favourable in all other respects.
Faecal coliform	Households, slaughter houses and food processing industries.	It creates public health problems for man and animals and potential disease problems for aquatic life.
Nitrate (NO_3)	Fertilisers used in farms and chemical industries.	High concentrations produce conditions known as methemoglobinemia (blue babies) which generally affects infants under six months of age.
Ammonia	Basic chemical industries.	Aquatic life exposed to levels over 1 mg/l suffocate. Lethal concentrations for a variety of fish species are in the range of 0.2 to 2.0 mg/l.
Copper	Basic chemical industries.	Excess copper is highly toxic to algae and invertebrates. It is only moderately toxic to mammals causing irritation of the skin and conjunctivity on an allergic basis.
Nickel	Semiconductor industry, metal - electroplating, motor vehicles and parts and basic chemical industries.	It is considered non toxic. In laboratory animals, it has induced a number of ocular anomalies, including anophthalmia and microphthalmia and has been shown to be a carcinogenic for rats.
Manganese	Basic chemical industries.	It is highly toxic to humans, especially in forms of dusts and fumes.
Zinc	Metal finishing and chemical process operation.	A variety of fresh water plants tested manifest toxic symptoms at concentrations of 10 mg/l. In a very low concentrations of Zn may be toxic to aquatic life. Soluble salts of Zn have a harsh metallic taste, small doses can cause nausea and vomiting, while larger doses cause violent vomiting and purging.

(Continued next page)

Table 5.4 (Continued)

Water indices	Possible major sources	Effects to living organisms and human uses
Cadmium	Metal - electroplating, textile, photography, ceramic manufacture, pigment works, and chemical industries.	Its toxicity has been implicated in serious cardiovascular disease in man. It also affects metabolism and may substitute for calcium in the bone structure. Excessive cadmium led to the occurrence of *itai-itai* disease which is characterised by rheumatic symptoms with intense pain in the bones. It may be an aetiological factor for various human pathological processes including testicular tumours, renal dysfunction, hypertension, arteriosclerosis, growth inhibition, chronic diseases of old age, and cancer. A cadmium concentration of 200 µg/l is toxic to certain fish.
Chromium (hexavalent)	Motor vehicle and parts, metal-electroplating and tanning.	Hexavalent chromium (Cr^{+6}) is irritating and corrosive to the mucous membranes if it is absorbed via ingestion, through the skin and by inhalation. It also causes nephrotoxicity in man. It is very toxic and carcinogenic to organisms. Excessive Cr^{+6} causes a lethal effect to some fishes and invertebrates.
Lead	Basic chemical industries, metal welding and steel industry.	Lead is highly toxic to humans. Lead poisoning can lead to chronic renal failure and polyneuropathy. In its effect on kidney function, lead acts much like cadmium.
Mercury	Basic chemical industries, electrical apparatus, paper and pulp manufacture, pharmaceutical preparation and agricultural herbicides and pesticides.	It tends to concentrate in the fetus and may cause permanent or fatal brain damage if the concentration is sufficiently high. It can cause acute renal failure and nephrotic syndrome.
Arsenic	It is derived from many industrial activities including pesticides, pigmentation in paints and fireworks and the manufacture of copper and lead alloys, glass, cloth and electrical semiconductors.	It is highly toxic to humans and aquatic organisms. A chronic, cumulative poison, it can cause eruption on the skin. Contamination of arsenic in drinking water may cause hyperkeratosis and skin cancer. Concentrations of 4 mg/l sodium arsenite have been found to reduce survival and growth of fish and to reduce bottom fauna and plankton population.

Source: Klein, 1959; Klein *et al.*, 1962; Krenkel, 1974a; Train, 1979; Moss, 1980; Considine and Considine, 1984; APHA, AWWA and WPCF, 1985; Rodricks, 1992.

serious. Generally, the whole network was unsuitable for living organisms including humans. It could only be used for navigation. The primary cause of low water quality was the large volume of waste water from industrial and domestic activities. However, the problem was compounded by the interference of the self-purification process of streams by the BMA's flood protection gates.

The worst condition of pollution occurred in the area west of Amphoe Bang Pli. Crowded factories and households generated a high proportion of waste water resulting in the deterioration of waterways and reduction of all forms of aquatic life. Conversely, water quality in the eastern part of Amphoe Bang Pli and the northern district of Bang Bo was better. This was due to the persistence of paddy and fish farming activities in most of these areas. When some gates were opened for irrigation or flood protection, however, polluted water was dispersed to other areas causing extensive environmental damage.

Recently, many aquatic flora, such as weeds and lilies, have disappeared, especially in the western part of Amphoe Bang Pli. Although some other areas of both Amphoes Bang Pli and Bang Bo experienced similar problems, they recovered during the wet season. Small fish have been reduced in number or eliminated in most areas. Frequently, injured and dead fish have been found. No monitoring system of surface water quality has been undertaken by the Office of National Environment Board or the Provincial Government. Also the Department of Industrial Works has been lax in forcing entrepreneurs to treat their waste water. Thus, water pollution within the canal networks of Amphoes Bang Pli and Bang Bo threatened aquatic life and local people.

CHAPTER VI

IMPACTS OF CHANGES IN WATER QUALITY ON THE LOCAL COMMUNITY

Rapid industrialisation has transformed the economic geography of Samut Prakan. Previous chapters have traced the nature of industrialisation and measured how it has affected water quality. Formerly, communities were peasant societies engaged in paddy and fish farming dependent upon the canals for agricultural resource inputs, household consumption, transport and amenities. Currently, new economic activities stemming from the inner cities of Samut Prakan and Bangkok have invaded the area bringing with them unfamiliar developments and alien labourers. In the process, the canals have been degraded. No longer can they serve local communities as before. Most local people have negative experiences to report about the canals. They have been forced to buy fresh water for drinking, cooking and washing purposes. Also the productivity of fish farms has declined causing a marked disparity in income between farmers, industrial workers and entrepreneurs.

The next step is to examine how changes in water quality have affected communities in Samut Prakan. More specifically, how has the deterioration in water quality affected local consumption, fishing, health and income; and how have individual residents reacted to these changes.

These issues are discussed by focussing attention on the micro-geography of Amphoes Bang Pli and Bang Bo — two areas whose social geography had been shaped by industrialisation and waste water. Data derived from relevant documents and reports in the Provincial Office of Samut Prakan are used to describe the onset of industrialisation in Amphoes Bang Pli and Bang Bo (Section 1). Then the survey method used in the field study is described (Section 2). Results from the survey are employed to gauge changes in lifestyle, water consumption, fishing activities and well-being brought about by changes in water quality (Section 3). Social movements formed to combat the adverse effects of water pollution are considered before examining the responses of both local and central governments to the manifest problems (Section 4).

1. AMPHOES BANG PLI AND BANG BO

In 1990, Samut Prakan Province had an area of 1,000 square kilometres comprising five Amphoes or districts: Muang, Phrapradaeng, Bang Pli, Bang Bo and Phrasamutjedi (Figure 6.1). In all Amphoes there was a population of 854,000 living in 516 villages. Amphoe Muang had the largest population — 345,800 — but as its municipal area accommodated 72,000 people it had fewer villages than anticipated. Amphoe Phrapradaeng had the second highest population (199,100) but the largest number of villages (175). Conversely Amphoe Phrasamutjedi had the smallest population (76,000) and villages (40) respectively. Thus Amphoes Bang Pli and Bang Bo together accounted for 27 per cent of Samut Prakan's population but 40 per cent of its villages (Table 6.1).

Table 6.1 Size of Districts, Population Number, Population Density, and Number of Villages in Samut Prakan, 1990

Amphoes	Size (km^2)	Population (no.)	Density (no. per km^2)	Village (no.)
Muang	190.6	345,795	1,814.7	97
Phrapradaeng	73.4	199,110	2,713.8	175
Bang Pli	374.8	146,455	390.8	130
Bang Bo	245.0	86,711	353.9	74
Phrasamutjedi	120.4	75,958	630.9	40
Total	**1,004.1**	**854,029**	**850.6**	**516**

Source: Derived from POPH, 1989; Sun Komun Changwat Samut Prakan, 1990.

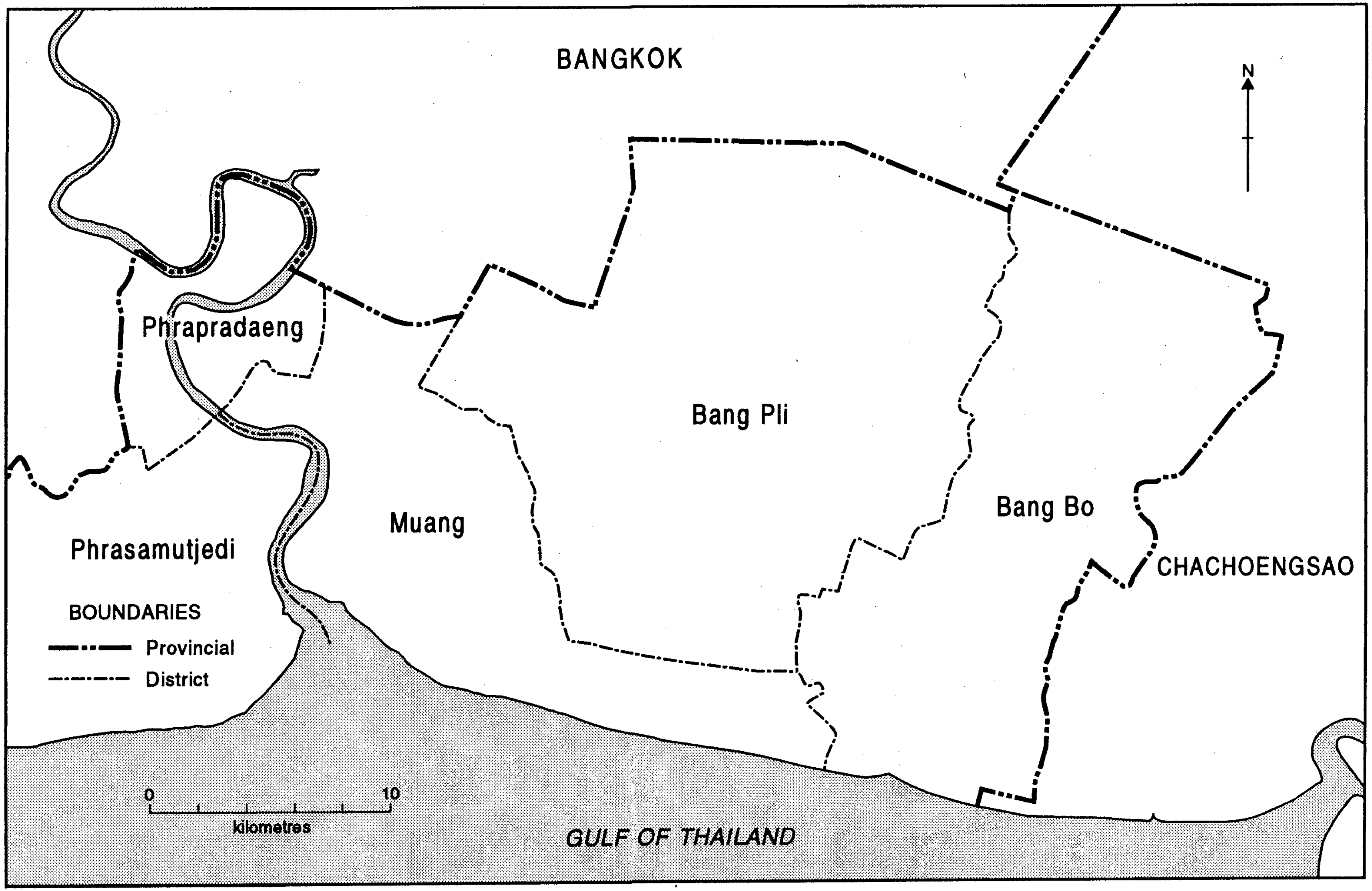


Figure 6.1 Political Administration Boundaries of Five Districts, Samut Prakan

In terms of population density, Amphoe Phrapradaeng had the largest number with more than 2,700 persons per square kilometre (Table 6.1). Amphoe Muang ranked second. Conversely, Amphoes Bang Pli and Bang Bo had very low population densities because they covered 60 per cent of the province's land area with a combined population of 233,000. Both had less than 400 people per square kilometre.

Basically, the high concentration of population in Amphoes Muang and Phrapradaeng corresponded with the urbanised area. Urban activities, however, have spilled over from those Amphoes into the Bang Pli district. As shown in Table 6.2, residential, commercial and industrial activities in Samut Prakan increased from 81 square kilometres in 1984 to 177 square kilometres in 1989 — an increase of 117 per cent. Conversely, agricultural land and open space declined from 855 square kilometres in 1984 to 746 square kilometres in 1989 — a decrease of 12.7 per cent. During this period, water bodies were increased by 15 square kilometres because farmers in many districts transformed paddy fields into fish ponds. Unquestionably, the city was invading agricultural land and open space, especially along major roads to the east of Samut Prakan.

Table 6.2 Major Land Use Types in Samut Prakan, between 1984 and 1989

Types of land use	1984 km²	1984 %	1989 km²	1989 %	Rate of changes km²	Rate of changes %
Residence	57.3	5.7	132.8	13.2	75.5	131.8
Commerce	2.9	0.3	5.5	0.6	2.6	89.7
Industry	21.2	2.1	38.5	3.8	17.3	81.6
Institution	7.0	0.7	6.2	0.6	-0.8	-11.4
Infrastructure	7.6	0.8	6.6	0.7	-1.0	-13.2
Agriculture and open space	854.8	85.1	746.4	74.3	-108.4	-12.7
Water bodies	53.2	5.3	68.0	6.8	14.8	27.8
Total	**1004.0**	**100.0**	**1004.0**	**100.0**		

Source: DTCP, 1991.

As shown in Tables 6.1 and 6.3, the lower population densities of Amphoes Bang Pli and Bang Bo reflected the vast area of land devoted to agriculture, particularly paddy and fish farming. Agriculture exceeded more than 50 per cent of their combined land area compared with less than 35 per cent in Amphoes Muang and Phrapradaeng. These differences stemmed from the latter's larger number of houses, factories, offices, markets and shopping centres crowded along the banks of Chao Phraya river and their incorporation into Bangkok. As shown in Table 6.4, only Amphoes Bang Pli and Bang Bo still had paddy fields. Their farmers practiced both paddy and fish farming whereas those in other Amphoes confined their attention to the latter.

During 1989-90, Amphoes Muang and Phrapradaeng gained more than half of Samut Prakan's total factories, industrial investment and labourers. However, Amphoe Bang Pli ranked third (Table 6.5). The increasing importance of Amphoe Bang Pli as the Province's new industrial area was evident in the appropriation of open space along Teparak and Bangna-Trat Roads. It housed both individual factories, and public and private industrial estates. Although Amphoe Bang Bo ranked last in industrial activities, a new industrial area was being developed. In 1992, the Provincial Office of Samut Prakan estimated that the number of unregistered, labourers from other provinces in all Amphoes, excluding local labourers, was more than 300,000 (DPP, 1992: 11). Not surprisingly, agricultural activities had declined in both Amphoes Bang Pli and Bang Bo as residential and industrial waste water threatened the livelihood of local people, especially fish farmers.

During the late 1980s and early 1990s, large sums of money poured into Amphoes Bang Pli and Bang Bo. Apart from investment in industry, it was directed into housing, sports clubs, theme parks and resort complexes (Figure 6.2). By 1991, there were seven golf courses in the study area, an entertainment theme park, a resort complex, a huge public housing development for low-income people, and a number of luxury private housings and modern apartment blocks for middle and high income earners. Also a new international airport in Amphoe Bang Pli will commence construction in 1996.

Table 6.3 Types of Land Use in Five Districts of Samut Prakan, 1990

Districts	Land uses: Agriculture km^2	per cent	Non-agriculture km^2	per cent	Total land use km^2	per cent
Muang	65.5	34.4	125.1	65.6	190.6	100.0
Phrapradaeng	18.8	25.6	54.6	74.4	73.4	100.0
Bang Pli	211.2	56.4	163.6	43.6	374.8	100.0
Bang Bo	128.0	52.2	117.0	47.8	245.0	100.0
Phrasamutjedi	80.3	66.7	40.1	33.3	120.4	100.0
Samut Prakan	**508.7**	**50.7**	**495.4**	**49.3**	**1004.1**	**100.0**

Source: Sun Komun Changwat Samut Prakan, 1990.

Table 6.4 Paddy and Fish Farming in Five Amphoes, Samut Prakan, 1990

Districts	Paddy field km^2	%	Fish farm km^2	%	Total agricultural land use km^2	%
Muang	-	-	56.7	19.3	65.5	12.9
Phrapradaeng	-	-	-	-	18.8	3.7
Bang Pli	82.7	45.5	102.0	34.9	211.2	41.5
Bang Bo	99.0	54.5	62.0	21.1	128.0	25.2
Phrasamutjedi	-	-	72.5	24.7	80.3	15.8
Samut Prakan	**181.7**	**100.0**	**293.2**	**100.0**	**508.7**	**100.0**

Note: During the year, farmers can interchange some parts of their land into paddy or fish farming depending upon the fluctuation of commodity price. Amphoe Bang Bo, for example, had a high rate of interchangeable farm practice. In addition, this table does not classify other agricultural practices such as cattle and poultry farms. The total agricultural land use, then, is not the summation of paddy and fish farms.

Source: Derived from Sun Komun Changwat Samut Prakan, 1990.

Table 6.5 Industrial Activities in Five Amphoes, Samut Prakan, 1989-90

Amphoe	Factory no.	Factory %	Investment (million baht)	Investment %	Labourer no.	Labourer %
Muang*	1,177	40.9	55,881.719	43.1	154,682	48.4
Phrapradaeng	947	32.9	32,544.292	25.1	84,531	26.4
Bang Pli*	474	16.4	27,498.637	21.2	56,802	17.8
Bang Bo	75	2.6	558.340	0.5	3,129	1.0
Phrasamutjedi	206	7.2	13,113.815	10.1	20,45	16.4
Total	**2,879**	**100.0**	**129,596.803**	**100.0**	**319,595**	**100.0**

Note: *Amphoes Phrapradaeng, Bang Bo and Phrasamutjedi represented the data in 1989. Amphoes Muang and Bang Pli also showed the data in 1989 including data of industrial activities in the Industrial Estates Authority of Thailand in 1990.

Source: POI, 1991a and IEAT, 1990.

These new built environments were exclusively designed for day trippers from Bangkok and foreign tourists. These developments had triggered a rise in land values as shown in Figure 6.3. The most expensive land was to the east and the west of Amphoe Bang Pli along Bangna-Trat Road. In 1991, their values were 25 million baht and 20 million baht per rai respectively. The lowest price of one million baht or less per rai, was in the northeast and the south of Amphoe Bang Pli, and the north and the south of Amphoe Bang Bo.[1] These areas were still under paddy and fish farming. Many farms, however, have been bought by developers and multinational enterprises for future development or speculation.

The data used to describe the onset of industrialisation, however, were inadequate for gauging the effect of the deterioration of water quality on local communities. This led to a field survey of households in Amphoes Bang Pli and Bang Bo.

[1] One rai is equivalent to 0.16 hectare or 0.4 acre.

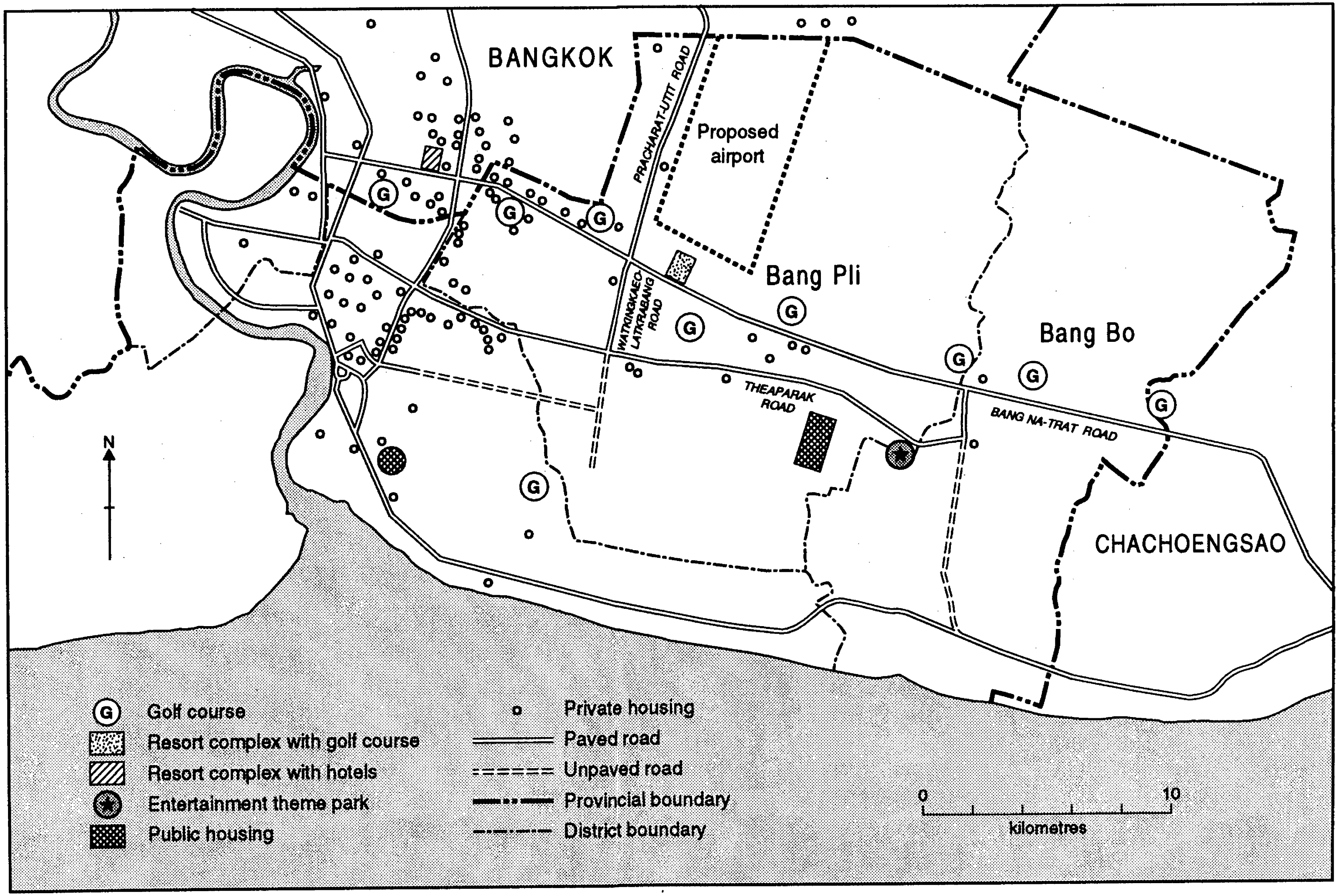


Figure 6.2 Land Development in Eastern Samut Prakan, 1991

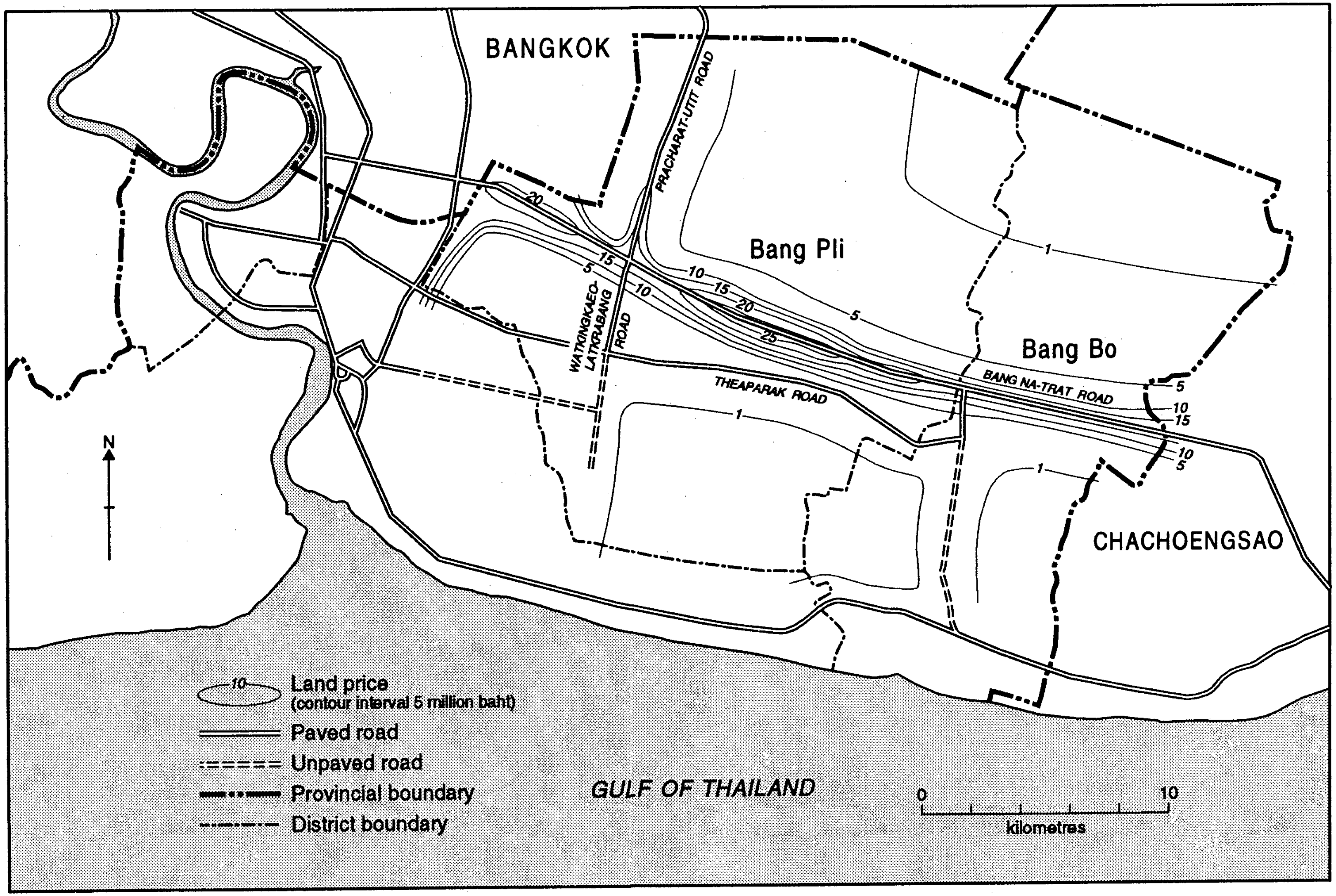


Figure 6.3 Derived Land Price in Amphoes Bang Pli and Bang Bo from Informal Interviews with Local Anonymous Informants during May-August, 1991

2. SURVEY

In studying the micro geography of Amphoes Bang Pli and Bang Bo, Samut Prakan, a local survey was undertaken. Similar to the sampling and analysis of water quality in the preceding chapter, social scientists have suggested there are six stages in deriving primary data from local respondents (Taylor and Bogdan, 1984; Walker, 1985; Marshall and Rossman, 1989):

Research rationale

Research setting and approach

Time of study

Site and sample selection

Collection technique

Data analysis

Assuming the deterioration of the environment has directly affected communities in Amphoes Bang Pli and Bang Bo, the objective of primary data collection and analysis was to assess the impact of industrialisation on local people. Attention in this study was paid to the head of household or individual living on the canal banks to gauge the changes triggered by industrialisation. Key questions centred on the family's way of life and the household economy rather than gender, age and literacy. To assess the complex processes involved in the interrelationship between industry, polluted surface water and communities, two alternatives are available — quantitative and qualitative approaches. A qualitative approach based on in-depth interviews was considered more appropriate. Informal conversations were the best way of encouraging informants to relate, in their own terms, experiences and attitudes relevant to the research problem (Taylor and Bogdan, 1984: 6; Walker, 1985: 4; Marshall and Rossman, 1989: 45-46).

During fieldwork, the note-book proved to be the best tool for recording information. Although a tape recorder captures all words spoken, it is unsuitable for face-to-face contact in Thailand especially in rapidly changing areas because it undermines the trust required for in-depth interviews. As suggested by Jones (1985: 57-58), the notes were made immediately after each interview. Photographs of the house and the surrounding area (i.e. farms and the canals) were important supplementary tools.

Analysis of qualitative information was an ongoing process (Taylor and Bogdan, 1984: 128). Basically, data collection and analysis went hand-in-hand because intensive analysis began as soon as possible after completing data collection. All data had to be evaluated. The 'tidy data', then, were coded to refine interpretations. The findings from qualitative research do not provide hard statistical evidence but they do provide plausible support for conclusions and interpretations of secondary data derived from government offices and other sources.

As mentioned in Chapter V, much of the six-month period of fieldwork was devoted to water sampling and analysis and to secondary data collection from reports and other documents in various government departments. Thus, the community interviews were restricted to the period between mid-May and early July, 1991. As the prime intention was to relate households to changes in water quality, the sampling frame was similar to that used in water collection. Only houses on the canal bank were chosen. Two households were selected for interviewing from each of the thirty water sample sites. Only forty-two informants of the sixty targeted, however, were willing to participate in the in-depth interview (Figure 6.4). As shown in the copy of the questionnaire in Appendix 2, key questions focused on five areas:

(a) household background (number in family, ages, sex, occupation, length of residence and migratory patterns);

(b) water consumption (sources — well, canal or rain water, problems, mitigation);

(c) fishing (frequency, volume, problems);

(d) health (sickness in family, type and frequency of illness); and

(e) income.

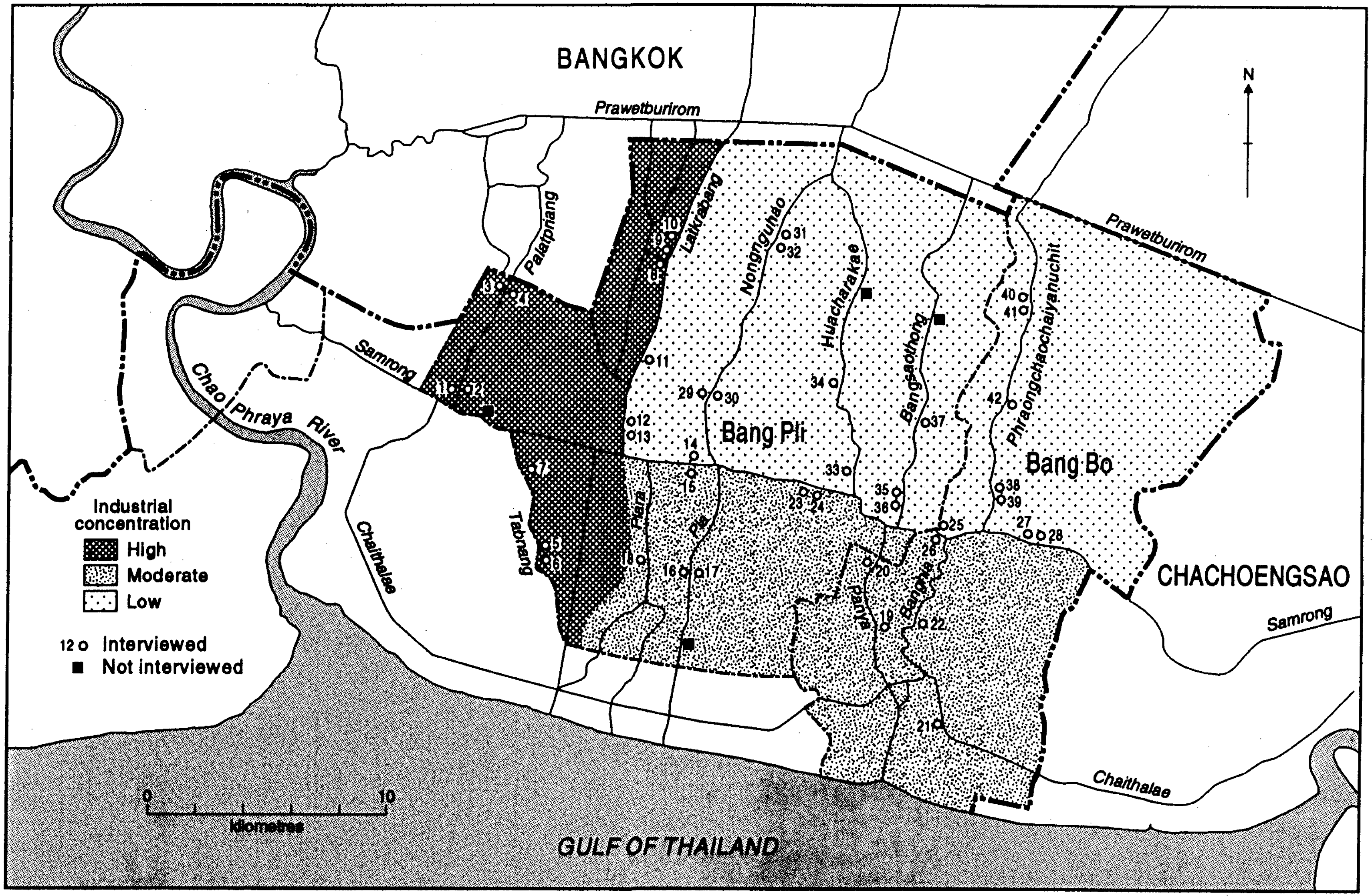


Figure 6.4 Sites of Local Informants in Three Industrial Concentrations in Amphoes Bang Pli and Bang Bo, Samut Prakan

3. RESULTS

A discussion of the survey results for each of the forty-two households is unwieldy. As water quality reflected the degree of industrialisation, the households were subdivided into three groups for analysis (Figure 6.4):

1. *High industrial concentration* — along Palatpriang, Latkrabang, Tabnang, and the west of Samrong Canals (a westward side of water gate at Bang Pli Sanitary Area). This zone had at least 120 individual factories. It was connected to industrial areas of Amphoe Muang and Bangpu' Industrial Estate.[2] Ten households were interviewed.

2. *Moderate industrial concentration* — along Plara, Pla, Panya, Banghia, and Samrong Canals (an eastward side of water gate at Bang Pli Sanitary Area). There were at least 150 factories in this zone including factories in Bang Pli Industrial Estate. Eleven households were interviewed.

3. *Low industrial concentration* — along Nongnguhao, Huacharake, Bangsaothong, and Phraongchaochaiyanuchit Canals. This zone had less than 90 factories. Twenty-one households were interviewed.

These zones were used for examining the results of the data on respondents, water consumption, fishing, health and income.

Respondents

Since the mid-1980s, rapid urbanisation and industrialisation have affected the livelihood of households. Many residents have considered how to survive in the changing physical and social environments. Before discussing the results of the survey the prime characteristics of households in three differing zones of industrial concentrations are discussed. Key factors are age of head of household, number of family members, house ownership and future plans.

High industrial concentration. Nine of the ten respondents in the area of high industrial concentration were over 40 years old — the other was 32 years old (Table 6.6). Family size ranged between 1 and 9 people with an average of 5.2. Six households

---

[2] Besides a number of factories located along major roads in Amphoe Muang, there were more than 240 factories in Bangpu' Industrial Estate.

Table 6.6 Specific Information of Respondents in Three Industrial Concentrations, Amphoes Bang Pli and Bang Bo, Samut Prakan, 1991

1. High industrial concentration

Case no.	Age of head of household	Family numbers	House ownership	Plan to move
1	77	4	rent	no
2	50	7	rent	yes
3	50	3	w/o rent	yes
4	46	5	rent	yes
5	50	8	rent	yes
6	64	7	w/o rent	yes
7	49	9	rent	no
8	45	1	own	no
9	45	5	own	no
10	32	3	rent	yes
n = 10	range = 32-77 mean = 51	range = 1-9 mean = 5.2	own = 2; rent = 6 w/o rent = 2	yes = 6 no = 4

2. Moderate industrial concentration

Case no.	Age of head of householder	Family numbers	House ownership	Plan to move
15	50	7	own	no
16	69	3	rent	yes
17	70	3	rent	no
18	42	5	w/o rent	no
19	44	5	rent	no
20	55	8	own	no
21	51	8	w/o rent	no
22	40	5	w/o rent	no
23	45	4	own	no
24	26	4	w/o rent	yes
26	50	6	rent	n.a.
n = 11	range = 26-70 mean = 49	range = 3-8 mean = 5.3	own = 3 rent = 4 w/o rent = 4	yes = 2 no = 8 n.a. = 1

Note: w/o - without, n.a. - not available

Table 6.6 Continued

3. Low industrial concentration

Case no.	Age of head of householder	Family numbers	House ownership	Plan to move
11	65	6	own	no
12	60	8	rent	yes
13	50	6	rent	yes
14	29	4	rent	no
25	59	4	rent	n.a.
27	78	5	rent	no
28	61	6	own	n.a.
29	50	6	rent	yes
30	50	4	own	no
31	37	6	own	yes
32	47	9	own	yes
33	54	7	rent	no
34	37	3	own	no
35	65	6	n.a.	n.a.
36	56	7	own	yes
37	54	4	own	no
38	55	7	own	no
39	60	3	own	no
40	28	3	rent	n.a.
41	49	6	rent	no
42	40	4	n.a.	n.a.
n = 21	range = 28-78 mean = 49	range = 3-9 mean = 5.4	own = 10 rent = 9 w/o rent = 0 n.a. = 2	yes = 6 no = 10 n.a. = 5

Note: w/o - without, n.a. - not available

exceeded this figure. More than half of the respondents in the area rented houses. Two paid no rent because they were minding the house for the landlord. Only two respondents owned their houses. When they were questioned about any future plans for moving out of the area, four informants had none. Six respondents planned to move to other places for various reasons — one informant had a new job, one's rent had expired, another had searched for an unpolluted fish farming area and some were forced to move because the landlords wanted to sell the land because it adjoined the residential and industrial areas of inner Samut Prakan and Bangkok. Most landlords wanted to sell their land to capitalise on the prevailing high price. More importantly, pollution problems had forced local residents to search for a better place to live. As one fish farmer at Latkrabang canal described (Appendix 4.1 and 4.3):

> This year, Khlong Latkrabang is so dry. It is also very dirty. I have left fish ponds idle without water for three months. I am also renting this land for farming. Perhaps I may go to some other place for accessible fresh water (Ref. no. 10).

Moderate industrial concentration. All respondents were over 40 years old with one exception (Table 6.6). Family size ranged between 3 and 8 people with an average of 5.3. Seven households exceeded this average. Four respondents rented houses. Another four stayed rent-free because they were house minding or staying with in-laws. Only three respondents owned their houses. As this area experienced less pressure from land developers than the first area, most respondents had no plans to move. Of the others, one wanted to move to look after grandchildren and the other was forced to move because of an impending land sale.

Low industrial concentration. Seventeen respondents in the area were over 40 years old — the remainder were between 20 and 39 years old (Table 6.6). Family members ranged between 3 and 9 people with an average of 5.4. Eight respondents rented dwellings, two lived rent-free with in-laws. Eleven owned their houses. Of the twenty-one respondents, five planned to move for various reasons — expiry of lease, land sale by landlord, land sale by house owner, and compulsory purchase of land for new international airport (two cases). A further eleven respondents wanted to stay and five did not want to reveal their plans. Although this area had experienced the least impact from urbanisation and industrialisation, developers and multinational enterprises were buying large land lots from local landlords. Two informants living north of Khlong Huacharake and Khlong Phraongchaochaiyanuchit described the impact on land transferred from local landlords to outside developers (Appendix 4.3):

> This large area (at Khlong Huacharake) is devoted to paddy farming, but the Siam Motor Group has already bought the land from Bangna-Trat Road to here for 3-4 million bath per rai. Some of us are still working on the farms until the new landlord asks us to stop and move out. We do not know what this land will be used for (Ref. no. 34)... Most of people here (Khlong Phraongchaochaiyanuchit) are engaged in paddy and fish farming. Some are giving up their farms, especially the people on the opposite bank, because the landlords are selling their land for between 700,000 and 800,000 baht per rai to rich Japanese developers for golf courses (Ref. no. 40).

Water consumption

Thai people including rural and urban residents usually use rain water for drinking and cooking if there is no tap water. Before the 1970s, local residents in Amphoes Bang Pli and Bang Bo used rain and canal water not only for drinking and cooking but for daily washing and bathing. When the Metropolitan Waterworks Authority (MWA) extended its service to these districts, some households used tap, rain and canal water, especially in areas of high and moderate industrial concentrations. Residents in some areas, however, have stopped consuming canal water for drinking and cooking because of contamination by domestic and industrial wastes. Thus, household water consumption has changed in all three industrial areas (Table 6.7).

High industrial concentration. Interviews in 1991 revealed all respondents in the high industrial zone consumed rain and tap water for drinking and cooking. Two respondents, however, used bottle and bore water and another used only bore water for drinking and cooking (Table 6.7). Three respondents used tap water for washing and bathing, another three used bore water, and the remainder used canal water. Only one used rain and tap water for all purposes. In this area, the canal water was simply too dirty to purify by boiling or filtering. Additionally, tap water was available from public and private services in Sanitary Areas, near factories or wealthy residences. All tap water was pumped from bore or ground water. Quality differed according to location and depth of the boring. Some private services offered better water quality but at a higher price than state enterprises. A few residents still bathed in the canal because they could not afford the fees.[3]

From the field survey, significant indicators of water pollution, especially dissolved oxygen (DO) and five-day biochemical oxygen demand (BOD_5), confirmed the informants' responses. As presented in Chapter V, values of DO and BOD_5 in areas of

3 In 1991, the water fee charged by the Provincial Waterworks Authority was around four baht per cubic metre, particularly in the Sanitary Area of Amphoe Bang Bo. The fee for private tap services was between 4 and 8 baht per cubic metre.

Table 6.7 Household's Water Consumption in Three Industrial Concentrations, Amphoes Bang Pli and Bang Bo, Samut Prakan, 1991

1. High industrial concentration

Case no.	Drink	Cook	Wash	Bath
1	rain & tap	rain & tap	rain & tap	rain & tap
2	tap	tap	tap	tap
3	tap	tap	tap	tap
4	tap	tap	tap	tap
5	rain	bore	bore	bore
6	rain	bore	bore	bore
7	rain & bottle	rain & bottle	canal	canal
8	bore	bore	bore	bore
9	rain	rain	canal	canal
10	rain & bore	rain & bore	canal	canal
n = 10	rain = 3 tap = 3 bore = 1 rain & tap = 1 rain & bottle = 1 rain & bore =1	rain = 1 tap = 3 bore = 3 rain & tap = 1 rain & bottle = 1 rain & bore =1	tap = 3 bore = 3 canal = 3 rain & tap = 1	tap = 3 bore = 3 canal = 3 rain & tap = 1

2. Moderate industrial concentration

Case no.	Drink	Cook	Wash	Bath
15	rain	bore	bore	bore
16	rain	tap & canal	tap & canal	tap & canal
17	rain & bore	rain & bore	tap & canal	tap & canal
18	rain	rain	canal	canal
19	rain & bottle	rain & bottle	canal	canal
20	rain	rain	bore	bore
21	rain & bottle	rain & bottle	bore & canal	bore & canal
22	rain	rain	bore	bore
23	rain & bottle	rain & bottle	tap	tap
24	rain & bottle	rain & bottle	tap	tap
26	rain	rain	tap	tap
n = 11	rain = 6 rain & bore = 1 rain & bottle = 4	rain = 4 bore = 1 rain & bore = 1 rain & bottle = 4 tap & canal = 1	bore = 3 tap = 3 canal = 2 tap & canal = 2 bore & canal = 1	bore = 3 tap = 3 canal = 2 tap & canal = 2 bore & canal = 1

Note: w/o - without, n.a. - not available

Table 6.7 Continued

3. Low industrial concentration

Case no.	Drink	Cook	Wash	Bath
11	rain & tap	rain & tap	tap	tap
12	rain & tap	rain & tap	tap	tap
13	rain	rain	tap	tap
14	rain	tap	canal	canal
25	rain	rain	tap	tap
27	rain	canal	canal	canal
28	rain	rain & canal	canal	canal
29	bore	bore	bore	bore
30	rain	rain	canal	canal
31	rain	rain	canal	canal
32	rain & bottle	rain & bottle	canal	canal
33	rain	rain	bore	bore
34	rain	rain	canal	canal
35	rain	bore	bore	bore
36	rain	rain	bore	bore
37	rain	canal	canal	canal
38	bore	bore	bore	bore
39	bore	bore	bore	bore
40	rain	rain	canal	canal
41	rain	rain	canal	canal
42	rain	rain	canal	canal
n = 21	rain = 15 bore = 3 rain & tap =2 rain & bottle = 1	rain = 10 bore = 4 tap = 1 canal = 2 rain & tap = 2 rain & bottle = 1 rain & canal = 1	bore = 6 tap = 4 canal = 11	bore = 6 tap = 4 canal = 11

Note: w/o - without, n.a. - not available

high industrial concentration were worse than those of other canals in Amphoes Bang Pli and Bang Bo. During dry and wet seasons, Tabnang canal had the lowest DO ranging 0.5-1.1 mg/l whereas its BOD_5 was between 10.0-14.0 mg/l. Khlong Latkrabang had better values of DO and BOD_5 than other canals in this zone ranging 0.8-4.4 mg/l and 3.0-10.0 mg/l respectively. If these values were re-calculated for this zone, average values of DO and BOD_5 were 1.6 mg/l and 12.7 mg/l respectively. The canal quality was then categorised in the fifth class of surface water standard. Unquestionably, the canal water was unsuitable for household consumption because oxygen was almost absent and organic waste was very high.

Moderate industrial concentration. All respondents mainly used rain water for drinking and cooking, and tap, bore and canal water for washing and bathing (Table 6.7). Sometimes the water gates compounded the pollution problem. Their unsystematic control not only allowed polluted water to flow into the canal network but also permitted sea water to degrade water quality. During the dry season, four informants in this area had to buy bottles of fresh water for drinking from nearby shops and washing water from a truck which normally ran throughout the district because tap water services were unavailable and the volume of bore water was insufficient.[4] Five respondents who had an access to bore or tap water still faced another problem. Many bores close to the seashore were usually brackish, contaminated by red dirt, or odoriferous, despite being operated by the Metropolitan Waterworks Authority.

As confirmed by re-calculating values of dissolved oxygen (DO) and biochemical oxygen demand in five days (BOD_5) from Chapter V, average DO and BOD_5 in the zone of moderate industrial concentration was 3.1 mg/l and 14.3 mg/l respectively. The DO and BOD_5 were categorised in third and fifth classes of surface water standard. Although DO indicated medium clean fresh water, the BOD_5 in this zone, however, was very poor. At best, residents could use canal water for washing after filtration.

Low industrial concentration. Most local respondents consumed rain water for drinking with three instances also drinking tap and bottle water (Table 6.7). Only three informants drank bore water. Ten respondents used rain water for cooking whereas another four combined rain together with tap, bottle and canal water. Of the remainder, four had bore water, two canal water and one tap. No specific source was specified for washing and bathing. Sometimes they would switch to rain water or water from trucks if they noticed the canal becoming greenish, brackish or when sea water occasionally intruded. Apparently, the MWA could not provide tap water to this area. Some

---

[4] East of Samrong Canal in Amphoe Bang Bo, fresh water from the truck cost between 8 and 10 baht per gallon. Many informants could not identify the operator and source of the water. Some residents in Amphoe Bang Bo, however, noticed a truck driver filling water from the bore at the Bang Pli National Housing Office.

residents, however, owned ground water sources and provided tap services to nearby houses.

As noted in Chapter V, average values of dissolved oxygen (DO) and five-day biochemical oxygen demand (BOD_5) in the low industrial concentration were re-calculated. They were 2.9 mg/l and 9.2 mg/l respectively. Although these values were categorised as similar to those in areas of moderate industrial concentration, the average BOD_5 was lower than in other zones. In addition, all canals were frequently diluted by fresh water from upstream. Most local residents in this area, however, used canal water in washing and bathing.

Fishing

Formerly, most local people caught fish from natural water bodies as a major source of protein for household consumption. Where rapid urbanisation and industrialisation occurred in Amphoes Bang Pli and Bang Bo, most residents progressively stopped taking fish from the canals.

High industrial concentration. Since the mid-1980s all respondents in the high industrial zone had not practiced fishing from the canals (Table 6.8). Thai carp (*Barbus gonionotus*), cat fish (*Clarias macrocephalus*), striped snakehead fish (*Channa striata*) and spotted knife fish (*Notopterus chitala*) were normally found in all canals. Their number, however, had declined. Other smaller fish, such as blue gourami (*Trichogaster trichopterus*) and red-tail rasbora (*Rasbora borapetensis*) have now disappeared from the high industrial zone. Eight of the ten respondents surveyed noticed a marked decline in fish numbers. Five reported increased malformation of fish — red dots on the fish's skin, a rotting tail and an absence of fins.

Moderate industrial concentration. Six of the eleven respondents had stopped fishing but the remainder still caught fish to eat (Table 6.8). Two respondents caught

Table 6.8 Fishing Activity in Three Industrial Concentrations, Amphoes Bang Pli and Bang Bo, Samut Prakan, 1991

1. High industrial concentration

Case no.	Frequency	Weight (kg/annum)	Problems
1	no fishing	-	dn
2	no fishing	-	dn, mf
3	no fishing	-	dn
4	no fishing	-	dn, mf
5	no fishing	-	dn, mf
6	no fishing	-	dn, mf
7	no fishing	-	dn, mf
8	no fishing	-	n.a.
9	no fishing	-	dn
10	n.a.	n.a.	n.a.
n = 10	no fishing = 9 n.a. = 1	n.a. = 1	dn = 3 dn, mf = 5 n.a. = 2

2. Moderate industrial concentration

Case no.	Frequency	Weight (kg/annum)	Problems
15	no fishing	-	dn, mf
16	no fishing	-	mf
17	n.a.	n.a.	dn
18	no fishing	-	mf
19	o/r	150-200	dn
20	m/y	800-1,000	mf
21	m/y	800-1,000	n.a.
22	o/y	400-500	dn, mf
23	no fishing	-	dn
24	no fishing	-	dn
26	no fishing	-	dn
n = 11	no fishing = 6 o/r = 1 o/y = 1 m/y = 2 n.a. = 1	150-200 = 1 400-500 = 1 800-1,000 = 2 n.a. =	dn = 3 dn, mf = 5 n.a. = 2

Note: n.a. - not available; o/r - once a week in rainy season; m/r - more than once a week in rainy season; o/y - once a week throughout the year; m/y - more than once a week throughout the year; dn - decreasing number; mf - malformed fish; sf - stinky fish.

Table 6.8 Continued

3. Low industrial concentration

Case no.	Frequency	Weight (kg/annum)	Problems
11	no fishing	-	dn
12	n.a.	n.a.	dn, mf
13	m/y	800-1,000	dn, mf
14	n.a.	n.a.	dn
25	n.a.	n.a.	dn
27	o/y	400-500	dn
28	o/y	400-500	dn
29	no fishing	-	n.a.
30	o/y	400-500	dn, sf
31	n.a.	n.a.	n.a.
32	no fishing	-	dn, mf
33	m/r	300-400	dn
34	no fishing	-	dn, mf
35	n.a.	n.a.	dn
36	n.a.	n.a.	dn
37	n.a.	n.a.	mf
38	n.a.	n.a.	dn
39	n.a.	n.a.	dn
40	n.a.	n.a.	mf
41	no fishing	-	mf
42	no fishing	-	dn, mf
n = 21	no fishing = 6 o/y = 3 m/r = 1 m/y = 1 n.a. = 10	300-400 = 1 400-500 = 3 800-1,000 = 1 n.a. = 10	dn = 10 mf = 3 dn, mf = 5 dn, sf = 1 n.a. = 2

Note: n.a. - not available; o/r - once a week in rainy season; m/r - more than once a week in rainy season; o/y - once a week throughout the year; m/y - more than once a week throughout the year; dn - decreasing number; mf - malformed fish; sf - stinky fish.

fish more than once a week throughout the year with total weight of 800-1,000 kilogrammes. A third caught 400-500 kilogrammes of fish once a week throughout the year. A fourth caught 150-200 kilogrammes weekly during the rainy season. Almost all residents in this zone observed a decline in fish numbers and increased malformations. Seven informants observed a decline in big fish numbers. Smaller fish had virtually disappeared. Five respondents had identified malformed fish. Their presence was highest during the dry season when the intrusion of sea water compounded the problem. A further possible course of malformation was the increased number of new dwellings.

Low industrial concentration. Six of the twenty-one respondents in the zone of low industrial concentration had not caught fish and a further ten declined to comment. There were five residents, however, who still caught fish. One landed between 800 and 1,000 kilogrammes weekly, three cases between 400 and 500 kilogrammes, and another between 300 and 400 kilogrammes. Although all sizes of fish were present, their number had declined (Table 6.8). Most reported that variety of fish had decreased and some found malformed fish.

Many informants, however, had stopped consuming fish once they found abnormal specimens. These people were not only residents living along the canals in the high and moderate industrial zones but people from areas remote from Amphoe Bang Bo. As two informants living respectively at Khlongs Nongnguhao and Phraongchaochaiyanuchit explained (Appendix 4.2 and 4.3):

> I used to eat fish from the canal (Nongnguhao), but I had to stop. The fish stunk of oil. I think the nearby factories [there were three industries: vehicle's spare parts, sports wares, and cold storage] could have caused the problem because they usually flushed waste water into the canal (Ref. no. 30) ... During the past few years, I found malformed fish which stopped me consuming them. They had damaged skin as I could see its red tissue. This situation in our canal (Phraongchaochaiyanuchit) was worse during the dry season (Ref. no. 41).

Health

As noted in Chapter III, diarrhoea and dysentery were mainly found in the industrial areas of Amphoes Muang and Phrapradaeng, Samut Prakan. Between 1986 and 1990, 97 per cent of the patients in public hospitals were migrant labourers. Clearly, local people residing in inner Samut Prakan knew how to avoid health risk from contaminated water. The field survey in 1991 revealed all respondents in Amphoes Bang Pli and Bang Bo had avoided diarrhoea and dysentery because they had rain, bottle and tap water for drinking and cooking (Table 6.7 and 6.9). Skin disease, however, was prevalent in all zones.

Table 6.9 Specific Types of Sickness Related to Household's Water Consumption and Medical Treatment Occurred in Three Industrial Concentrations, Amphoes Bang Pli and Bang Bo, Samut Prakan, 1991

1. High industrial concentration

Case no.	Skin disease	Treatment	Diarrhoea	Treatment	Dysentery	Treatment
1	no	-	no	-	no	-
2	no	-	no	-	no	-
3	no	-	no	-	no	-
4	no	-	no	-	no	-
5	no	-	no	-	no	-
6	no	-	no	-	no	-
7	yes	no	no	-	no	-
8	no	-	no	-	no	-
9	yes	no	no	-	no	-
10	yes	no	no	-	no	-
n = 10	yes = 3 no = 7	no = 3	yes = 0 no = 10	-	yes = 0 no = 10	-

2. Moderate industrial concentration

Case no.	Skin disease	Treatment	Diarrhoea	Treatment	Dysentery	Treatment
15	no	-	no	-	no	-
16	yes	no	no	-	no	-
17	yes	cure himself	no	-	no	-
18	yes	no	no	-	no	-
19	yes	no	no	-	no	-
20	no	-	no	-	no	-
21	yes	no	no	-	no	-
22	no	-	no	-	no	-
23	no	-	no	-	no	-
24	no	-	no	-	no	-
26	no	-	no	-	no	-
n = 11	yes = 5 no = 6	cure himself = 1 no = 4	yes = 0 no = 11	-	yes = 0 no = 11	-

Table 6.9 Continued

3. Low industrial concentration

Case no.	Skin disease	Treatment	Diarrhoea	Treatment	Dysentery	Treatment
11	no	-	no	-	no	-
12	no	-	no	-	no	-
13	no	-	no	-	no	-
14	yes	no	no	-	no	-
25	no	-	no	-	no	-
27	yes	no	no	-	no	-
28	yes	no	no	-	no	-
29	no	-	no	-	no	-
30	yes	no	no	-	no	-
31	yes	no	no	-	no	-
32	no	-	no	-	no	-
33	no	-	no	-	no	-
34	no	-	no	-	no	-
35	no	-	no	-	no	-
36	no	-	no	-	no	-
37	no	-	no	-	no	-
38	no	-	no	-	no	-
39	no	-	no	-	no	-
40	no	-	no	-	no	-
41	no	-	no	-	no	-
42	no	-	no	-	no	-
n = 21	yes = 5 no = 16	no = 5	yes = 0 no = 21	-	yes = 0 no = 21	-

High industrial concentration. Only three respondents reported skin disease from bathing in the canal. All reported itchiness and skin rashes (Table 6.7 and 6.9). They did not resort to medical treatment. The rest avoided skin infection by using clean water from tap or bore for washing and bathing. Other water-borne diseases were not reported in this area.

Moderate industrial concentration. Five of the eleven respondents had skin rashes from bathing in the canal (Table 6.9). One resolved to medicated talc from a pharmacy, three others switched to tap and bore water when they felt itchy, and the remainder had no treatment. Other respondents did not have skin diseases because they had tap and bore water for bathing. No other water-borne diseases were reported.

Low industrial concentration. Eleven respondents bathed in the canal (Table 6.7). Six had no skin problem (Table 6.9). The other five had skin rashes but they did not seek treatment. Although two respondents used canal water for cooking, they were not sick. Respondents did not report any water-borne diseases.

Income

Previously, all respondents in Amphoes Bang Pli and Bang Bo had only one job. Most worked as a fish or paddy farmer while others worked as a day labourer, a boat or bus driver, an industrial labourer, a government official, and an employee in a private firm. Since the mid-1980s, some respondents had two jobs. Others had changed occupation because they had to offset the rising cost of living. Apparently, some farmers, who owned small parcels of land, changed their interests to other activities such as room or house renting and small shop owning, especially when they lived near factories.[5] The 1991 survey revealed there were many jerry-built houses and flats along small lanes connected to Teparak, Bangna-Trat, Watkingkaeo-Latkrabang and Pracharat-Utit Roads. In addition, land owning respondents became millionaires by taking advantage of rising prices.

High industrial concentration. In 1991, there was only one respondent who had two jobs. He earned around 600,000 baht a year (Table 6.10). Of those with a single job, three had changed occupations. Two were in debt and became a small shop owner and a fish farmer. The other retired from a government official and became a millionaire by selling land. Five respondents did not change occupations — three remained as fish farmers, one as an industrial worker and another a day labourer. The three fish farmers earned between 67,500 and 270,000 baht per annum depending on farm size. Unfortunately, they lost income from the contamination of the Tabnang and Latkrabang

[5] Room or house renting has provided a very good income to the renter. The room fee varied depending upon its location and the room condition. In Amphoe Bang Bo, the fee for a single room without toilet was between 500 and 600 baht per month, whereas a similar room near the Bang Pli Industrial Estate cost between 700 and 800 baht a month. A single room with toilet in the public housing beside the Estate cost 1,200 baht per month.

Table 6.10 Household's Occupation and Estimated Annual Income in Three Industrial Concentrations, Amphoes Bang Pli and Bang Bo, Samut Prakan, 1991

1. High industrial concentration

Cas eno.	Former occupation	Present occupation	Reason of occupation change	Estimated annual income (baht)
1	paddy farmer	shop owner	in debt	180,000
2	rice miller	fish farmer	in debt	300,000
3	n.a.	plant nursery & employee in private firm	n.a.	600,000
4	industrial labour	industrial labour	-	36,000
5	fish farmer	fish farmer	-	270,000*
6	fish farmer	fish farmer	-	230,000*
7	day labourer	day labourer	-	22,000
8	unemployed	unemployed	-	n.a.
9	government official	land leasing	retired	>1,000,000
10	fish farmer	fish farmer	-	67,500*

2. Moderate industrial concentration

Cas eno.	Former occupation	Present occupation	Reason of occupation change	Estimated annual income (baht)
15	orchard farmer	orchard farmer & room renter	more income	240,000
16	paddy farmer	day labourer	low productivity	22,000
17	fish farmer	day labourer	too old	22,000
18	n.a.	fish farmer & government official	n.a.	540,000
19	n.a.	fish farmer & a day labourer	n.a.	82,000
20	unemployed	unemployed	-	n.a.
21	day labourer	day labourer	-	22,000
22	n.a.	fish farmer	n.a.	180,000
23	fish farmer	industrial labour (foreman)	water pollution	120,000
24	day labourer	day labourer	-	22,000
26	carpenter	carpenter	-	30,000

Note: n.a. - not available;
* In 1991, all fish farmers in the area could not earn any income from the farm because of contaminated canal water by industrial waste.

(Continued next page)

Table 6.10 Continued

3. Low industrial concentration

Case no.	Former occupation	Present occupation	Reason of occupation change	Estimated annual income (baht)
11	boat driver	shop owner & room renter	retired, more income	372,000
12	bus driver	bus driver	-	72,000
13	boat driver	boat driver	-	66,000
14	industrial labour	industrial labour (foreman)	-	180,000
25	employee in private firm	employee in private firm	-	96,000
27	n.a.	unemployed	retired	n.a.
28	paddy farmer	room renter	secure income	86,800
29	n.a.	merchant	n.a.	600,000
30	day labourer	day labourer	-	22,000
31	fish farmer	fish farmer	-	405,000
32	fish farmer	fish farmer & merchant	more income	630,000
33	boat driver	boat driver	-	66,000
34	industrial labour	industrial labour (foreman)	-	144,000
35	unemployed	unemployed	-	n.a.
36	paddy farmer	land dealer	more income	>1,000,000
37	n.a.	fish farmer & day labourer	n.a.	85,000
38	n.a.	shop owner	n.a.	540,000
39	paddy farmer	monk	expired farm contract	n.a.
40	n.a.	paddy farmer	n.a.	157,500
41	paddy farmer	paddy farmer	-	196,000
42	paddy farmer	shop owner	low productivity	240,000

Note: n.a. - not available

canals. The day labourer received 22,000 baht per annum and an unskilled industrial worker 36,000 baht a year. Only one respondent was unemployed.

Moderate industrial concentration. Three respondents in the zone had two jobs (Table 6.10). The first respondent combining as an orchard farming and a room renting to earn an annual income of 240,000 baht. The second one would not give a reason for having two jobs. Apparently, he worked as a fish farmer and a government official with an annual income of 540,000 baht. The third respondent took a position as a day labourer to offset the decline in his fish farm productivity — the combined income was 82,000 baht per annum. As he revealed (Appendix 4.3):

> Since fish canning and paint industries have established near this canal, my farm productivity has been reduced by one-third. Once I earned 100,000 baht for each load; now I can make only 60,000 baht. As I cannot afford to improve water intake, I will have to find another job (Ref. no. 19).

Among those with only one job, three respondents had changed occupations. One gave up fish farming because of water pollution. Later he became an industrial worker (foreman) with an annual income of 120,000 baht. Two had been paddy and fish farmers before taking up day labouring for 22,000 baht per year. Three respondents had never changed their occupations. Two were day labourers and the other a carpenter earning 22,000 and 30,000 baht per annum respectively. A fish farmer would not give his past occupation but earned 180,000 baht a year from his present job. One respondent had no job but was looked after by her sons and daughters.

Low industrial concentration. Three of the twenty-one respondents had two occupations. The first respondent had been a boat driver until he retired. Afterwards he became a shop owner and a room renter with an annual income of 372,000 baht. The second informant had been a fish farmer. Later he was working as both a fish farmer and merchant earning 630,000 baht per annum. A third respondent would not reveal his past occupation but he now worked as a fish farmer and day labourer with an annual income of 85,000 baht (Table 6.10).

Of those respondents with a single occupation, three had changed from being paddy farmers to activities offering more secure incomes — one was a room renter earning 86,000 baht per annum; the second case was a land dealer with more than a million per year; and the third was a shop owner with 240,000 baht per annum. In contrast, there were eleven respondents who had maintained their positions — a bus driver, a boat driver, an industrial foreman, a merchant, an employee in a private firm, a day labourer, a shop owner, a fish farmer and a paddy farmer with annual incomes ranging between 22,000 and 600,000 baht. Two cases were unemployed. One respondent had given up his career after losing his paddy farm because his landlord would not renew the contract. The landlord sold the land to a developer. As revealed in an interview with a housewife in the eastern Amphoe Bang Bo near Khlong Phraongchaochaiyanuchit (Appendix 4.1 and 4.3):

> Formerly, my husband and I worked in the paddy field. It was a big field — 65 rais (10.4 hectares). Later, our landlord wanted to sell his land to a private housing developer, *Bang Na Garden.* Then, my husband had to buy this small house and land here. He has now become a monk. I have no work. However, all my sons and daughters are working in the factories at Paknam (in Amphoe Phrapradaeng); my son-in-laws also are working there. They are looking after me and my nieces (Ref. no. 39).

4. LOCAL REACTION

When local residents in Amphoes Bang Pli and Bang Bo were faced with problems they formed informal groups to discuss causes and formulated a plan of attack. Farmers and non-farmers, however, differed in reaction to water pollution (Figure 6.4). Both formed separate informal groups to tackle the situation. Whereas the farmers attempted to resolve the pollution problem on their farms, non-farmers took their problem to the perpetrator. If the farmers were able to manage the problem, they would not pursue it further.[6] But if they could not manage it they would, like the non-farmers, report the matter to officials. A major problem, however, was the difficulty of identifying the appropriate officials.

Most complaints from Amphoes Bang Pli and Bang Bo went to the Provincial Office of Samut Prakan (POSP), the Provincial Administration Organisation (PAO), the Provincial Office of Public Health (POPH), or the Provincial Office of Industry (POI). Interviews with the POSP officials revealed there were between 300 and 400 complaints each year from Samut Prakan during the second half of the 1980s. Between October 1989 and September 1990, the POPH had 93 complaints about pollution problems from all over the province (Table 6.11). Air pollution had the highest number of complaints

---

[6] Whenever fish farmers found dead fish or experienced low productivity, they perceived the water intake was brackish, sour or dirty. They reacted by adjusting the pH balance or improving the water by adding calcium hydroxide or potassium permanganate into the pond. Also, calcium hydroxide and potassium permanganate can be used as disinfectant (Pakhon, 1987: 186-187). Sometimes it worked if the water had low pH value or was not too polluted. Farmers west of Amphoe Bang Pli, however, realised the polluted water could not be checked by these means. This prompted them to inform the officials about their difficulties.

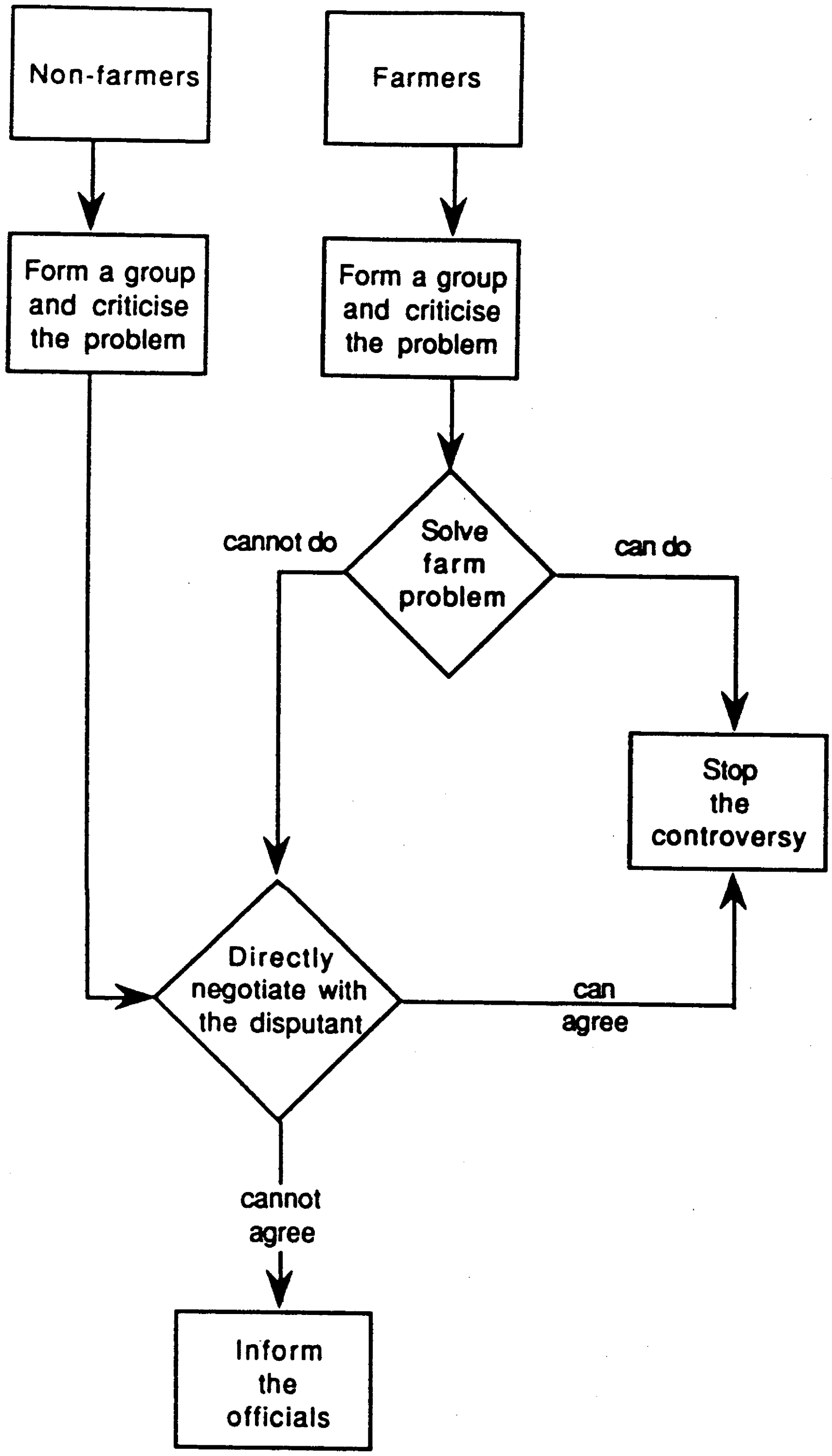


Figure 6.5 Flow Chart of the Local People's Reaction

Table 6.11 Number of Complaints Following Four Major Pollution Types in Five Districts of Samut Prakan during October, 1989 and September, 1990

District	Types of pollution Water		Air		Noise		Solid and hazardous wastes	
	no.	%	no.	%	no.	%	no.	%
Muang	9	52.9	20	38.5	9	50.0	2	33.3
Phrapradaeng	2	11.8	2	3.8	1	5.6	3	50.0
Bang Pli	6	35.3	7	13.5	0	44.4	1	16.7
Bang Bo and Phrasamutjedi	0	0.0	23	44.2	8	0.0	0	0.0
Samut Prakan	**17**	**100.0**	**52**	**100.0**	**18**	**100.0**	**6**	**100.0**

Note: In all columns, sources of pollution came from industrial and residential activities.

Source: pers. comm. POPH officials, 24 April 1991.

because smoke, odour and dust from the factories were widespread. Water pollution reported by people living along the canals ranked third.

In terms of water pollution, Amphoe Muang had the highest number of complaints. Amphoe Bang Pli had more than Amphoe Phrapradaeng because it was the target for most of the relocated water-polluting industries from Bangkok and Samut Prakan. For instance, interviews with industrial entrepreneurs showed Amphoe Bang Pli had attracted: one food processing firm from Thonburi, one chemical products firm from Amphoe Phrapradaeng, and two metal coating firms from Amphoe Muang and Thonburi.[7] Their relocation was triggered by the expiry land leases or by pressure from local residents about their pollution (Appendix 5). Amphoes Bang Bo and Phrasamutjedi had no complaints about water pollution. Apart from POPH, there were other accusations of pollution that could not be substantiated.

[7] Thonburi is a part of Bangkok Metropolitan Area which is situated on the west of Chao Phraya River.

Residents along Samrong Canal and other canals in the southern zone made frequent complaints to local government. This is because the major Samrong Canal received inflows from smaller waterways. The complaints brought temporary relief. As a resident at the mid-Samrong Canal revealed (Appendix 4.3):

> Some time ago, residents around here were faced with terrible problems from waste water. We then made a complaint to the Provincial Office resulting in entrepreneurs being pushed to construct waste deposit ponds. Now the situation is better (Ref. no. 26).

Many factories along Samrong Canal, however, continued flushing their waste water into it.

The field survey revealed that activities such as fruit canning and poultry industries illegally released their untreated waste water into the Canal. A black substance could be seen for four kilometres, from the back of the factory flowing westward to the water gate in Amphoe Bang Pli. These industries have been subjected to protests by local people. Although the industries have been warned by the Department of Industrial Works (DIW) on several occasions, they still have not improved their waste treatment methods.

Further information from confidential records of the Provincial Office of Industry (POI) in 1991, revealed a similar situation. Since 1989, five factories had been requested to improve their water treatment systems. A fruit and juice canning plant at Banghia Canal in Amphoe Bang Bo, for example, has been warned four times between 1989-1990 (Table 6.12). Local residents have protested about these factories flushing their waste into public canals. The POI requested the DIW in Bangkok to investigate the cause of these problems. This action resulted in temporary factory closure. Nevertheless, entrepreneurs negotiated with the officials and made small improvements to their treatment systems. This resulted in the factories bein re-opened and they still continue to generate water pollution. An informant living near the mid-Samrong Canal expressed his disappointment with officials (Appendix 4.3):

Table 6.12 Significant Firms Being Warned on Their Inefficient Water Treatment System, Amphoes Bang Pli and Bang Bo, Samut Prakan, 1989-1991

Name of firms	Activity	Location	Time of warning
Gaisod Srithai	Frozen chicken	Khlong Latkrabang, Bang Pli	7/6/90
Thai Agri-Food Co.	Fruit and juice canning	Khlong Samrong Bang Pli	13/3/89 21/11/89 20/7/90 3/8/90
General Foods Poultry Co.	Frozen chicken	Khlong Samrong Bang Pli	14/5/91
Hi-Q	Fish canning	Khlong Banghia Bang Bo	20/11/89
K-Thai Metal	Metal finishing	Khlong Latkrabang, Bang Pli	31/7/89

Source: pers. comm. POI officials, 19 September 1991.

> We had informed the Provincial Office of Samut Prakan several times about the industrial waste water and noise. However, the government did not help us (Ref. no. 23).

The above situation indicates the inability of officials to enforce entrepreneurs to abide by regulations. This may be due to the national policy of giving priority to economic development. Environmental quality has not been raised as a prime issue in Thailand since the Fourth National Economic and Social Development Plan (1977-1981). Officials responsible for industrial promotion and environmental improvement are constrained by existing policies. Local people in Amphoes Bang Pli and Bang Bo, therefore, have been prey to rapid industrialisation.

RESUME

Chapter VI has illustrated how the private sector has relocated activities from crowded inner Bangkok and Samut Prakan to open space or agricultural land in Amphoes Bang Pli and Bang Bo. With the tacit encouragement of provincial and central governments, industrialisation and its waste by-products have damaged peasant communities and hurt their livelihood. Their impact, however, has varied with the degree of industrial concentration. Although the characteristics of residents were similar across the whole area, their experiences reflected the extent of industrial concentration.

In the zone of *high industrial concentration* most respondents planned to move because of pressures of urbanisation, industrialisation and pollution problems from inner Samut Prakan and Bangkok. Although public and private services provided available tap water throughout the area, few residents could afford the fee. Some had to use contaminated canal water. As a result, many residents used rain, tap and bore water for drinking and cooking, and tap, bore and canal water for washing and bathing. Since the canals were polluted by domestic and industrial wastes, all respondents had stopped fishing. They also noticed a marked declined in fish numbers and increased fish malformations. There was no report on water-borne diseases, except residents who bathed in the canal had skin rashes. However, contaminated canal water damaged fish farming. All fish farmers had lost income while other residents who worked in different careers had not experienced the adverse effects of water pollution. Some had even made huge profits from rapid urbanisation.

In the zone of *moderate industrial concentration* most respondents had no plans to move because the presences of urbanisation and industrialisation pressures were lower than in the high industrial zone. Since tap service was not available throughout the area, all respondents mainly used rain water for drinking and cooking, and tap, bore and canal water for washing and bathing. During the dry season, some had to buy water from shops and trucks. Although some canals were polluted, some residents still caught fish for household consumption. As in the high industrial zone, all residents noticed a decrease in fish numbers and an increase in the number of malformed fish. There was no report on water-borne diseases, except residents who bathed in the canal had skin problems. Polluted canal water lowered fish farm productivity which forced some fish farmers to seek second jobs. Others who had non-farm jobs supplemented their income by renting rooms.

In the zone of *low industrial concentration* more than half of respondents did not have a plan to move out of their communities. Most residents consumed rain water for drinking and cooking, and used tap, bore and canal water for washing and bathing. The canals were less contaminated by domestic and industrial wastes than other areas. Some residents still caught fish for consumption but some had given it up as an occupation. Most residents noticed a decline in fish numbers and malformed fish. There were no reports of water-borne diseases. Some residents experienced skin rashes when they bathed in the canal. Although half of the residents had never changed their occupations, some had taken advantage of rapid urbanisation and industrialisation by taking second jobs as shop owners, room renters and land dealers.

The boundaries between the zone of industrial concentration, however, are blurring. Fresh pressures from Bangkok and Samut Prakan are shifting parts of the zone of moderate industrial concentration into the higher category. Parts of the zone of low industrial concentration are being similarly transformed. This survey, therefore, is a snapshot of an ongoing process.

Clearly, the reactions of local people to water pollution varied. Farmers unable to combat the problem have joined non-farmers in confronting the polluters. When their confrontation failed they brought their complaints to provincial and central governments. Government officials — provincial and central — however, have been unable to resolve their problems. The national policy of promoting industry has confused officials responsible for maintaining the urban environment. Their inaction has allowed the private sector to transform both rural society and economy to meet the needs of industrial entrepreneurs and land developers. This raises the issues: how can public services in Samut Prakan be improved; and how can cooperation between the provincial and central governments and entrepreneurs be managed to resolve environmental problems and regain the quality of life for local people? The next chapter reveals some answers to these questions.

PART III

MANAGING GREATER BANGKOK'S ENVIRONMENTAL CRISIS

CHAPTER VII

MICRO-PLANNING FOR SAMUT PRAKAN

Since the mid-1980s inner Samut Prakan, covering Amphoes Muang and Phrapradaeng, has been transformed into an urban area. With more public facilities and investment incentives offered by government agencies, residential, industrial and commercial activities have expanded from this urban core into Amphoes Bang Pli and Bang Bo, especially along major roads linking the Eastern Seaboard in Chonburi Province. Large shopping complexes, golf courses, industrial estates and housing have been constructed by domestic and foreign investors. Without effective control and monitoring, these activities have generated waste that has degraded soil, air and the canal network in both inner city and new suburban localities. Of course these activities have realised significant income. Since 1989 the Provincial Government's annual revenue has exceeded 10 billion baht. These funds, however, have been absorbed by the Royal Thai Government (RTG). In return, the RTG has provided funds for the Provincial Government which represents less than one-tenth of its total revenue (POSP, 1991: 6).

Within Thailand's three tiers of administrative structure — central, provincial and local — provincial and local governments are directly responsible for maintaining the peace and developing public facilities. Apart from the Bangkok Metropolitan Area and Pattaya, provincial governments have a more dominant role than local governments in urban development.[1] In Samut Prakan, the Provincial Government's attempt at urban improvement runs counter to the RTG's objectives. This conflict has highlighted key issues. Why is there a gap between the Provincial Government's needs and the RTG's requirements; what has been the Provincial Government's perception of the changing environment; how have the provincial authority and the RTG managed the urban

[1] As noted in Chapter III, the Bangkok Metropolitan Area and Pattaya have no provincial government. They are administered as a special local government.

environmental crisis in Samut Prakan; and how has the Provincial Government coped with the conflicting demands between State, the private sector and local people.

Initially, the structure of Thailand's authoritarian system is described to demonstrate how each level of government operates. Then, an investigation is made of attempts by Samut Prakan's Provincial Government to mitigate manifest environmental problems and formulate policies (Section 1). Afterwards, interference by the RTG in local management issues is discussed to illustrate how it has sought to monopolise control over both the physical and social environment even though these are under the jurisdiction of the Provincial Government (Section 2). This leads to an examination of the state-business relationships and recommendations for a better living environment in Samut Prakan (Section 3).

1. PROVINCIAL GOVERNMENT' S ROLE

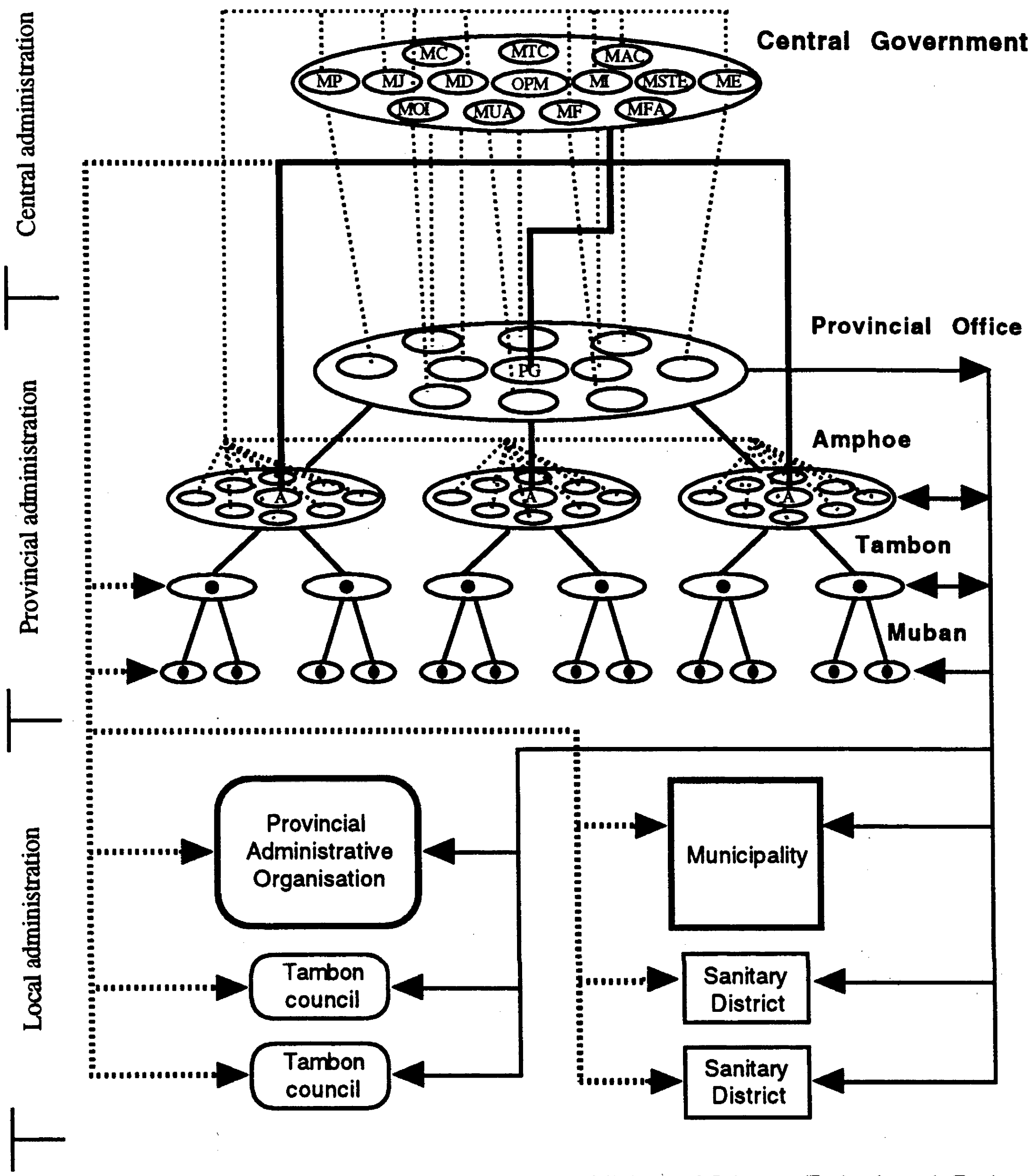
The provincial government is responsible for managing development at local government level. Municipalities govern urban areas and the Provincial Administrative Organisation (PAO) is responsible for rural areas. Apart from reviewing local government performance, the provincial government establishes the province's development policies and guidelines, and requests additional assistance and budget supplementation from the RTG. In return, the RTG monitors the provincial administration. Ideally, provincial governments would like to exercise the dominant control over managing physical and social resources within their domain. At present, they have to share power with the RTG and local governments. Before examining the role of the Provincial Government as a major actor in Samut Prakan's urban development, Thailand's authoritarian political structure has to be comprehended.

Thailand's Centralised Administration

Thailand has a highly centralised administrative system which, as noted, is divided into three levels, namely, central, provincial and local (Figure 7.1). Top-down authoritarian administration is the norm. At the apex is the RTG or central government which comprises the Cabinet and 14 functional ministries. Its major mission is to serve the people. This task involves stating national goals and objectives and incorporating them in the National Economic and Social Development Plan. In addition, it monitors the performance of both provincial and local governments to ensure that they adhere to national goals.

The Provincial Government's hierarchical organisation is divided into four layers: *Sumnakngan Changwat* (Provincial Office), *Amphoes* (Districts), *Tambons* (Sub-districts) and *Mubans* (Villages). Its operation is complicated because most Central Government ministries are represented in both the Provincial Office and the Districts. Both the Provincial Governor and District Officers, especially Head Officers or *Nai Amphoes,* are appointed by the Department of Local Administration in the Ministry of Interior. Heads of sectoral and sub-sectoral offices are appointed by different departments in other ministries. Normally, their term of office is for four years. At lower levels, the Heads of the Sub-districts (*Kamnans*) and Villages (*Phuyaibans*) are elected by local people. These elections, however, have to be approved by the Provincial Governor and the *Nai Amphoes* respectively. The position of *Kamnan* or *Phuyaiban* can last until retirement (60 years old); or the occupant can resign from his position before retirement if the Governor permits (Sternstein, 1976: 3; Pramote, 1986: 125; Prathan, 1986: 225-232; Saman and Suthi, 1990: 63-70).

Local administration comprises the provincial administrative organisation (PAO), the municipalities of city, town or commune, the sanitary district, and the tambon council. Municipality and the sanitary district authorities operate within urban areas



OPM - Office of the Prime Minister
MI - Ministry of Interior
MD - Ministry of Defence
MOI - Ministry of Industry
ME - Ministry of Education
MJ - Ministry of Justice
MF - Ministry of Finance
MSTE - Ministry of Sciences, Technology & Environment
MAC - Ministry of Agriculture & Cooperative
MTC - Ministry of Transport & Communications
MP - Ministry of Public Health
MC - Ministry of Commerce
MFA - Ministry of Foreign Affairs
MU - Ministry of University Affairs
PG - Provincial Governor
A - *Nai Amphoe*
———— Representatives of the Ministry of Interior
············ Representatives of the other Ministries
······▶ Authoritarian control by the Ministry of Interior
——▶ Authoritarian control by the provincial administration

Figure 7.1 Structure of Thai Political Administration

whereas tambon councils are responsible for non-urban areas.[2] They are recognised as self-governing entities because local people can choose members of each administrative level by general election. All sections of the local administration, however, have little autonomy. Their powers and duties are carefully and uniformly spelled out in the *Provincial Administrative Organisation Act of 1955*, the *Municipal Act of 1953*, the *Sanitary District Act of 1985* and the *Revolutionary Order No. 326 (B.E. 2515)*.[3] There is little room for initiative and innovation. Further, they are subject to intervention by both central and provincial governments. For example, the Ministry of Interior can dissolve members of the PAO or the provincial council for a new election if they contravene the laws. Although the provincial council is supposed to manage non-urban areas, the provincial governor is in charge of its administrative duties.[4] In other sectors, the governor and the *Nai Amphoes* can review the municipality's and the Tambon council's performances, whereas the *Nai Amphoes* and the *Kamnans* also supervise the Sanitary District's administration. This intervention is designed to prevent misconduct in local administration (Sternstein, 1976: 3-9; Pramote, 1986: 127-133; Prathan, 1986: 237-251; Saman and Suthi, 1990: 71-83).

As noted, local administration has limited authority. The PAO, municipality, and sanitary district have similar responsibilities — the provision and maintenance of public utilities, education and medical services.[5] Their activities, however, have to collaborate

---

[2] Municipalities are classed as cities, towns or communes. Under the *Municipal Act of 1953*, cities must have a population of at least 50,000 with an average density of not less than 3,000 persons per square kilometre. A town must have a population of at least 10,000 with an average density of 3,000 persons per square kilometre, but a town must be established where the provincial office is located. The central government may establish commune municipalities at its discretion. Sanitary district is a quasi-urban unit of administrative organisation. It is also established where the Amphoe office is located. It has to gain annual revenue and population density not less than 300,000 baht and 1,500 people per square kilometre respectively. If the sanitary district is located without the Amphoe office, it should gain annual revenue more than 400,000 baht (Sternstein, 1976: 6-8; Prathan, 1986: 248).

[3] Sternstein (1976: 8) used *'Provincial Government Act'* for *'Provincial Administrative Organisation Act'*.

[4] The governor has a dual role since he heads both the provincial and local administrations. He must balance his responsibilities as a Central Government Official with his obligations as the chief executive representing the people in his province (Sternstein, 1976: 6).

[5] The tambon council has more limited authority. Within its area, it mainly approves development projects and liaises with central and provincial governments.

with the policies of central and provincial government. With the rapid industrialisation and urbanisation of Samut Prakan, local administration has been over-shadowed by its Provincial Government. Consequently, the Provincial Government has had the greatest influence on Samut Prakan's social and physical transformation.

Provincial Government in Urban Environmental Management

In 1991, Samut Prakan's Provincial Government reported that the area was experiencing six major problems — uncontrolled urban growth, traffic congestion, industrial pollution, domestic solid waste, floods, and shortage of infrastructure (e.g. roads) (Table 7.1). These issues overlapped. Urban sprawl was rated as the most important issue because it aggravated the difficulties of managing residential and industrial land use, providing infrastructure and mitigating environmental deterioration. Other issues such as industrial slums and public health are not perceived as major problems, though they have become more serious with the onset of urbanisation. Many attempts have been made to resolve these issues. Only some mitigation has been effected by the Provincial Government — a result attributed to its limited political power and budget.

In seeking to control urban growth, for example, the Provincial Government desired to zone land by declaring a *City Planning Act* for Samut Prakan. Responsibility for designing and proclaiming the *City Planning Act* resided with the Department of Town and Country Planning (DTCP) under the Ministry of Interior. The Provincial Government, however, has no power to enforce the DTCP's recommendation. Further, the other offices under the Provincial Government's control cannot effect mitigation without assistance. The Provincial Office of Industry (POI), for instance, has less than fifteen officers. As there were only three engineers qualified in pollution control in 1991, it is not possible for waste management to be investigated in a large number of factories (pers. comm., POI officials, 24 September 1991). Moreover, most heads of ministerial agencies are not local people. They are selected by the various ministries to work in

Table 7.1 Major Provincial Problems and Its mitigation, Samut Prakan, 1991

Problems	Mitigation
1. Uncontrolled urban growth especially between residential and industrial land uses	1.1 Declare a City Planning Act for Samut Prakan as soon as possible.
	1.2 Cooperate with private sector to help improve the lifestyles of people living in slum areas.
2. Traffic congestion due to increasing volume of trucks and passenger vehicles	2.1 Local policing has to be more efficient.
	2.2 Improve existing roads.
3. Industrial pollution	3.1 Investigate polluting industries.
	3.2 Encourage both businessmen and local residents to care more for the environment.
	3.3 Request permission from the Royal Thai Government to establish a Provincial Office of Environment as well as from Ministry of Industry to let the Provincial Office investigate illegal factories.*
	3.4 Construct industrial waste treatment plant for Samut Prakan area.
	3.5 Ask the Department of Industrial Works not to permit the establishment of new polluting industries outside industrial estates.
4. Domestic solid waste	4.1 Encourage the private sector to take action on solid waste management.
	4.2 Request Royal Thai Government to provide more money for solid waste management.
5. Flood	5.1 Organise a special flood mitigation office.
	5.2 Provide new surface water resources to obviate need for ground water and curb land subsidence.
	5.3 Dredge all canals.
6. Infrastructure shortage	6.1 Request more telephone lines and water supplies from Telephone Organisation of Thailand and Metropolitan Waterworks Authority respectively.

Note: * Normally, the Department of Industrial Works and the Industrial Estate Authority of Thailand under the Ministry of Industry are the only agencies inspecting the factory condition.

Source: Derived information from POSP (1991: 10-14).

branch offices housed in the headquarters of Samut Prakan's Provincial Office. Staffing numbers in ministerial branches range between two and fifteen officers. Rarely does the Provincial Government manage any development projects by itself. Its role is to coordinate the administration of both central and local governments.

Rapid economic growth has boosted Samut Prakan's revenue but the Provincial Government cannot use its receipts for urban management. In 1989, the Provincial Government collected more than 10 billion baht in revenue for the first time (Table 7.2). By 1991 its revenue was over 20 billion baht. The annual average rate of growth in revenue between 1988 and 1991 exceeded 40 per cent per annum. By 1991, Samut Prakan had one of the country's highest provincial revenue collections. All revenue, however, had to be sent to exchequer of the RTG. Allocations to provinces are made from this budget. Table 7.2 shows Samut Prakan's revenue surpassed expenditure. Indeed, expenditure provided by the RTG was less than 10 per cent of total revenue. This small return has irritated provincial residents. In 1992, most residents wanted the Provincial Government to spend 50 per cent of its revenue on provincial development. As economic and industrial growth rates have accelerated, the Division of Planning and Projects (DPP, 1992: 18) recommended that the RTG should provide 100 baht per head of population or approximately 80 million baht to the PAO for infrastructure development. Government has responded to its manifest problems by developing policies for provincial development. Four major issues have been identified: the encouragement of all forms of economic development; the mitigation of pollution problems; moral improvement; and the encouragement of family life (Table 7.3). These issues did not really reflect genuine needs because the Provincial Government had to tailor them to meet national policy. At best these policies submitted to the Ministry of Interior were designed to impress the RTG. In the same vein the Provincial Government inserted proposals in provincial guidelines to facilitate economic development but ignored social issues. The guidelines provided details on approaches for stimulating industrialisation while simultaneously maintaining and sustaining the environment.

Table 7.2 Revenue and Expenditure in Samut Prakan Province, 1989-1991

Year	Revenue Baht	Revenue Increase (%)	Expenditure Baht	Expenditure Increase (%)	Balance Baht	Balance Increase (%)
1987[a]	5,238,890,000	-	n.a.	-	n.a.	-
1988[a]	7,644,340,000	45.9	n.a.	-	n.a.	-
1989[b]	11,754,546,335	53.8	1,135,013,043	-	+10,619,533,292	-
1990[b]	16,885,463,115	43.6	1,287,481,495	13.4	+15,597,981,620	46.9
1991[b]	21,050,177,321	24.7	1,649,359,483	28.1	+19,400,817,838	24.4

Note: n.a. - not available

Source: [a] RD, 1989.
[b] DPP, 1992.

Six proposals have been developed by the Provincial Government within provincial guidelines (POSP: 1991: 22-23):

1. The relocation of 356 polluting industries into public industrial estates, especially the Bangpu' and Bang Pli Industrial Estate so that efficient waste control can be instigated;

2. The construction of a hazardous waste treatment plant within the Province;

3. The introduction of new production techniques to reduce costs;

4. The development of a Provincial Centre of Industrial Information Service;

5. The establishment of a public waste water treatment plant in Amphoe Phrapradaeng;

6. The lobbying of the Joint Public and Private Sector Consultative Committee (JPPCC) to encourage the provincial economy's development.

In 1990, the Provincial Government requested a five-year development plan (1992-1996) worth 6,350 million baht. The plan highlighted the importance of environmental issues, particularly the need for environmental protection projects and

Table 7.3 Major Provincial Policies Reflecting Ministry of Interior's Needs, Samut Prakan, 1991

Major issues	Details
1. Encourage all forms of economic development	1.1 Promote human skills especially for youth and women to support other provincial development. 1.2 Infrastructure improvements to service rapid economic growth. 1.3 Promotion of cottage industry. 1.4 Increase supply of water resources for household and farm consumption.
2. Mitigate pollution problems	2.1 Encourage land zoning to control mixed land uses. 2.2 Support efficient flood control system, drainage and waste water management to protect the environment. 2.3 Improve solid waste management by establishing a provincial incinerator. 2.4 Closely monitor industrial entrepreneurs to ensure their waste is treated properly.
3. Improve morale	3.1 Encourage development of individuals. 3.2 Encourage social development by providing suitable accommodation, adequate social welfare, and secure livelihood. 3.3 Boost economic development by encouraging individuals to have at least two jobs, and establishing development funds for villages.
4. Boost family life	4.1 Reduce population growth through the promotion of family planning. 4.2 Pay more attention to child development and to develop skills of women. 4.3 Encourage secure employment. 4.4 Assist homeless children, disabled and old people who cannot live by themselves. 4.5 Encourage secure society by reducing crime rates, accidents, and drug use.

Source: Derived from POSP (1991: 15-19).

improvements to social development. However, the RTG allowed the Provincial Government 4 million baht in 1989 which was only sufficient to sponsor three environmental projects (*Phuchatkan*, 2-8 July 1990: 67). In its Five-year Development Plan (1992-1996), the Provincial Government identified seven environmental projects valued at 4,830 million baht or 76 per cent of the total budget. These projects are — waterways dredging and flood control; water treatment system; solid waste management; water resource conservation and development; training programmes on environmental conservation for local leaders and teachers and posters on environment; land use development; and forest conservation (CCRDPL and FPDPC, 1990) (Table 7.4). All projects have to be reviewed for budget allocation, however, by the RTG.

Water dredging and flood control was the most important scheme. It accounted for 56 per cent of total expenditure. Although most expenditure was focused on rural areas, it protected the inner city of Samut Prakan and the eastern Bangkok Metropolitan Area from flooding. Given this primary issue, the RTG may be willing to provide the requested budget (Table 7.4).

Table 7.4 further shows waste water treatment, especially for residential and industrial activities, received the second largest allowance. It attracted only 17 per cent of the total five-year budget which was concentrated on the Town Municipalities of Muang and Phrapradaeng. Areas covered by the sanitary districts of other Amphoes were not included in the projects. In addition, the Provincial Office of Industry and the Department of Industrial Works under the Ministry of Industry have not been asked to take any responsibility in these areas. In rural areas, the projects are confined to the treatment of waste water from hospitals.

Solid waste management was the third significant issue in the Provincial Development Plan. Budget allocation for this activity was concentrated in the Municipalities. Clearly, the Provincial Government has ignored the environmental deterioration arising from the rapid growth of residential and industrial activities in

Table 7.4 Samut Prakan's Five-Year Provincial Development Plan on Environment Improvement, 1992-1996

Project area	Target areas			
	Urban area (million baht)	Responsible Departments	Rural area (million baht)	Responsible Departments
Waterways dredging and flood control	—	—	3,567.92	RID, CDD, DPW
Water treatment system	1,190.20*	DPW, TMM, TMP	0.68**	DH
Solid waste management	69.32	TMM, TMP	0.35	DH
Water resource conservation and development	—	—	3.23	DF, DH
Training programmes on environmental conservation for local leaders and teachers and posters on environment	—	—	1.63	NED
Land use development	—	—	0.91	LDD
Forest conservation	—	—	0.06	RFD

Note: * The treatment system was for residential and industrial waste water.
** The water treatment was for hospital waste water only.

CDD — Community Development Department, Ministry of Interior
DF — Department of Fisheries, Ministry of Agriculture and Cooperative
DH — Department of Health, Ministry of Public Health
DPW — Department of Public Works, Ministry of Interior
LDD — Land Development Department, Ministry of Agriculture and Cooperative
NED — Non-formal Education Department, Ministry of Education
RFD — The Royal Forestry Department, Ministry of Agriculture and Cooperative
RID — The Royal Irrigation Department, Ministry of Agriculture and Cooperative
TMM — Town Municipality of Muang, Samut Prakan
TMP — Town Municipality of Phrapradaeng, Samut Prakan

Source: POSP, 1991; DPP, 1992: 15-16.

Amphoes Bang Pli and Bang Bo. As yet, no scheme has been based on population forecasts, economic growth, mixed land use in sanitary districts and accelerated growth of built environment in suburban localities. Further, the Provincial Government has not attracted much cooperation from the private sector to resolve urban problems. Assistance has to be requested from various departments of the RTG (e.g. Department of Public Works, the Royal Irrigation Department and Land Development Department).

2. STATE INTERFERENCE

As they are controlled by the Ministry of Interior, provincial and local governments do not have the necessary authority or finance to manage urban areas efficiently. The Ministry, as noted in Chapter III, can withdraw a provincial governor, lord mayor or any official if his work does not meet the RTG's requirements. This control, exerted by the Ministry of Interior, has frustrated administrators, especially provincial officers, charged with the fate of resolving manifest environmental problems. As Girling (1981: 186) has indicated, the Thai bureaucracy, as an institution, has a logic overriding the convictions of individuals. Conversely, once the RTG has decided upon a major development proposal, provincial and local governments have to comply even though it may not be in their interest. When a provincial government requests for the RTG's assistance to manage any problem, the assistance, in turn, disrupts provincial administration.

In fact, state interference conceals two main aims: the promotion of industrialisation and urbanisation outside the Bangkok Metropolitan Area; and the RTG's desire to maintain its monopoly control over provincial resources. The RTG's control is exerted through large national public schemes and the discouragement of the Provincial Government initiatives, especially in pollution control and protection by offering fitful assistance.

Direct Intervention

Since the 1980s, the RTG has proposed the seven major public projects in Samut Prakan which are listed in Table 7.5 (Supasak, 1988: 215-226; Duangkamol, 1991: 192-193). All of them, except the flood protection scheme, are intended to relieve congestion generated by the relocation of residential and industrial functions from the Bangkok Metropolitan Area. Four proposals have commenced. In the late 1980s, two projects were completed (i.e. Bang Pli National Housing and Bangpu' Industrial Estate). Three projects have not yet started — the new international airport, the additional water supply for industrial activities, and public waste water treatment plant. Given their scale and involvement of the RTG agencies, they will have a marked effect on Samut Prakan's urban management.

Flooding has been a major problem in both the eastern Bangkok Metropolitan Area and Samut Prakan's inner city. Since 1983, the Department of Public Works (DPW) and the Royal Irrigation Department (RID) have built a concrete wall along Chao Phraya River, dredged all canals, and provided more storm drainage in Amphoes Muang and Phrapradaeng. In addition, water gates and levees have been constructed in a north-south alignment along Kingkaeo and Tamru Canals in western Amphoe Bang Pli (RID, 1984: 5-6) (Figure 7.2). Essentially, these initiatives merely shifted the flood problem from one place to another. The flood protection scheme was initially proposed to relieve annual flooding in eastern Bangkok but the project also resolved the problem in Amphoes Muang and Phrapradaeng. Yet this project has caused adverse environmental impacts on Amphoes Bang Pli and Bang Bo. Large areas now face severe annual floods because these locations are outside the flood protection zone. Most local residents and industrial entrepreneurs in these Amphoes complained during interviews with them in 1991 that they had experienced flooding during the wet season because the new gates blocked water flow. Other canals degenerated into septic tanks holding waste water derived from residential and industrial activities during the dry season. As noted in Chapter VI, the

Table 7.5 Seven Public Projects Proposed for Samut Prakan since the 1980s

Projects	Responsible agency	Status
1. Flood protection scheme	RID, CDD, DPW	Under construction
2. Nongnguhao International Airport	DA	Start construction in 1994
3. Public housing:	NHA	
- Bang Pli National Housing (or Muang Mai Bang Pli)		Completed in 1987
- Keha Nakhon Luang		Under construction
4. Public industrial estates:	IEAT	
- Bangpu' Industrial Estate		Completed in 1988
- Bang Pli Industrial Estate		Under construction, especially the second phase.
5. Water supply for industrial activities	MWA	Under consideration
6. National highways linking to ring roads around Greater Bangkok	DH	Under construction
7. Public waste water treatment plant	DIW	Under consideration

Note:
CDD — Community Development Department, Ministry of Interior
DA — Department of Aviation, Ministry of Transport and Communication
DH — Department of Health, Ministry of Public Health
DIW — Department of Industrial Works, Ministry of Industry
DPW — Department of Public Works, Ministry of Interior
IEAT — Industrial Estate Authority of Thailand, Ministry of Industry
MWA — Metropolitan Waterworks Authority, Ministry of Interior
NHA — National Housing Authority, Ministry of Interior
RID — The Royal Irrigation Department, Ministry of Agriculture and Cooperative

Source: Supasak (1988: 215-226); Duangkamol (1991: 192-193).

deteriorating quality of canal water has harmed fish farming and altered residential lifestyles.

Nongnguhao International Airport is another major project which will affect Samut Prakan's physical and social environment (Figure 7.3). Since the 1960s, the Airport had been proposed as regional aviation centre for Southeast Asia and the

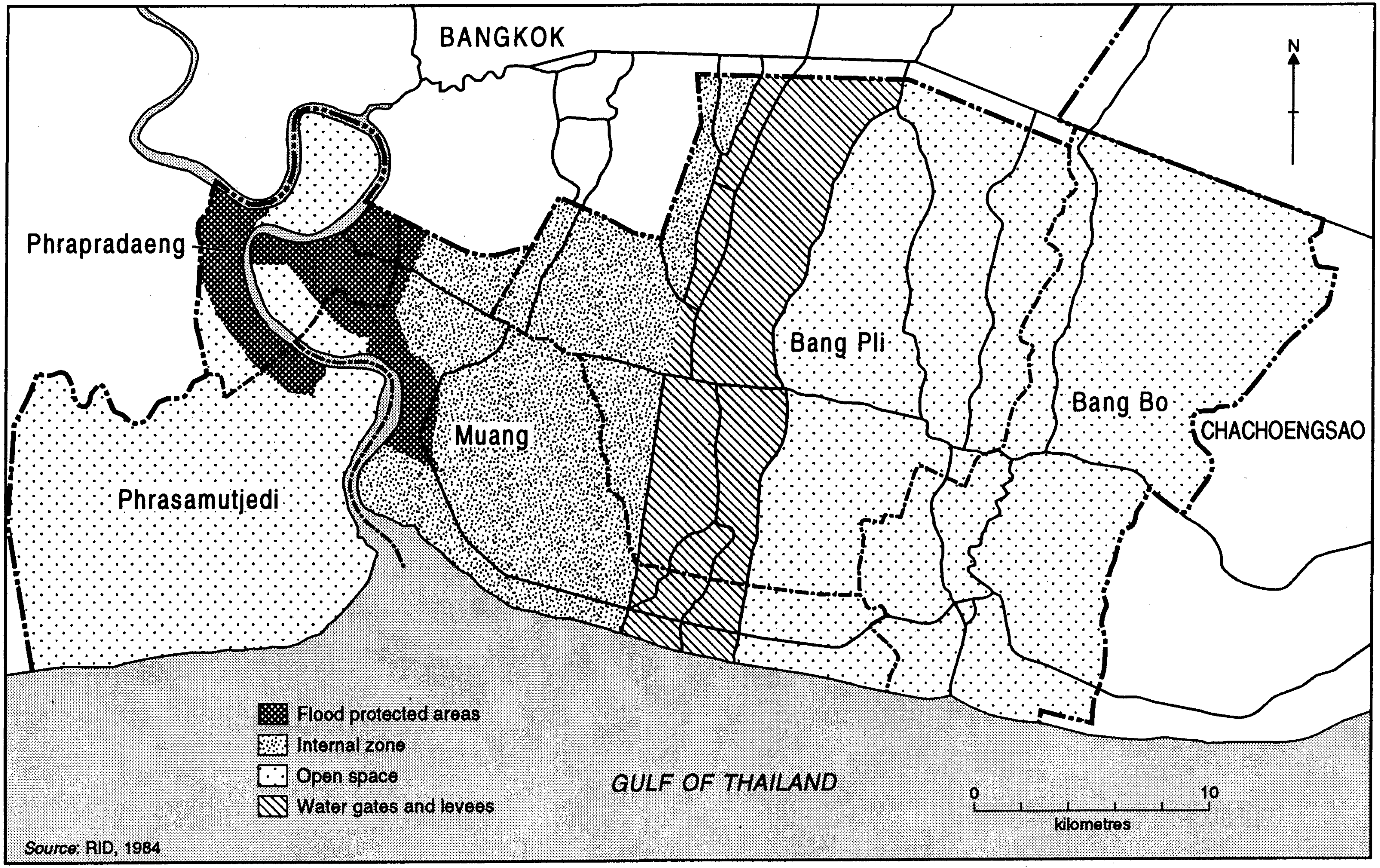


Figure 7.2 The Flood Protection Scheme for Inner Samut Prakan

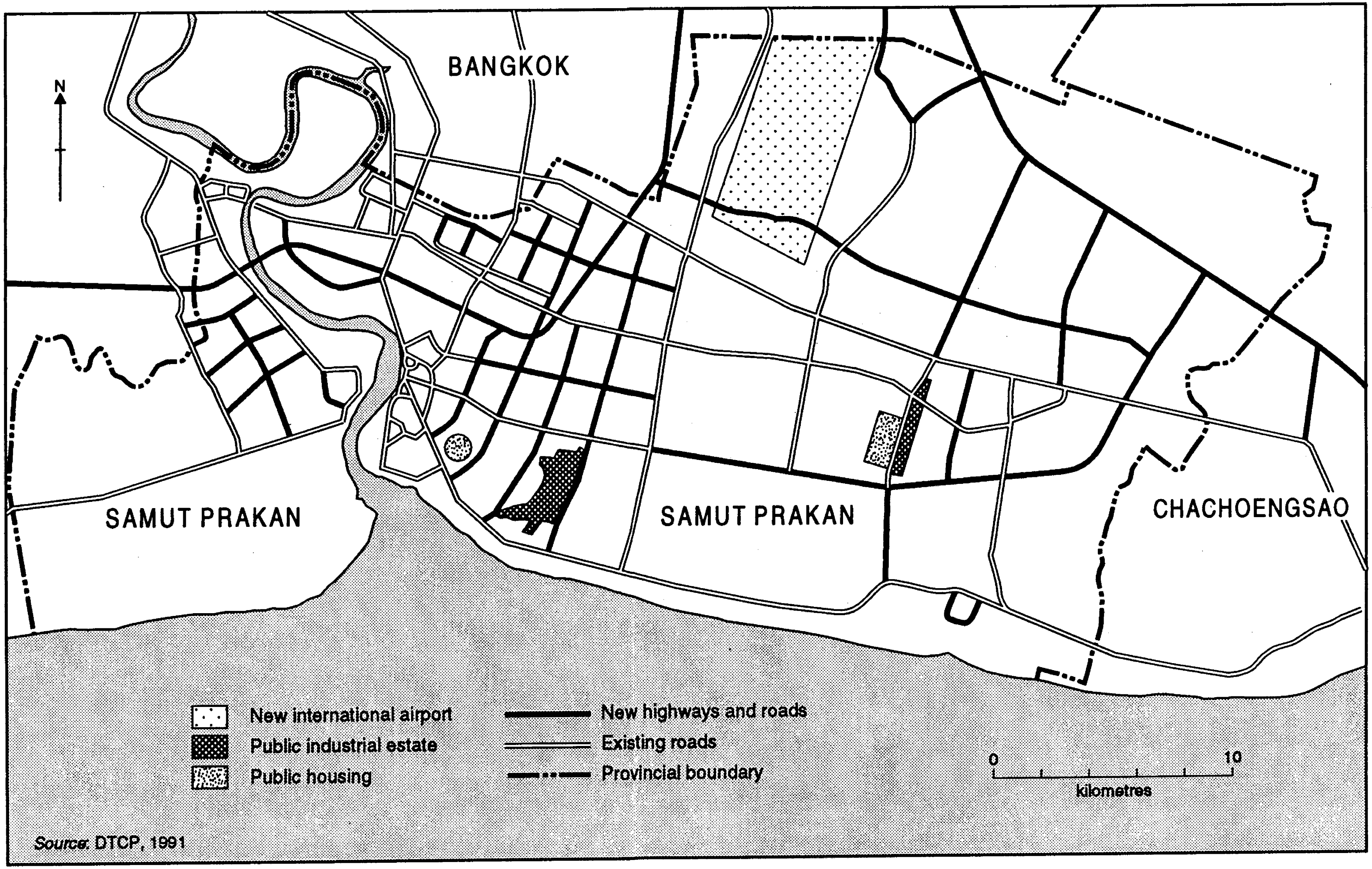


Figure 7.3 Major Public Development Projects in Samut Prakan

country's second major air terminal. An area of 31 square kilometres covering four sub-districts in northern Amphoe Bang Pli had already been claimed for the Airport's construction, but the project had been repeatedly postponed for more than 20 years. Local residents have already sold their land though they have been permitted to continue their occupancy. During the period of the project's suspension, most farmers in the area have shifted from paddy to fish farming. In the late 1980s, the RTG renewed its interest in the Second Airport. This change has resulted in adverse effects to the RTG itself and local residents. The RTG has to direct more funds into land improvement because fish farmers have degraded soil structure, whereas local residents have had difficulty in finding new homes. The compensation for their land set at 1960s prices is insufficient to buy new land or even to resettle in another area. Now the project is scheduled to start in 1994 (*Krungthep Thurakit Sutsupda*, 21-27 July 1990: 7; *Phuchatkan*, 9-15 September 1991: 66).

Other public projects have also transformed large areas of agricultural land in Amphoes Muang, Bang Pli and Bang Bo into industrial estates, public housing and new highways (Figure 7.3). The RTG has proposed large-scale projects in Bangkok's vicinity before the City Planning Acts for Samut Prakan and other neighbouring provinces have been promulgated. Unquestionably, all projects are designed to attract further funding from both public and private sources. As mentioned in Chapter VI, there are many new private developments along Bang Na-Trat and Teparak Roads such as industrial estates, housing, shopping centres, golf courses and resorts (see also Figure 6.3). This new built environment has emerged before the Provincial Government could promulgate its plan for controlling urban sprawl. Moreover, the Provincial Government is unable to investigate any adverse effect arising from the RTG's projects. Local residents, for example, have complained about illicit waste water from the Bangpu' and Bang Pli Industrial Estates. The Provincial Office of Industry, and even the Provincial Governor, however, cannot examine the issue without permission from the Governor of the Industrial Estate Authority of Thailand or the Minister of Industry (pers. comm., POI officials, 24 April 1991). Samut Prakan's Provincial Government, therefore, has no right to question the RTG's activities within its own domain.

Some public projects are limited in scope. Others lack inter-agency collaboration. For example, the water supply scheme was only designed to serve industrial activities in Amphoes Phrapradaeng and Muang. The scheme's aim is to overcome land subsidence from over-exploitation of the area's ground water, especially within inner Samut Prakan. Industrial areas in other districts were excluded from the project. Consequently, firms there had to make use of bore water causing land subsidence. Although the Bang Pli Industrial Estate in Amphoe Bang Pli had its own ground water service for supplying residential and industrial activities, its quality was unsuitable for both production process and drinking. Consequently, the Estate's management requested the Metropolitan Waterworks Authority (MWA) for an extension of its service so the water quality and land subsidence issues could be resolved. In 1991, MWA had plans to extend its service to Bang Pli and Bang Bo districts but it was unable to find a new source of surface water suitable for industrial use.

The provision of inner Samut Prakan's public waste water treatment plant illustrates the confusing responsibilities among public agencies. As noted in the Five-year Provincial Development Plan, the Provincial Government of Samut Prakan has requested cooperation from the Department of Public Works (DPW) under the Ministry of Interior to construct a public water treatment system. Suitable space was sought in the Town Municipalities of Muang and Phrapradaeng. The Provincial Office of Public Works (POPW) revealed, however, that the DPW could not commence the project because suitable land was not available. Even if the plant was constructed as planned, it would serve residential and industrial activities in the inner Samut Prakan and the areas southern districts of Bangkok (pers. comm., POPW officials, 13 June 1991). Simultaneously, the Ministry of Industry's Department of Industrial Works (DIW) has proposed a plan for industrial waste treatment in Amphoes Phrapradaeng and Muang but not the industrial areas of Amphoes Bang Pli and Bang Bo. Clearly, conflict caused by the overlapping responsibilities of public agencies is almost inevitable.

Indirect Intervention

Besides its large public schemes, the RTG has offered assistance to resolve industrial pollution by relocating noxious firms, establishing an environmental fund, and controlling land uses in Samut Prakan through the promulgation of comprehensive and specific plans. Indirectly, these endeavours have deterred the improvement of urban environment by the Provincial Government. Basically, the RTG wants to improve the Bangkok Metropolitan Area's urban environment by controlling industrial growth within the city before seeking to resolve Samut Prakan's problems. Some polluting industries, therefore, have been relocated in specific industrial estates near Bangkok, especially those on the Eastern Seaboard. Nevertheless, some have been relocated outside designated estates. Despite the Provincial Government's request, the RTG has not made concrete proposals on how land use activities in Samut Prakan should be reorganised to exclude polluting industries. Yet provincial guidelines for economic development recorded that 356 polluting industries had to be relocated in the industrial estates. This massive relocation postponed consideration by the RTG. Further political instability in the early 1990s led to a new Cabinet with a policy that ignored industrial pollution.

Since the late 1980s, as noted in Chapter III, the growth of direct foreign investment in the manufacturing sector accelerated, especially in Greater Bangkok. There have been many attempts to resolve industrial pollution between 1988 and 1992 by four Thai Cabinets (see Table 7.6).[6] None achieved much success. In 1988, the Chatichai administration resolved that ten polluting industries must be shifted out from the Bangkok Metropolitan Area (BMA) and Samut Prakan (e.g. dyeing, chemical products, petroleum products, basic metal, fabricated metal, non metals, plastic and rubber products, animal

---

[6] As it lasted only one month, Suchinda's Administration did not make any resolutions on industrial pollution. Social upheaval terminated the Government's term in May 1992.

Table 7.6 Thai Cabinets, 1988-1992

Cabinet	Date
Chatichai Choonhavan	August 1988 - February 1991
Anand Panyarachun	February 1991 - March 1992
Suchinda Kraprayun	April 1992 - May 1992
Anand Panyarachun	June 1992 - September 1992
Chuan Leekpai	September 1992 -

food products, tanneries, machinery and parts and transport equipment industries). These industries totalled 1,241 factories — 715 in the BMA and 526 in Samut Prakan.[7] No guidance, however, was given about where to locate polluting industries. In 1989 another resolution advised that there should no industrial promotion in Greater Bangkok because of its highly congested industrial and urban areas (pers. comm., IEAT officials, 14 June 1991).[8]

In August 1991, the Ministry of Industry (MOI) under the Government of Anand Panyarachun announced that within three years 500 polluting firms had to be re-established in special industrial estates located in Latlumkaeo and Nongchok Districts within Pathumthani Province and the BMA respectively. Each estate covered an area of approximately 20 hectares. If any factory wanted to avoid forced relocation, it had to improve its waste treatment system. Otherwise, it would have to cease operations. (*Phuchatkan Raiwan*, 30 August 1991).

[7] In the BMA, there were 656 polluting firms whose individual investment value was less than 10 million baht and 59 polluting firms with more than 10 million baht. In Samut Prakan, there were 384 polluting firms whose individual investment value was less than 10 million baht and 142 polluting firms with more than 10 million baht (pers. comm., IEAT officials, 14 June 1991).

[8] The IEAT followed the RTG's resolution by not allowing businessmen to establish factories on its estates within Bangkok. The Ministry of Industry through the Department of Industrial Works and the Provincial Office of Industry, however, allowed industrialists to establish factories in Bangkok.

In late 1992, the MOI under the Government of Chuan Leekpai gave industrial entrepreneurs in BMA and Samut Prakan another three-year period of grace in which to improve their pollution treatment systems. If any factory could not manage its waste, it was be closely controlled by officials or relocated to an industrial estate. No further permits were to be given to entrepreneurs to establish polluting industries within the BMA and Samut Prakan other than in nominated industrial estates. Simultaneously, the MOI reported that there were 153 and 313 polluting firms in the BMA and Samut Prakan respectively. Four new industrial estates have been identified for relocating these factories. Their sites are on Bang Na-Trat Road (Samut Prakan), Phutthamonthon Road (BMA), Rangsit (Pathumthani), and Nonthaburi (*Bangkok Post*, 17 Nov 1992: 20). Yet, the MOI has asked the Provincial Office of Industry in Samut Prakan to count the number of polluting firms because existing statistics were outdated (*Phuchatkan Raiwan*, 15 and 28 December 1992).

The number of industries investigated for generating pollution in Samut Prakan has varied with the change from one RTG Cabinet to another. While factories were re-investigated, the urban environment deteriorated. In 1992, the current government did not continue the former government's proposal to develop two special industrial estates. Instead, four different sites have been proposed. Clearly, each Cabinet attempts to achieve a compromise with the private sector over industrial waste management. This uncertainty has confused provincial officials about national policies on industrialisation and environmental protection.

The Environmental Fund is another attempt by the RTG to resolve industrial pollution short of relocating offenders. In 1991, Anand Panyarachun's Cabinet created the Environmental Fund to assist any province wishing to combat environmental degradation and promote environmental protection and conservation. It provided a start up capital of 500 million baht. In July 1992, the RTG transferred 4,500 million baht from the Oil Fund to the Environmental Fund. Undoubtedly, many provinces asked for financial assistance. A major aim of the RTG, however, was to share part of the fund with non-government organisations working in the field of environmental conservation. In theory, any provincial government can ask for the rest. In practice, Phuket and Pattaya were the major recipients of the money because these two world-famous tourist spots had been affected adversely by rapid urbanisation. Although Samut Prakan has more serious environmental problems than these tourist spots stemming from both industrialisation and urbanisation, the RTG has ignored Samut Prakan's request for financial assistance from the Environmental Fund (*Bangkok Post*, 9 July 1992: 1-3). Since September 1992, Chuan Leekpai's Cabinet has not re-addressed this problem.

In assessing the quality of Samut Prakan's environment, the Office of the National Environment Board (ONEB) under the Minister of Sciences, Technology and Environment has had an insignificant role. Although the ONEB has monitored water quality in the Chao Phraya River which flows through the province and air quality in the inner city, no remedial action has resulted. Yet the Provincial Government has asked the RTG for technical and financial assistance for resolving environmental problem, especially in the inner city. Moreover, there has not been an environmental assessment of Amphoes Bang Pli and Bang Bo. Not surprisingly, the Provincial Government deprived of the RTG financial assistance, has established its own Environmental Section and Environmental Fund.

In 1992, the Provincial Government established the Division of Planning and Projects (DPP) to assess environmental problems. This division also suggested that the Provincial Government form committees at Amphoe and Tambon levels to closely monitor manifest difficulties and establish environmental information systems. Then, committees at each level can help one another to resolve the issues. In addition, the Provincial Government has agreed to establish an Environmental Fund supported by both the public and private sectors in Samut Prakan (DPP, 1992: 19-21).

City planning has been involved by the RTG and Provincial Government as the third instrument to combat polluting industries. Frequent Cabinet changes have not only influenced industrial and environmental protection policies but have delayed the declaration of a comprehensive plan for Samut Prakan by the *Ministerial Resolution* and the implementation of specific plans for urban areas by the *City Planning Act.* As mentioned, the Department of Town and Country Planning (DTCP) is the only agency engaged in comprehensive provincial planning. In 1965, the Ministry of Interior had a specific plan for the urban area of Samut Prakan, especially Amphoes Muang and Phrapradaeng. Subsequently, there has been no plan for Samut Prakan, though the DTCP was established in 1975. In 1990, the DTCP did draw up a comprehensive plan for Samut Prakan. Land use patterns are outlined which incorporate existing land holdings and practices, and major public development schemes (Figure 7.4). The new plan, however, does not include any development project by local governments including the Provincial Administrative Organisation which are responsible for non-urban areas (pers. comm., PAO officials, 16 August 1991). After the third public hearing in Samut Prakan the plan was revised.[9] Most feedback, however, came from land developers, industrial investors or business associations (pers. comm., DTCP officials, 15 August 1991).[10] Unquestionably, the main purpose of urban planning in Thailand is to seek the highest and best economic return from land. This return may consist of profit for a specific developer or landowner on one site, or the creation of a maximum number of jobs on another. This search, however, may clash with social, moral and aesthetic values (Johnson, 1989: 162). In other words, the interests of private and public sectors may be opposed to the concerns of local residents.

By 1991, the *Ministerial Resolution for Samut Prakan* had not been declared. The DTCP wanted to declare it simultaneously with plans for Bangkok Metropolitan Area (BMA) and its other neighbouring provinces. Obviously, the comprehensive plan for BMA has been corrected many times by public hearings and the RTG during the late

---

9 From the third public hearing on 13 Dec 1990, there was another correction of the proposed comprehensive plan to increase areas of industrial and recreational activities whereas agricultural area had to be reduced (*Phang Muang*, 1-15 January 1991: 5).

10 In late 1990, the Federation of Thai Industries notified the DTCP to correct land use designing in a comprehensive plan for Samut Prakan because the plan would obstruct industrial investment (*Phang Muang*, 16-30 November 1990: 7).

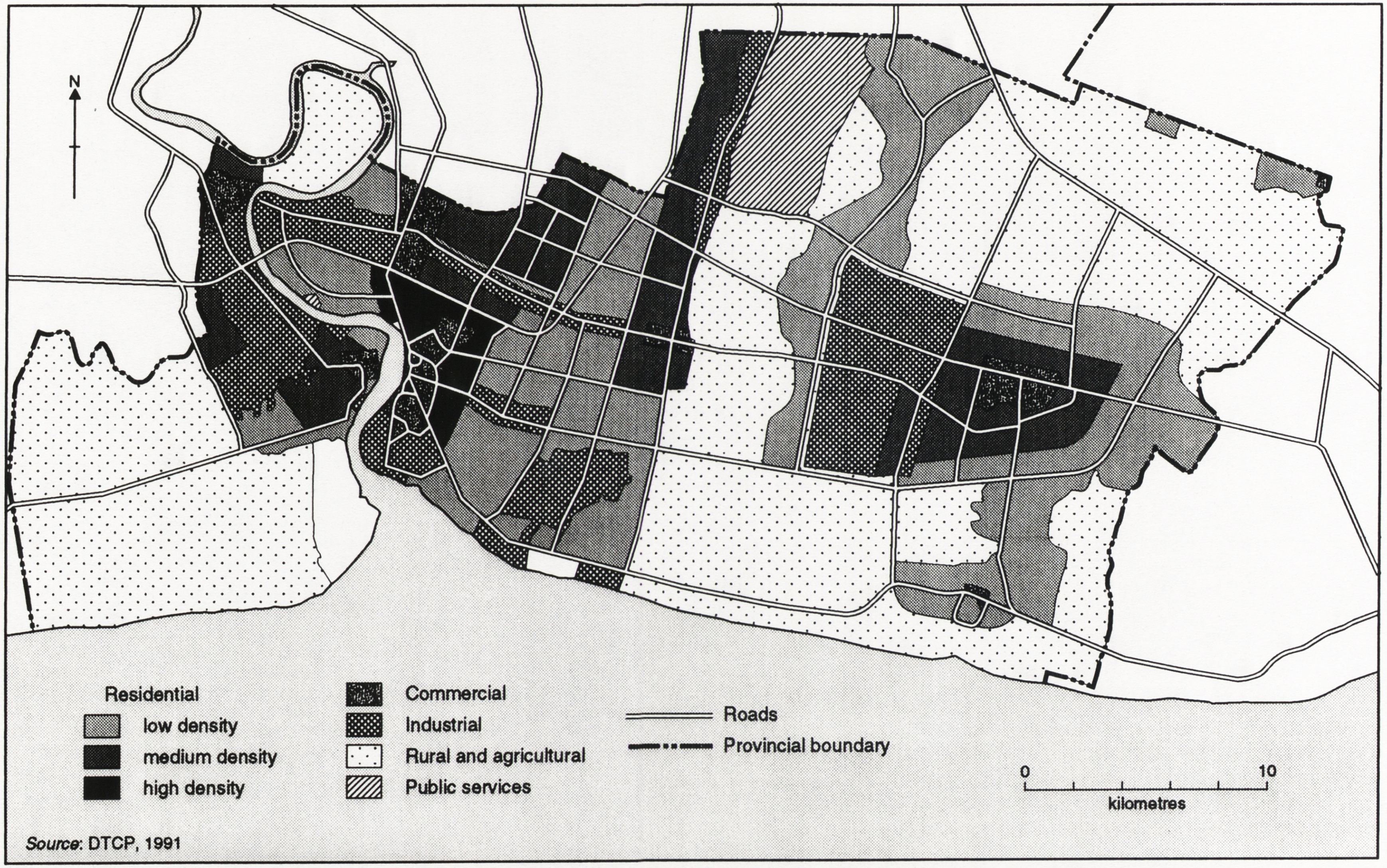


Figure 7.4 Proposed Land Use Planning for Samut Prakan, 1991

1980s and the early 1990s (pers. comm., DTCP officials, 15 August 1991). On 6 July 1992, the DTCP has announced BMA's comprehensive plan or a ministerial regulation in the Royal Gazette Issue No. 109. This regulation is Bangkok's first master city plan. Still, Samut Prakan has been waiting for its plan (*Bangkok Post*, 10 Aug 1992: 5). This delay certainly limits provincial attempts at improving the urban environment.

In 1991, the Ministry of Interior also asked the Department of Town and Country Planning (DTCP) to employ legal controls over large private projects which affected urban development in Nonthaburi, Pathumthani and Samut Prakan. Any development project that accommodates more than 50,000 people had to be investigated to assess the effect of construction on the environment (*Phuchatkan Raiwan*, 16 Dec 1992). This action may help the provincial government to control urban development. Although the provincial government controls all construction in urban areas, intervention by the DTCP will confuse provincial officials.

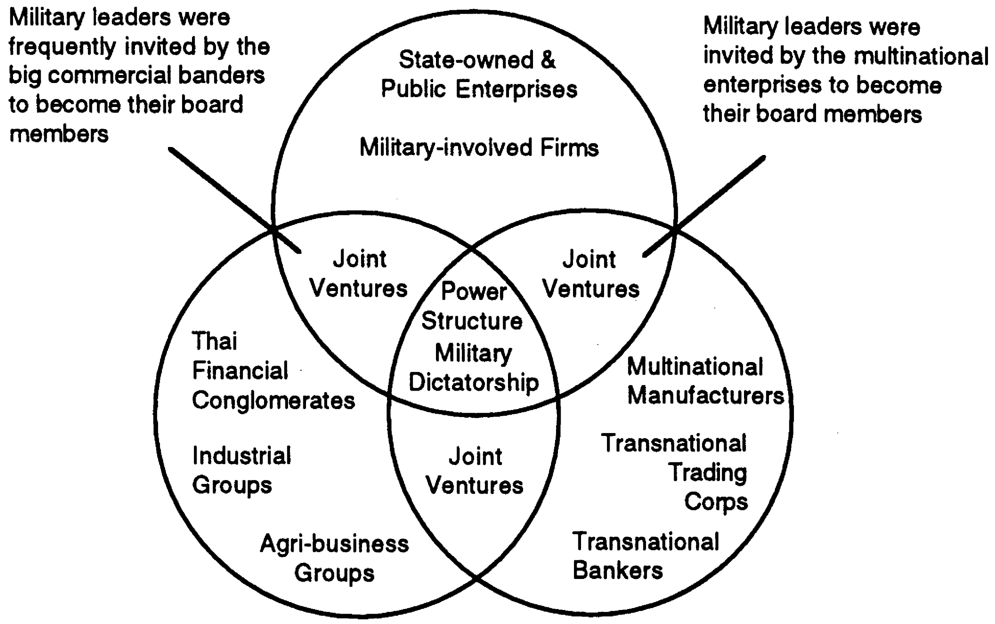
Clearly, the RTG's projects do not reflect local needs. All projects facilitate an acceleration of industrial development by the private sector. The RTG has not restricted where businesses are located. As noted by Harvey (1985: 1-13), their investments have fallen into the primary and secondary circuits of capital. The primary circuit involves in the direct production of goods and services while the secondary circuit comprises investment in fixed assets including elements of 'the built environment of production' (e.g. factories, shops) and 'the built environment of consumption' (e.g. housing, recreational facilities). The RTG's investment, however, has been tardy. The public waste treatment system for residential and industrial activities in the inner city of Samut Prakan was not commenced until 1993. As a result, rapid industrialisation and urbanisation have degraded the social and physical environment of suburban localities in Amphoes Bang Pli and Bang Bo. Although the Provincial Government needs to improve the environment, its authority and finance are absorbed by the RTG, and as well, as its intention is discouraged by the bureaucracy.

3. STATE-BUSINESS RELATIONSHIPS

Thailand has become known as a country of coups. This overriding perception conveys an image of fundamental instability. Thai instability, however, is endemic among key senior personnel and ephemeral groups rather than the basic political, social and economic system. In Cabinet, there has been a changing combination of key groups — military and police officers, bureaucrats, businessmen and civilians. No group has been able to eliminate the influence of other groups. Competition among these groups for power, therefore, forces them to compete for social support. Any group able to organise or articulate its views can obtain some degree of influence (Overholt, 1988: 155-156). No matter which group becomes dominant in Cabinet, state-business arrangements which permit the exploitation of Bangkok's and Samut Prakan's natural resources survive.

As outlined by Suehiro (1989: 281-283), the new industrial policy established between the late 1960s and the early 1970s, together with the marked economic growth, became the driving forces changing the structure of major business groups in Thailand (i.e. state enterprises managed by the military and bureaucratic élites, the multinational enterprises, and domestic capitalist groups) (Figure 7.5). At least until the early 1970s, the domestic capitalist groups could not overcome foreign economic forces and the Thai bureaucracy. Between 1944 and 1976, they had to do business under the political patronage of military-bureaucratic élites based in Bangkok (Morell and Chai-Anan, 1981: 49; Irwan, 1989: 418-424; Anek, 1992: 1-4). Unquestionably, the industrial activities centred in the privatised city of Bangkok reflected the needs of these élites.

In 1973, fundamental changes occurred in state-business relationships after the people's uprising (October 14 Revolution). Further the oil crisis threatened the existing political and economic system. State enterprises were declining because of inexperienced and weak management by the military-bureaucratic élites. Private business patronage by the élites also declined. Simultaneously, there was a withdrawal of some foreign



Source: Suehiro (1989: 282)

Figure 7.5 The Tripod Structure of Dominant Business Groups: 1947-1973

capital.[11] Domestic capitalist groups were forced to improve their traditional methods of expanding by recruiting business. They could get access to political power through the mechanism of political parties and the parliamentary system, not depending on unstable political patrons.[12] In addition, business leaders and economic technocrats were invited from the RTG to cope with national economic difficulties in the planning bodies. During the 1980s the number of technocrats in the Cabinet gradually increased (see Appendix 6 and more detail in Chapter VIII).[13] Although technocrats had no real power in Thai

---

[11] After the political upheaval, foreign capital especially of American and Japanese firms markedly withdrew from the Thai economy between 1973 and 1976. For example, General Motors and Ford cancelled their investment as well as two major Japanese firms in Union Kanebo Spinning and Capital Kanebo Textiles sold all their shares to Thai partners, so that overall Japanese share holdings in Thai industry dropped from some 49 per cent in 1976 to 25 per cent in the 1980s (Kraisak, 1984: 144).

[12] Since 1973, most businessmen have established a patron-client relationship with politicians. They have provided capital to support political parties. Some became members of the parties in order to have influences on economic policy making or to get involved in public development schemes (Rangsan, 1989: 142-143).

[13] Since the early 1960s, backgrounds of members in the Thai cabinets have fluctuated between military (including policemen), bureaucrats, businessmen and civilians. The military and bureaucrats are usually a majority of the cabinet after there is a coup d'état (i.e. between 1959-1975, 1976-1980 and 1991-1992).

politics, they steadily increased their influence in the decision-making process on economic issues. This fact suggests that the domestic capitalist groups and their political agents are now emerging as a significant counter-force in Thai politics (Girling, 1981; Morell and Chai-Anan, 1981; Kraisak, 1984; Suehiro, 1989; Irwan 1989; Anek, 1992; Murray, 1992: 13).[14] Subsequently, domestic entrepreneurs and their political agents have extended their influence outside the privatised city of Bangkok.

Since the late 1980s, the increased power of domestic capitalist groups in the Cabinet, together with the influx of direct foreign investment, has spurred industrial activities in Greater Bangkok, particularly in Samut Prakan. State-owned manufacturing firms were losing one after another. The number of public enterprises decreased from 141 in 1957 to 66 in 1986 (Rangsan, 1989: 34). However, the military and bureaucratic élites mainly hold such infrastructure and service sectors as highways, railways, sea- and air-ports, electricity, water supply, and telephone (Kraisak, 1984: 143; Suehiro, 1989: 276; Robison, 1989: 377). As the Provincial Government of Samut Prakan did not exercise much bargaining power with the RTG and the private sector it could not manage the urban environment efficiently. Domestic and overseas business groups have mainly taken advantage in monopolising provincial resources by sharing their surplus with the RTG.

Since the early 1990s the RTG has transformed Samut Prakan into a recipient for spill-over investment from Bangkok and overseas (Figure 7.6). As a result, Samut Prakan functions as a microcosm of the larger privatised city of which it is part. In the process, paddy and fish farms have been transformed into roads, industrial estates, and housing. Some farmers and their children have become industrial workers. An influx of

---

If there is a people's uprising, the businessmen and civilians predominate the cabinet (i.e. 1975-1976, 1980-1991 and 1992).

14 Since the end of the 1970s, the RTG has adopted export-oriented industrialisation together with import-substitution industrialisation. Under the protected condition of these strategies, industrial and banking capitals were able to expand to a point where, in some cases, domestic capitalist groups developed their strength to invest abroad (e.g. Chareon Pokphan Group). In addition, several industry and business associations (e.g. the Federation of Thai Industries, the Thai Bankers Association and the Thai Chamber of Commerce) have played a substantial role in initiating or resisting public policies and legislative measures to maintain their interests (Hewison, 1989: 150; Anek, 1992: 168).

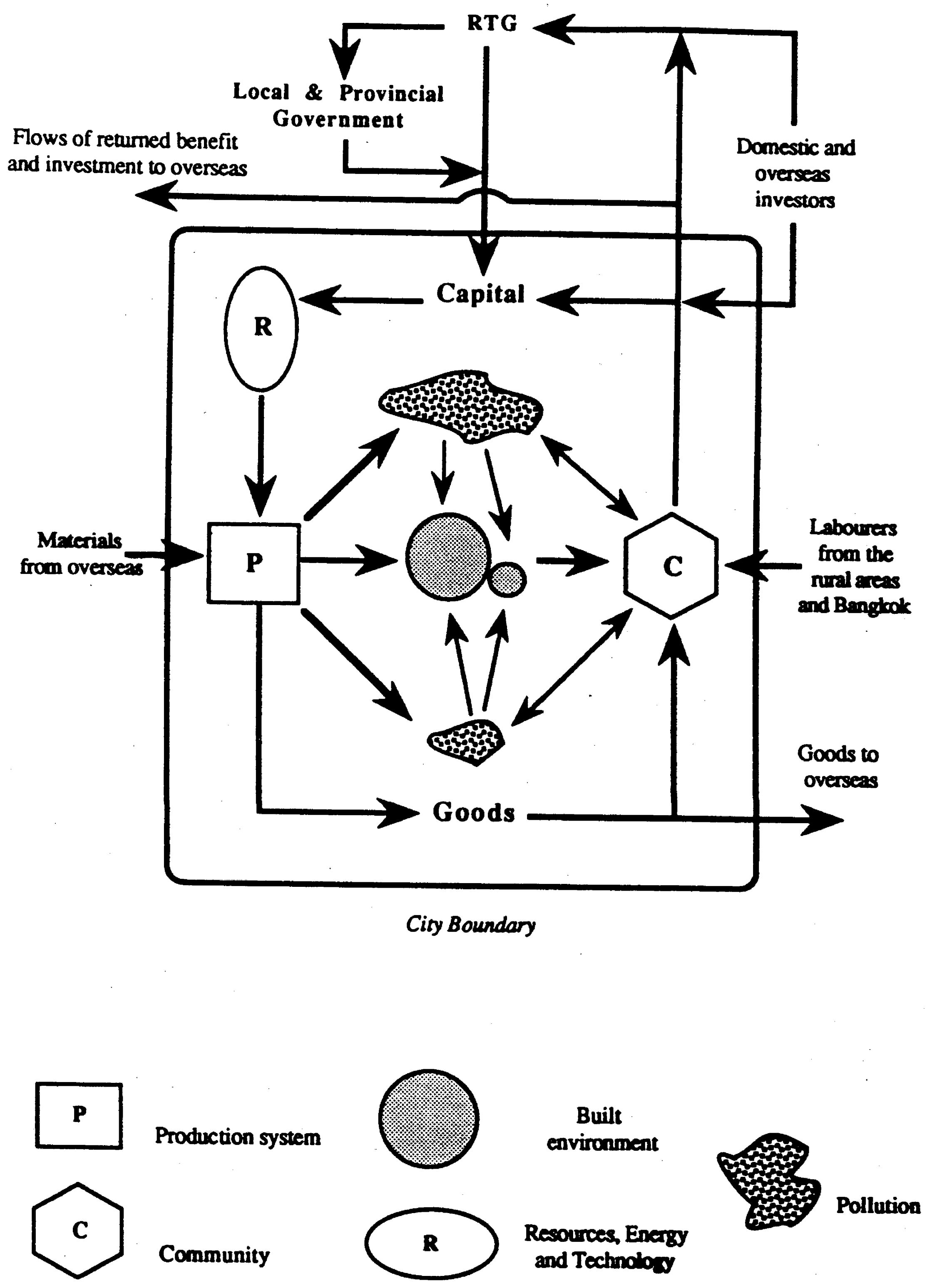


Figure 7.6 Samut Prakan's Existing Industrialisation and Urban Management in the early 1990s

labourers migrated to the Province in the search for higher paid jobs. Generally, domestic entrepreneurs, singly or in joint ventures with overseas entrepreneurs, have constructed their factories along major roads whereas most multinational enterprises have concentrated their investments within industrial estates. As industrialisation and urbanisation have accelerated, the resultant pollution has degraded the living environment. Little investment has been directed to pollution treatment and control — it is not a profitable activity!

Unquestionably, no business group counts pollution treatment in its production costs because an additional cost lessens its competitiveness in domestic and overseas markets. However, if the urban environment is not secured, no one can get benefit from industrialisation. The RTG, the Provincial Government and all business groups inevitably have to bear this burden together. Initially, the RTG and the Provincial Government themselves have to start with pollution control at the sources and with environmental monitoring. Then they have to get cooperation with business groups to resolve environmental problems.

In pollution control, the Department of Industrial Works and the Provincial Office of Industry should stop permitting new polluting firms to establish in Samut Prakan. The RTG should urgently relocate all polluting industries into the industrial estates where it is convenient to manage waste. Furthermore, public waste treatment facilities have to be constructed in order to provide sufficient service to households, commercial and industrial activities where they locate outside the industrial estate (Figure 7.7).

As the Provincial Government has collected more revenue during the past few years, the RTG should provide the Provincial Government technical and financial support in matching proportion to encourage the Division of Planning and Projects (DPP) to monitor environmental problems, especially in the canal network. In addition, the RTG could assist the DPP establish an Environmental Fund in order to provide loans to small- and medium-scale industries that want to improve their treatment facilities.

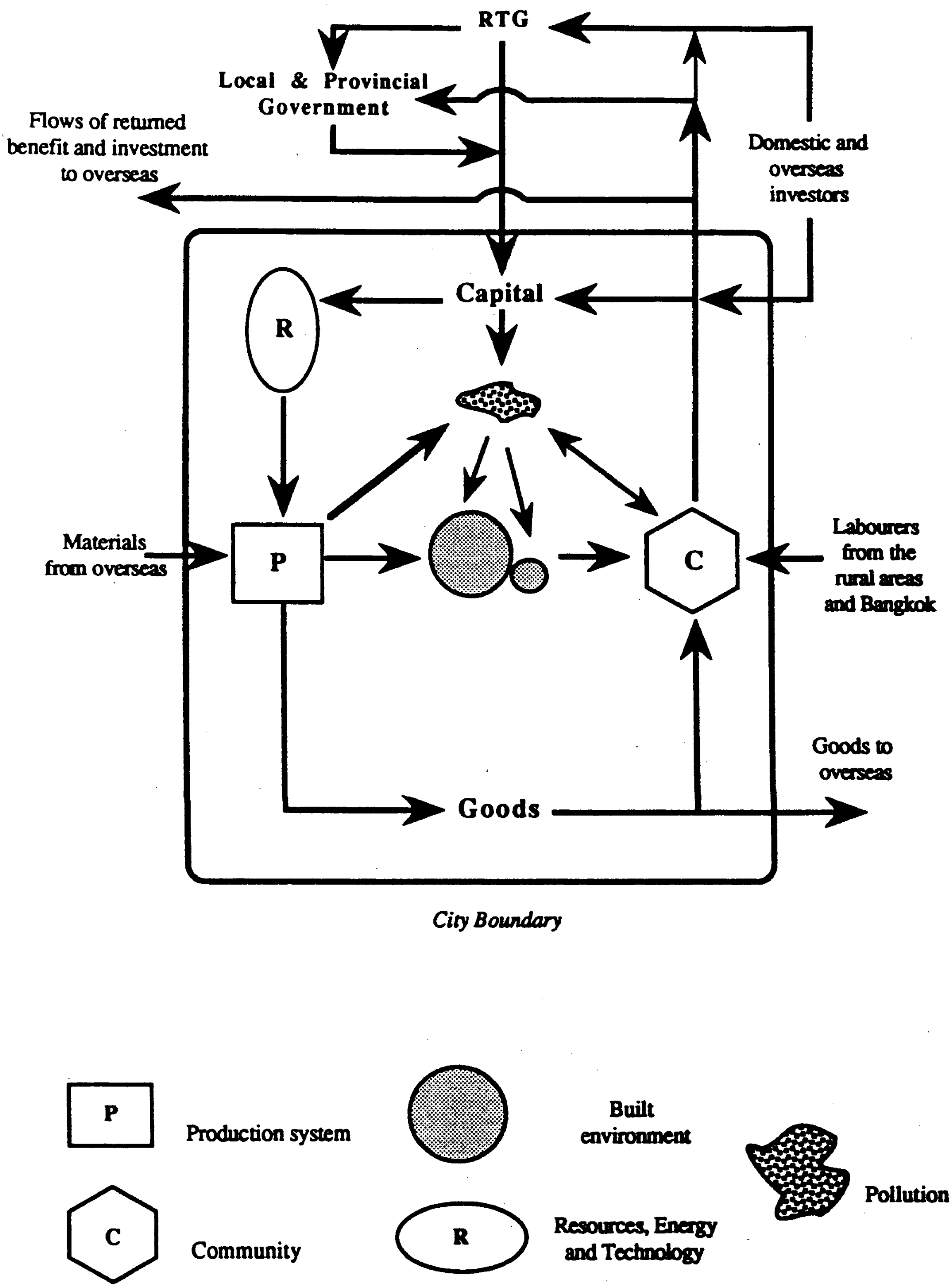


Figure 7.7 Suggested Local Administration on Industrialisation and Urban Environment for Samut Prakan

Finally the RTG and the Provincial Government could have bargaining power with business associations to lobby industrial entrepreneurs in environmental protection and in upgrading industrial technology. For example, the Provincial Government can ask for collaboration from local businessmen through the Joint Public and Private Sector Consultative Committee (JPPCC) or the Provincial Chamber of Commerce, while the RTG can influence both domestic and the multinational enterprises through the Federation of Thai Industries, the Thai Bankers Association, the Thai Chamber of Commerce and the Foreign Chambers of Commerce. Moreover, if public agencies could not sufficiently provide any urban service, especially water supply and waste collection and treatment, privatisation of some services may be necessary. This will let the private sector get involved in urban management.

RESUME

This Chapter has highlighted that Thailand's administrative structure is a major barrier to improving Samut Prakan's urban environment. In theory, the provincial government has power to monitor the performance of local administration. In practice, the Provincial Government of Samut Prakan — as elsewhere in Thailand — has limited authority and finance to manage the urban areas. Heavily reliant on assistance from the RTG, it is not surprising most local needs are ignored, being subservient to national demands. At best, the Provincial Government has been able to formulate development guidelines reflecting national policy.

The RTG's interference hampers the Samut Prakan's Provincial Government attempts at environmental improvement. Public development proposals initiated by the RTG run counter to the Provincial Government's supports. Most projects earmarked for Samut Prakan reflect national demands and encourage the private sector (i.e. domestic and foreign businessmen) to alter the provincial landscape for its own benefit. Undoubtedly, the relationship between state and business groups is a patron-client relationship. Their collective will is to monopolise provincial resources with little thought being given to conservation.

Apparently, no one wants to invest in environmental treatment and control because it is non-profitable activity. The RTG usually compromises with the businessmen in this matter. At the same time, the RTG has delayed environmental protection schemes, which allows polluting activities to continue. As the urban environment deteriorates, both the economy and community are affected. Therefore, the RTG, the Provincial Government, and all business groups have to assume a collective responsibility for environmental degradation if they still want to accumulate wealth from Samut Prakan's resources without social upheaval.

However, how will the Provincial Government react to the changing world economy? Since the early 1990s, the rapid industrialisation of Indonesia, China and Vietnam has attracted direct foreign investment. Some Thai capitalist groups and foreign firms have invested in these countries. Consequently, Samut Prakan may lose its attraction as a prime site of industrial activities. Unquestionably, this situation is beyond the Provincial Government's control. The RTG will have to intervene by creating new policies which will make Samut Prakan's urban environment more attractive to investors. Further issues are raised — how are the major policies in the National Economic and Social Development Plan developed? What are the key influences affecting policy making? How does the bureaucracy implement policy and check on performance? These issues prompt an investigation of the evolution of the National Plans and the Thai bureaucracy in the next chapter. Particular attention will be paid to the RTG's attempt to integrate industrialisation and urban environmental protection within Greater Bangkok.

CHAPTER VIII

MACRO-PLANNING FOR GREATER BANGKOK

Since 1961, the implementation of the National Economic and Social Development Board's Plans have transformed Greater Bangkok into a 'privatised city'. External pressures especially from the United States, Japan, the International Monetary Fund (IMF) and the World Bank have been influential in plan formulation, though the Royal Thai Government (RTG) has remained the most powerful agent. Raising economic growth by industrialisation has always been the most important national planning objective. In the process, Greater Bangkok has become Thailand's prime industrial base for both domestic and foreign investors. Supported by an accommodating urban policy and lax environmental regulations, Greater Bangkok has attracted both public and private investment, and large numbers of labourers from rural areas. Despite political, economic and social instabilities in Greater Bangkok, rapid industrialisation and urbanisation is proceeding.

Such rapid changes in Greater Bangkok since the 1960s raise a series of key issues — how have National Economic and Social Development Plans influenced industrial and urban environmental patterns in Greater Bangkok? Reflecting on the planning process, who have benefited from these Plans? More specifically, how have industrial, urban and environmental policies been influenced by the changing composition of Thai Cabinets and overseas pressure? How well have public agencies performed in providing urban services for industrial investors and in managing the environment? Will the neglect of the urban environment jeopardise the sustainability of Greater Bangkok as a privatised city?

Examination of industrial, urban and environmental policies within the national planning framework provides grounds for examining how the aims of successive Cabinets influenced by external pressure groups have affected Greater Bangkok (Section

1). Then, the roles of public agencies in providing urban services, especially for industrial activities, and managing the urban environment are investigated (Section 2). Finally, recommendations for sustaining the privatised city of Greater Bangkok are discussed (Section 3).

1. INDUSTRIAL DEVELOPMENT AND THE URBAN ENVIRONMENT

By 1993, the Office of the Prime Minister's National Economic and Social Development Board (NESDB) had promulgated seven five-year National Plans to guide economic and social development. As noted, industrial policy has been a recurrent theme in national planning in a bid to encourage economic growth. Since the Fourth National Plan (1977-1981), urban policy has been designed to accommodate new industrial activities whereas environmental policy has been restricted to conserving resources. National plans are designed by technocrats without being subject to parliamentary scrutiny or public hearing (Rangsan, 1989: 20). Policies and their implementation, however, have been altered to accommodate shifts in the composition of Cabinet and external pressures from superpower and international financial organisations.

Since the first National Plan was brought down in 1961 military dictators or appointed civilian prime ministers have regularly overridden technocratic objectives. Most Cabinets have cooperated with external pressure groups to maximise financial and technical assistance. Yet they have sought to make Thailand a 'strong state' with the highest prestige and influence being invested in the position of Prime Minister. The Prime Minister's influence has been limited by his personality and the extent to which he enjoys the support of his party or, in the case of a military Prime Minister, the Army. However, the Prime Minister is always dependent upon the support of opposition political groups and the public. Civilian prime ministers have been less powerful than their military counterparts due to the weaknesses in the party system. Even the power of a military Prime Minister, however, is by no means absolute. No Prime Minister has maintained office where he has pursued policies that split his party or provoked vocal public opposition. Invariably, he has been overthrown by a coup or mass uprising (Suchit, 1982: 60-61). Although Cabinet reshuffles are frequent during a fixed four-year term, the bureaucratic system is resilient to political change.

The bureaucracy, as a tool of Cabinet administration, therefore, effectively controls Thai society and its resources. As noted in Chapter VII, top-down administration can mobilise resources through direct and indirect revenue collection and through the reorganisation of manpower and production. Not only can effective institutions mobilise state revenues for domestic purposes, but they can alleviate some of the severe pressures on Thai leaders from the international economy arising from deficits in balance of payments and debt repayments (Migdal, 1988: 207). Unquestionably, the Thai bureaucrats' perception of economic development is based on the exploitation and conversion of natural resources, not resource sustainability (Chai-anan and Kusuma, 1992: 24-25). National policies have supported the RTG's attempt to maximise resources and facilitate labour migration with little attention being paid to any adverse environmental effects. Since the First National Plan (1961-66), industrial and urban policies have encouraged the transformation of Greater Bangkok to meet the needs of the RTG, domestic and overseas investors, and foreign creditors unaffected by much consideration of environmental conservation (Table 8.1).

Both the *First National Economic Development Plan* (1961-1966) and the *Second National Economic and Social Development Plan* (1967-1971) promoted industrialisation through supporting import substitution activities.[1] No attention was given to the need for special urban and environmental policies. The import substitution strategy protected the investments and markets of both domestic and multinational enterprises. Simultaneously, state investment was relegated to the provision of supporting infrastructure with an emphasis on road improvements within Bangkok and the construction of regional highways. Without strong planning regulations, all public development schemes and private investments were dictated by market forces. As import-substitution industries

[1] Full name of the first National Plans does not cover 'social development'.

Table 8.1 Influences of Internal and External Pressure Groups to the Industrial, Urban and Environmental Policies of the National Economic and Social Development Plan Transforming Greater Bangkok, 1961-1992

Plan	Policy			Impact on Greater Bangkok	External influence	Cabinet	
	Industrial	Urban	Environment			Dominant group	Period
First Plan (1961-1966)	ISI	None	None	Most infrastructure schemes were constructed in Bangkok to support industrialisation.	The US, IMF, and the World Bank were influential in the RTG's decision making.	MB	1959-1963
Second Plan (1967-1971)	ISI	None	None	Most infrastructure schemes were constructed in Bangkok to support industrialisation.	The US, IMF, and the World Bank were influential in the RTG's decision making.	MB MB	1963-1969 1969-1971
Third Plan (1972-1976)	ISI & EOI	None	None	The RTG annexed Thonburi as a part of Bangkok Metropolitan Area (BMA). More emphasis on the construction of housing for low income earners and other infrastructure had been proposed in the BMA.	After the social uprising of 14 Oct 1973, the influence of the US, IMF and the World Bank waned because of rising nationalism and the departure of American troops in Thailand.	MB MB MB BC BC BC BC	1972-1973 1973-1974 1974-1975 1975-1975 1975-1976 1976-1976 1976-1976
Fourth Plan (1977-1981)	ISI & EOI	Polycentric development	REMR	The RTG attempted to redistribute industry to regional cities to decrease immigration rate of Bangkok and improve its urban environment and infrastructure. The RTG identified sites of new industrial and residential activities in Bangkok's vicinity and promoted the new economic zone of the Eastern Seaboard in Chonburi Province.	After the coup d'état of 6 Oct 1976, the US, IMF and the World Bank regained their influence. Apparently, the World Bank sponsored the 'secondary city' project. Increasingly, Japanese and EEC investors had a more powerful influence on the RTG's policy making.	MB MB MB MB BC MB	1976-1977 1977-1979 1979-1980 1980-1980 1980-1981 1981-1981

Note: ISI — import-substitution industrialisation; EOI — export-oriented industrialisation; RMER — resources management and environmental rehabilitation; PPP — polluter pays principle; MB — Military and bureaucrats; BC — Businessmen and civilians covering politicians; EEC — European Economio Community.

(Continued next page)

Table 8.1 Influences of Internal and External Pressure Groups to the Industrial, Urban and Environmental Policies of the National Economic and Social Development Plan Transforming Greater Bangkok, 1961-1992 (Continued)

Plan	Policy			Impact on Greater Bangkok	External influence	Cabinet	
	Industrial	Urban	Environ-ment			Dominant group	Period
Fifth Plan (1982-1986)	ISI & EOI	Polycentric development	RMER	Decentralisation of industrial and residential activities from Bangkok to regional cities was still promoted. However, the RTG maintained and developed infrastructure, especially road, water supply and flood protection schemes for the BMA.	Between 1980 and 1987, the World Bank and IMF intervened in the RTG's economic policies on financial and tax and tariff systems. Between 1986 and 1987, the Japanese Government pushed the RTG to complete the Eastern Seaboard.	BC BC	1981-1983 1983-1986
Sixth Plan (1987-1991)	ISI & EOI	Polycentric development	RMER	Decentralisation failed because industrialisation and urbanisation continued to be concentrated in Greater Bangkok. Its spill-over effect extended to neighbouring provinces (i.e. Chachoengsao, Ayutthaya, Saraburi, Ratchaburi, Chonburi, and Rayong Provinces).	Between 1988 and 1990, large sums of foreign direct investment poured into the Thai economy. After the coup of 23 Jan 1991, overseas assistance and foreign direct investment declined rapidly.	BC BC	1986-1988 1988-1991
Seventh Plan (1992-1996)	ISI & EOI	Regional network strategy	RMER & PPP	Industrial growth in Bangkok has slowly declined. The National Plan aimed at transforming Bangkok into a centre for services and finance in Southeast Asia. This has encouraged rapid industrialisation and urbanisation within Greater Bangkok. Further growth has linked to the new economic zone in Chonburi Province.	Between the social uprising in May 1992 and mid-1993, overseas assistance increased. In contrast, foreign direct investment decreased because of alternative sites to invest outside Thailand.	MB BC MB BC	1991-1992 1992-1992 1992-1992 1992 -

Note: ISI — import-substitution industrialisation; EOI — export-oriented industrialisation; RMER — resources management and environmental rehabilitation; PPP — polluter pays principle; MB — Military and bureaucrats; BC — Businessmen and civilians covering politicians; EEC — European Economio Community.

grew Bangkok became the country's key production and consumption centre — the concentration of industrial activities in its inner city area leading to urban sprawl along major highways. Brought down during a period of military domination under Prime Minister Marshal Sarit (1958-1963) and Thanom Kittikachorn (1963-1973), the aim of the first two plans was to maintain social stability and boost economic growth through foreign investment and technical assistance.[2] The latter were embodied in conditional loans from the United States, the IMF and the World Bank. In return these lenders supervised the national planning activities of Thai bureaucrats. At this time urban planning and the environment were not on their agenda (Morell and Chai-anan, 1981: 5; Suchit ,1982: 48-49; Rangsan, 1989: 28-29; Hewison, 1989: 149; Robison, 1989: 377; Rimmer, 1992: 3).

The *Third National Economic and Social Development Plan* (1972-76) introduced export-oriented industrialisation as a new strategy because import substitution was less effective as the domestic market was saturated. No thought, however, was given to developing special urban or environmental policy.[3] In the process, the RTG introduced a program of export incentives in its new *Investment Promotion Act of 1972* which encouraged the development of domestic capital and the expansion of manufacturing output for both national and overseas markets (Robison, 1989: 377). Consequently, Bangkok retained its position as the country's prime industrial base. As the urban sprawl continued, the Bangkok Metropolitan Administration extended its boundary, with the RTG's consent, and annexed Thonburi Province on the left bank of Chao Phraya River. Many plans for improving Bangkok's urban environment were introduced including slum clearance, new housing construction for low income earners, and other infrastructure developments in a bid to attract more domestic and overseas investment. Invariably, this

---

[2] During Sarit and Thanom governed Thailand, stability and order were maintained through a combination of strategies: suppression of potential opponents, cooptation of intellectuals and businessmen, dominance over the communications media, and patronage based on extensive corruption (Morell and Chai-anan, 1981: 5).

[3] In 1975, the RTG declared the *Town Planning Act* and the *Enhancement and Conservation of National Environmental Quality Act* (NEQA 1) which affected the establishment of both the Department of Town and Regional Planning under Ministry of Interior and the National Environment Board (NEB) under the Office of the Prime Minister respectively. However, there no clear urban and environmental policies were formulated in the Third National Plan.

aggravated the problem and widened the disparity in incomes between Bangkok and the rest of the country. Although there was no explicit environmental policy, the Third Plan required the Ministry of Industry to expand its activities to cover pollution (air and water) and occupational health. Also the budgets of municipalities and sanitary districts were augmented to provide more expenditure on sanitation and the disposal of solid waste (Stubbs, 1981: 15). Along with rapid industrialisation and urbanisation, political instability occurred in Bangkok because of the power struggle in Cabinet between military and bureaucrats on one side against businessmen and civilians on the other.[4] Simultaneously, the influence of the United States, the IMF and the World Bank declined as there was a marked withdrawal of foreign investment following rising nationalism and the departure of American troops in Thailand (Robison, 1989: 378; Rangsan, 1989: 32).

The *Fourth National Economic and Social Development Plan* (1977-1981) maintained both import substitution and export promotion as its primary industrial strategies. There was also an amendment of the *Investment Promotion Act of 1977* to attract business ventures to sites outside Greater Bangkok, especially to the Eastern Seaboard in Chonburi (TDRI, 1991: 7). As part of the Fourth National Plan, the polycentric concept and 'secondary city' project sought to decentralise and promote regional growth.[5] This policy, however, was unsuccessful. Neither the Eastern Seaboard nor other regional cities attracted private enterprises because of the absence of infrastructure. Contrary to the policy's precepts, most new infrastructure (i.e. roads, electricity, water supply and telephone) was concentrated in Greater Bangkok. Besides, no attention was paid to either environmental protection or local improvement within urban areas because environmental policy aimed at managing and rehabilitating resources in the rural areas. With strong support of Cabinets dominated by the military and

---

4 During the Third National Plan, the people's uprising on 14 October 1973 brought an end to military rule. The number of military personnel in subsequent Cabinets declined. Even the overthrow of the civilian government in 1976 did not restore the military groups to its former importance. Nevertheless, the military maintained its veto power over subsequent Prime Ministers and Cabinets as governments became shifting coalitions of parties in which factions of Bangkok-based capital were the dominant influences (Robison, 1989: 378; Rangsan, 1989: 32).

5 The secondary city projects were aimed at Khon Kaen, Nakhon Ratchasima, Ubon Ratchathani, Udonthani, Chonburi, Phitsanulok, Chiangmai, Phuket, and Songkla-Hat Yai (Phisit, 1988: 88; Rimmer, 1992: 33).

bureaucrats after the coup d'état of 6 October 1976, the IMF and the World Bank had another chance to exert greater influence over domestic policy through their role in alleviating debt and capital formation problems.[6] Unquestionably, these lenders supervised technocrats in urban and environmental policies designed to support the Thai economy.[7] In addition, Japanese and the European Economic Community (EEC) investors had increasingly intervened in the RTG's policy making body, especially the NESDB (Rangsan, 1989: 27).

The *Fifth National Economic and Social Development Plan* (1982-86) continued to encourage import substitution and export-oriented industrialisation with the supportive strategies of growth decentralisation, resource management and environmental rehabilitation in the rural areas. The Eastern Seaboard was promoted as a site for large industrial activities and the country's second sea-port whereas there was little development of infrastructure in other regional cities. In contrast, Bangkok's urban environment was maintained and improved through the construction of expressways, water supply and flood protection which attracted industrial entrepreneurs (Phisit, 1988: 90). These activities throughout the Fifth Plan were promoted by a strong business-civilian coalition under Prime Minister General Prem Tinsulanond.[8] The Prem Cabinets developed a reputation for efficient economic management under the supervision of the World Bank and the IMF.[9] In the latter phase of this Plan, the Japanese Government provided assistance to develop the Eastern Seaboard.[10] While such intervention

6 In the late 1970s, the Thai economy experienced increasing debt, budget and balance of payments deficits after the second oil shock of 1979. Loans from the IMF and the World Bank were conditional on structure adjustment involving the reduction of protection levels, a devaluation and the deregulation of prices (Robison, 1989: 378-390).

7 The World Bank sponsored a 'secondary city' project in a bid to mitigate the over concentration of population and industrial activity in Bangkok (Phisit, 1988: 88).

8 In fact, General Prem Tinsulanond had been appointed Prime Minister since 12 March 1980 or the latter phase of the Fourth National Plan (1977-1981). He had been a head of five consecutive Cabinets which mainly consisted of businessmen and civilians (see Appendix 6).

9 The World Bank and the IMF intervened in the RTG's financial and tax and tariff systems. In 1983, the RTG devalued the Thai currency and changed some specific tax collection procedure under supervision of the IMF (Rangsan, 1989: 36-47; Robison, 1989: 379).

10 Between 1986 and 1987, the Japanese firms (e.g. construction and petrochemical firms) asked the Japanese Embassy in Bangkok as well as the Japanese Government to put pressure on the RTG to complete the Eastern Seaboard (Rangsan, 1989: 36-47).

strengthened Thailand's export-oriented industrialisation, it aggravated Greater Bangkok's congestion.

The *Sixth National Economic and Social Development Plan* (1987-1991) still concentrated on import substitution and export-oriented industrialisation. Urban and environmental policies continued to maintain polycentric development, and resource management and environmental rehabilitation in the rural areas. No consideration was given to protecting the environment in urban areas in the Sixth National Plan. The promotion of regional cities in this Plan failed because Greater Bangkok attracted most investment. As a result, there has been a shift in emphasis among planners towards managing the Greater Bangkok's spatial structure more efficiently and equitably rather than trying to stop its growth (Phisit, 1988: 80-97; Rimmer, 1992: 12). Further, uncontrolled industrialisation and urbanisation in Greater Bangkok triggered a spill-over into Chachoengsao, Ayutthaya, Saraburi, Ratchaburi, Chonburi, and Rayong Provinces generating severe infrastructural problems and environmental deterioration. Such frantic investment reflected the rising number of businessmen and civilians in the Cabinets under General Prem Tinsulanond and General Chatichai Choonhavan.[11] Simultaneously, the influence of the IMF and the World Bank was replaced by other international creditors (e.g. the Asian Development Bank or ADB) because the RTG could obtain cheaper alternative loans and improve the balance of payments (Robison, 1989: 378). After the coup on 23 February 1991, however, overseas assistance and direct foreign investment declined sharply.[12]

[11] General Chatichai strongly encouraged new public and private investment. He reduced power of the state's policy agency, the NESDB, reducing the Board to a planning and consultative bureau without any vetting power over new projects (Murray, 1992: 28).

[12] Undeniably, Chatichai's attempts to transform the Thai political structure caused the coup. He had broken up the traditional consensus of Thai politics — the finely balanced cooperative relationship between the military, the bureaucracy, businessmen and civilians, each with their own roles, and each tacitly agreeing not to interfere with the other. By eliminating the influence of civil service and all opposition parties, Chatichai slowly transformed his inner Cabinet into the Government's most powerful decision-making body. However, the Chatichai experiment was brought to an end by a coup d'état in late February 1991. As a result, the military and bureaucratic groups had regained their control of the Cabinet during the latter phase of the Sixth National Plan. The NESDB was retrieved a more powerful role (Murray, 1992: 39).

The *Seventh National Economic and Social Development Plan* (1992-96) not only focused on import substitution and export-led industries, but it also emphasised the promotion of the service sector following shifts in the direction of the world economy. As the Seventh National Plan highlighted that Bangkok was expected to be a centre of air-transport, finance, commerce and service supported by industrial centres in neighbouring provinces in order to compensate for its industrial decline. It also incorporated a regional network strategy to resolve the spatial inequalities generated by urban-based industrialisation centred on Greater Bangkok by inducing regional economic expansion through accelerated rural development. Within the regions, this approach was designed to move attention from concentrating on a single municipality to the coordinated exchange of goods, people and information between regional clusters of cities through improved transport and communication links (Rimmer, 1992: 25). Although both resource management and environmental rehabilitation were encouraged in the Seventh Plan, there was stronger emphasis on the 'polluter pays' principle. The Plan also put a stronger stress on physical environmental quality measurements (e.g. the amount of 'biochemical oxygen demand' in all water bodies has to be less than 4 mg/l). There was no guarantee, however, that these values could be achieved.[13] These attempts were initially made by the first interim Government of Anand Panyarachun dominated by military and bureaucrats.[14] Between 1991 and 1992, there were four Cabinets — the outcome of a series of military coups and a popular uprising. The political instability affected both the effectiveness of industrial, urban and environmental policies and disrupted external pressures exercised by superpowers and international financial organisations. The RTG, therefore, had the most influence on the National Economic and Social Development Board.[15]

---

[13] As the government relied on the private sector to stimulate the national economy during the 1990s, there was a danger that the new environmental policy could obstruct industrial investment.

[14] Between March 1991 till April 1992 and May till September 1992, Anand Panyarachun was a Prime Minister of two interim governments. Although he is a leading businessman, his former background was a technocrat as well as a diplomat in the Ministry of Foreign Affairs. In his two Cabinets, there was a high proportion of technocrats that was influential to government's decision making and the NESDB's policy making.

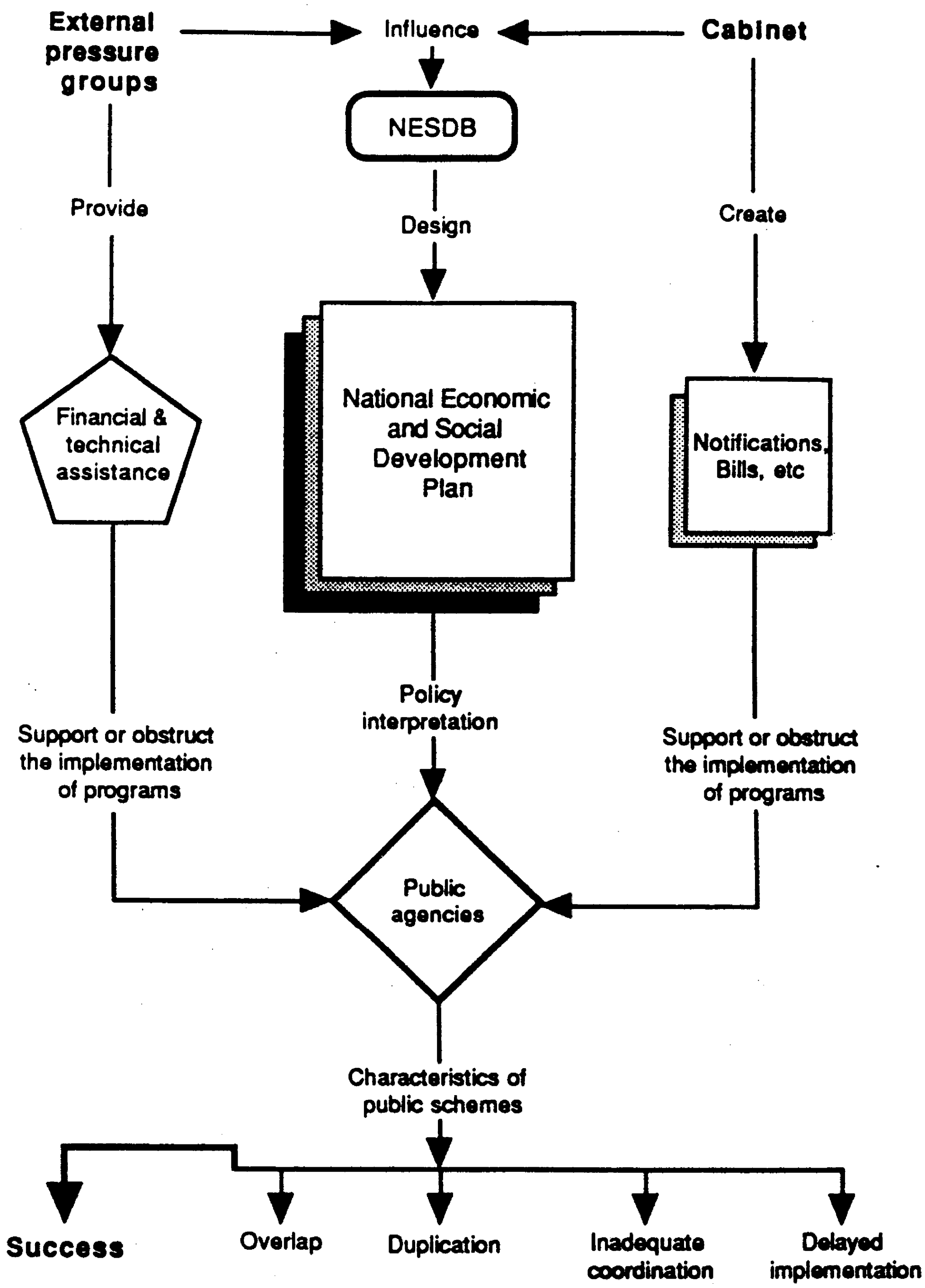
[15] On 9 September 1991, it was the first time in Thailand that there was a public hearing of the National Plan throughout the country by mass media. The Anand Government and civilians had criticised a draft of the Seventh National Plan before it was corrected and implemented later that year.

Popular uprisings in 1975-1976, 1980-1991 and 1992 undermined Thailand's 'strong state' and the commitment with external pressure groups. Although most Cabinets could extract and appropriate resources, members were too preoccupied in power struggles. Cabinets have changed regularly but public agencies have been more stable. All public agencies of the RTG have played a major role in the transformation of Greater Bangkok with the support of national policies. The prime goal of all policies has been to encourage industrialisation through supporting the private sector's expansion. As this support has had positive and negative effects, there is a need to understand the administration of public agencies and its relationship to industrial and urban environmental development.

2. THAI BUREAUCRACY

The Thai bureaucratic system is well-known for its red tape and inefficiency. Although policies outlined in the National Economic and Social Development Plan are intended as guidelines, most public agencies do not follow them. Since the Fifth National Plan (1982-86), there has been a strong emphasis on administrative reform due to the lack of coordination between planning and implementing agencies at all levels of government. As noted, shifts in the composition of Cabinet and external pressures could damage such coordination in the provision of public services.

As illustrated in Figure 8.1, technocrats in the National Economic and Social Development Board have prime responsibility for policy design, though this is subject to intervention by Cabinet and external pressure groups. Once the Plan has been published, both groups either support or obstruct programs to meet their own agendas. While international organisations exert their influence through financial assistance and the supervision of technocrats engaged in national planning, Cabinet control is exerted through the promulgation of notifications, bills, ministerial resolutions or acts. As noted, different public agencies have their own interpretation. These do not necessarily



Note: External pressure groups — Superpower nations and the international organisations
NESDB — National Economic and Social Development Board

Figure 8.1 Performances of Public Agencies Reflecting National Policy and External Pressure Groups

coincide. Inevitably, there is an overlap and duplication of functions (Chai-anan, 1982: 89). At best, this process results in inadequate coordination. At worse, it delays implementation.[16] Significantly, the powers of appointment and removal of top bureaucrats from office is the Cabinet's preferred effective tool for curbing threatening behaviour (Migdal, 1988: 214). Shuffling bureaucrats, therefore, is an effective way of speeding or delaying the implementation of national policies.

During the early 1990s, there were twenty-five major government departments and twenty public enterprises under nine Ministries involved in industrial development and urban environmental management (Table 8.2). As noted, the NESDB outlines different national development policies. Most Ministries, however, have never created their own plan to reflect national policies. Consequently, sub-agencies have to draw up their own implementation plans (pers. comm., NESDB officials, 16 July 1991; pers. comm., officials of Ministry of Industry, 29 August 1991). This lack of coordination is a feature of top-down administration. Further, there is no horizontal coordination between ministries and implementing agencies. Not surprisingly, performances of different public agencies involved in the same development scheme differ markedly because of variations in interpretation of goals and objectives by individual officials (Chai-anan, 1982: 93). Greater Bangkok's industrial promotion and urban policies, therefore, can be described separately.

Industrial Promotion

No central agency is involved in promoting industrial development in Thailand. The Department of Industrial Promotion under the Ministry of Industry should be the major agency in promoting industrial activities, but its role is limited only to providing loans to small- and medium-scale industries and advising entrepreneurs how to improve

[16] Chai-anan (1982: 89-92) also pointed out bureaucratic values and behaviour are another cause of unsuccessful public administration. For example, personalism and factionalism could lead to non-cooperation among public agencies or corruption of public resources.

Table 8.2 Major Government Departments Involved in Industrial, Urban and Environmental Development

Ministries	Departments
Office of the Prime Minister	Office of the Board of Investment Office of the National Economic and Social Development Board Electricity Generating Authority of Thailand*
Ministry of Agriculture and Co-operative	The Royal Irrigation Department
Ministry of Commerce	Department of Export Promotion Department of Internal Trade Department of Foreign Trade Public Warehouse Organisation*
Ministry of Finance	The Customs Department The Fiscal Policy Office The Revenue Department Bank of Thailand*
Ministry of Industry	Department of Industrial Promotion Department of Industrial Works Department of Mineral Resources Thai Industrial Standards Institute Industrial Estate Authority of Thailand*
Ministry of Interior	Department of Labour Department of Lands Department of Public Works Department of Town and Country Planning Expressway and Rapid Transit Authority of Thailand* Metropolitan Electricity Authority* Metropolitan Waterworks Authority* National Housing Authority* Provincial Electricity Authority* Provincial Waterworks Authority*
Ministry of Public Health	Department of Health
Ministry of Science, Technology & Environment	National Energy Administration Office of the National Environment Board National Research Council of Thailand Department of Science Service Thailand Institute of Scientific and Technological Research*
Ministry of Transport & Communications	Department of Aviation Harbour Department The Department of Highways Department of Land Transport Post & Telegraph Department Bangkok Mass Transit Authority* Express Transportation Organisation of Thailand* Port Authority of Thailand* Telephone Organisation of Thailand* The Communications Authority of Thailand * The State Railway of Thailand*

Note: * Public enterprise

Source: Adul, 1990. *The Siam Directory 1990-91.*

processing technology. Instead, the Board of Investment (BOI) under the Office of the Prime Minister has the more significant task of supporting promotional activities and providing investment incentives to medium- and large-scale industries, especially manufacturing exports. Other government departments, such as Bank of Thailand and the Customs Department (CD) take care of capital circulation and duty exemption of goods respectively (see Appendix 7 and 8). These uncoordinated efforts have resulted in Greater Bangkok's rapid industrialisation and uncontrolled urban sprawl.

As noted, there have been efforts to redistribute industrial activity to regional cities since the Fourth National Plan (1977-1981). However, they have been limited by conflicts between the Board of Investment and the Customs Department. The Board has sought to disperse industrial activity from Greater Bangkok to three investment zones (see Appendix 8). Only those projects which exported 80 per cent of their production or established their factories on designated industrial estates were permitted to locate in Greater Bangkok. This strategy was undermined by the Customs Department reducing duty on imported goods to five per cent. Further it weakened the Board's incentive to attract firms from Greater Bangkok (pers. comm. BOI officials, 17 June 1991).[17]

Moreover, the Departments of Export Promotion, Internal Trade, and Foreign Trade do not have roles in reallocating industries. They have mainly assisted domestic investors to market their products. Most multinational enterprises, however, do not require these services as they have their own marketing networks. Consequently, they are less likely to be attracted away from Greater Bangkok.

Many departments in the Ministries of Industry, Interior, and Transport and Communications have been influential in accommodating industry (Table 8.2). For instance, the Industrial Estate Authority of Thailand (IEAT) has developed factory sites

[17] Before 1990 the Customs Department under Ministry of Finance collected an average of 50-60 per cent on duty of imported goods, especially machinery and mechanical appliances following the Customs Tariff Decree B.E. 2530 (A.D. 1987), Section 12. In 1990 the Department declared a notification of the Ministry of Finance number 13/2533 which cancelled the former rate of duty collection of five per cent on imported goods.

with waste treatment systems. The Department of Labour has sought to reduce the number of labour disputes. In addition, the Ministry of Sciences, Technology and Environment has tried to improve industrial processes to conserve energy, foster innovation and develop new products. Coordination between government agencies engaged in providing urban infrastructure — roads, telephone, water and electricity — has been inefficient. Consequently, Greater Bangkok has grown largely in response to market forces (Watson Hawksley and SISAT, 1987: 2-4).

The Ministry of Interior controls water and electricity supplies in every province. Its agencies, the Metropolitan Electricity Authorities (MEA) and the Metropolitan Waterworks Authorities (MWA) service the Bangkok Metropolitan Area, Nonthaburi and Samut Prakan, whereas the Provincial Electricity Authorities (PEA) and the Provincial Waterworks Authorities (PWA) serve other provinces. Yet these organisations have rarely cooperated to resolve supply deficiencies. As a result, they have become dependent upon other departments providing electricity or water. For example, the Electricity Generating Authority of Thailand (EGAT) under the Office of the Prime Minister supplies electricity to metropolitan and provincial utilities derived from hydro power, lignite, natural gas and kerosene (Table 8.2). Although under different Ministries, the Departments of Public Works (DPW), Mineral Resources (DMR) have assisted metropolitan and provincial utilities to find ground water to supplement their supplies (pers. comm., DMR official, 29 August 1991; pers. comm., MWA official, 12 September 1991).

Many departments are engaged in road construction within Greater Bangkok — the Department of Public Works (DPW), the Expressway and Rapid Transit Authority of Thailand (ERTAT), and the Department of Highways (DOH) (Table 8.2). Lack of coordination between Public Works and other departments in other Ministries are frequent. Although Public Works constructs roads for local government (e.g. the municipality and the provincial administration organisation) and the Bangkok Metropolitan Administration, the route networks are planned independently of the

Expressway and Rapid Transit Authority of Thailand and the Department of Highways (pers. comm., an official of Samut Prakan's Provincial Office of Public Works, 13 June 1991).

As noted, the Department of Industrial Promotion (DIP) under the Ministry of Industry has assisted small- and medium-scale industrial entrepreneurs with technological advice and financial support. However, the DIP's responsibility focuses on only domestic industry (DIP, 1989: 2). Three departments under the Ministry of Science, Technology and Environment — the National Energy Administration, the Department of Science Service, and the Thailand Institute of Scientific and Technological Research — provide advice on production, but most of research is concentrated in improving quality or setting standards. As no assistance is given to large-scale or capital-intensive industries, such as petrochemicals, major pollution handling techniques have rarely been developed. Most industrial entrepreneurs, therefore, have been highly dependent on imported technology.

Managing the Urban Environment

The Department of Town and Country Planning (DTCP) has the prime responsibility for managing urban environment by controlling urban land use, construction and its negative impacts on the community. After receiving policy guidelines from the NESDB, the DTCP assists the municipalities and other urban communities in preparing general guidelines for urban land use. Urban management guidelines are incorporated in three main plans — regional, comprehensive and specific.[18] Basic infrastructure outlined in these plans is designed primarily to serve industry — the dispersion of other land uses being designed to minimise conflict. As there is no coordination between the DTCP and the National Environment Board (NEB) environmental values do not figure prominently.

[18] Normally, the DTCP is responsible for designing seven different plans — regional plan, provincial structure plan, comprehensive plan, specific plan, community development plan, rural development plan, and project plan.

In practice, urban development planning is a time consuming activity. After a regional plan is accomplished, a comprehensive provincial plan takes at least two years to pass through public hearings and a parliamentary consideration. Even then, its validity is limited to five years. Once the comprehensive plan is brought down a specific plan for urban areas within the province is developed — another time consuming process (pers. comm., DTCP officials, 15 August 1991). This protracted planning arrangement cannot keep pace with rapid industrialisation and accelerating urbanisation. As there is little control over development, government has to resolve the resultant environmental problems.

Urban planners in Thailand have restricted their interpretation of 'environmental value' to the development of green belts, open spaces and recreational areas. No consideration is given to expressing environmental quality in terms of clean air, clear water and uncontaminated soil. Significantly, there is no classification of industrial land use which recognises polluting and non polluting industries, though three different types of residential land use are identified.

Environmental quality monitoring and control should be the responsibility of a central co-ordinating agency. No such agency exists to monitor, protect and improve environmental quality. Responsibilities are fragmented. NESDB's Environmental Division established in 1973 formulates a national environmental improvement and protection plan. The National Environment Board (NEB) under the Office of the Prime Minister, as noted, created by *the Enhancement and Conservation of National Environmental Quality Act of 1975* (NEQA 1), establishes policy and coordinates environmental management among other public agencies.[19] The NESDB's Environmental Division, however, has been perceived as being ineffective and having an

[19] The *Enhancement and Conservation of National Environmental Quality Act of 1975* (NEQA 1) provided for the establishment of a new National Environment Board, with an office to handle its administration. A considerable number of technical personnel were transferred from the NESDB Environmental Division to staff this office. The Environmental Division itself, however, survived specialising on incorporating environmental matters in national planning (Stubbs, 1981: 23).

image of pro-development. Conversely, the National Environment Board (NEB) has not been given strong legal powers because of fears it would become a super agency. As a result, NEQA 1 had three major deficiencies: the absence of any overriding authority; the lack of power to enforce environmental impact assessment requirements; and ambiguities in environmental standards (Stubbs, 1981: 10-12, 22-23).

In 1978, the *Improvement and Conservation of National Environmental Quality Act of 1978* (NEQA 2) restructured the National Environment Board. It removed the Board from the Office of the Prime Minister to a more subordinate role in the new Ministry of Science, Technology, and Energy.[20] NEQA 2 sought to overcome the deficiencies in the NEQA 1. However, it gave the NEB only limited authority to monitor and control environmental problems. In particular, the new Act did not invest the Board with power to punish the polluters. Environmental law continued to be a means of administrative regulation rather than a way of resolving disputes between public and private interests (Stubbs, 1981: 10-12).

In 1992, NEQA 2 was replaced by the new *Improvement and Conservation of National Environmental Quality Act of 1992* (NEQA 3). The Act split the National Environment Board into three independent sections — the Office of Environmental Policy and Planning, the Department of Pollution Control, and the Department of Environmental Quality Promotion. It also provided the Department of Pollution Control with the power to investigate and fine polluters. The Department's powers, however, overlapped with the Department of Industrial Works which was responsible for industrial pollution monitoring and control. Further the Environmental Division within the NESDB has maintained its functions.

Apart from the Environmental Division and the National Environment Board, four agencies are responsible for urban environmental management — the Department of Industrial Works (DIW), the Industrial Estate Authority of Thailand (IEAT), the

[20] The Ministry of Science, Technology, and Energy was later renamed as the Ministry of Science, Technology, and Environment.

Department of Health (DH) and the Department of Public Works (DPW). Although both DIW and IEAT have authority to monitor the impact of factories on the environment and enforce regulations. Only the DIW has a unit engaged in environmental planning (TDRI, 1991: 36).[21] Yet the Department of Health (DH), whose main responsibility is for family planning, food hygiene, and occupational health, has supplied assistance on waste treatment and pollution control. Some support is provided by the Department of Public Works (DPW) to provincial governments, municipalities, and sanitary districts especially on the construction of road, water storage, and sewage treatment systems. Unquestionably, there is a lack of coordination. Although both DIW and IEAT are under the Ministry of Industry, there is no coordination in waste management. Further, there is an overlapping responsibility between the DH and the DPW in waste management because the Ministry of Health and the Ministry of Interior operate independently.

3. SUSTAINING GREATER BANGKOK

Before discussing safeguards on Greater Bangkok's urban environment, it is necessary to reiterate the importance of resolving the lack of coordination between urban and environmental policies, the absence of interpretation of these policies at a ministerial level, and bureaucratic inefficiencies.

Urban and environmental policies have been subordinated to an economic policy based on industrialisation. Since the Fourth National Plan (1977-1981), no attempt has been made to direct polluting industries to specific locations. Instead attention has focused on reducing economic disparities between urban and rural areas through polycentric development. Although there are clearer strategies in urban and environmental policies (i.e. regional network strategy and polluter pays principle) in the Seventh National Plan (1992-96), there is still a lack of coordination. No environmental

[21] Basically, the enforcement of industrial pollution regulations rests with the DIW 's Industrial Environment Division. The Division is responsible for approval of environmental impact assessment reports based on the recommendations of the NEB and of pollution control measures proposed in factory license applications. However, the Division has difficulty in performing both its operational and enforcement functions on a nationwide basis because in 1991 it had less than 100 inspectors (Watson Hawksley and SISAT, 1987: 3/32; pers. comm. DIW officials, 8 July 1991).

safeguards are considered in urban policy despite Bangkok being promoted as a centre of finance and service. More emphasis, however, has to be concentrated on the importance of industrial waste reduction, treatment and disposal, environmental monitoring, shifts to less-polluting energy inputs, improvements in plant operations, and the redesign of end products. These criteria, however, may increase production costs and reduce industrial competitiveness in the world market. In addition, concentrating polluting industries in estates would allow for better monitoring and control waste disposal (TDRI: 1991: 8-9).

Top level ministerial officials rarely cooperate on any development issue. In theory, all ministries, as outlined in Figure 8.2, should cooperate to discuss and draw implementation plans for their departments and divisions from NESDB guidelines. Such an arrangement would not only correct ministerial coordination but it would also improve coordination between government departments, and provincial and local governments. If development projects are to be accomplished, Cabinet's resolutions and overseas assistance should encourage institutional changes. However, establishment of new committees for hosting development schemes or resolving problems is not always the best solution. As noted by Chai-anan (1982: 92), the Thai Cabinet has preferred to set up a committee for every conceivable type of problem. Committee members, however, have not been able to resolve bureaucratic red tape and other related problems until differences of inter-governmental co-ordination are dissolved.

The Royal Thai Government has to halt uncontrolled industrialisation and urbanisation to prevent further environmental deterioration. Unless environmental problems are addressed they may, together with an economic crisis, ignite social upheaval that could end Greater Bangkok existence as a 'privatised' city. Only a good balanced approach between economic development and urban environmental management can sustain the Extended Metropolitan Area. Although the power struggle between political groups in Cabinet and external pressures may distort the balance, a rejuvenated bureaucratic system could resolve such difficulties.

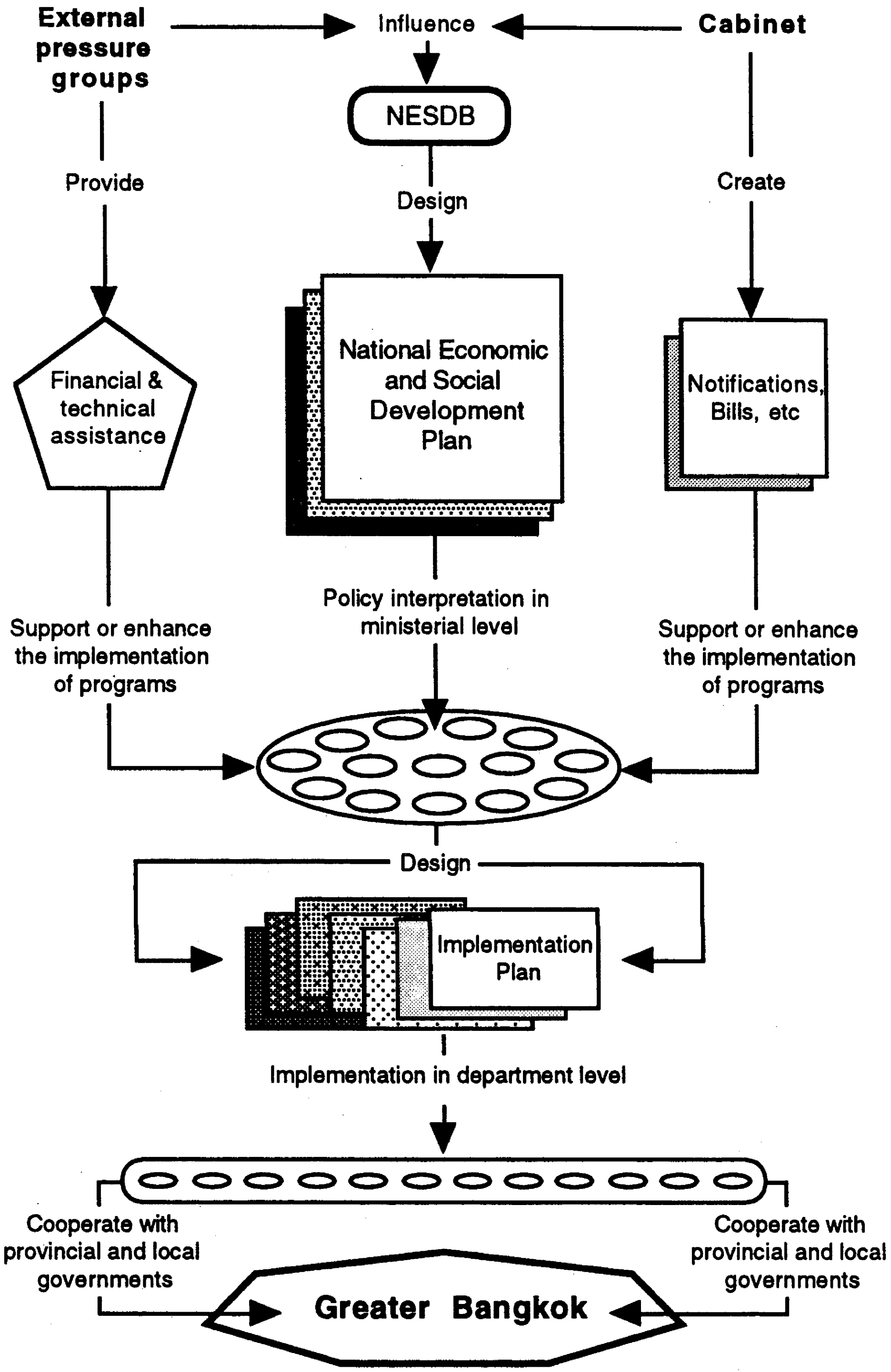


Figure 8.2 Suggested Bureaucratic System Managing Greater Bangkok's Economy and Urban Environment

RESUME

Until the late 1950s the Royal Thai Government was not in control of its destiny. It was subject to external pressure exercised by the United States and international financial organisations, notably the IMF and the World Bank through conditional loans. Before these loans were provided the rate of economic growth had to be raised and military and bureaucratic power expanded. These pressures influenced national policy guidelines designed by the NESDB. Economic growth based on exploitation of resources was the norm. Little control was exerted over industrialisation or the resultant industrialisation concentrated on Greater Bangkok.

Since the late 1980s, the Royal Thai Government has sought to free itself of constraining external pressures. Although there has been a high rate of direct foreign investment the influence of multinational enterprises has been limited by Thailand's political instability. As the Government has gained more political control, the NESDB has time to accommodate its wishes rather than those of external groups.

Management of Greater Bangkok's urban environment would be less chaotic if all ministries coordinated their plans and projects. Such plans would have to recognise the interplay between internal forces and external pressures. Further, institutional changes would eliminate bureaucratic red tape and inefficiency. Local environmental problems within Greater Bangkok have to be resolved if it wants to maintain its attraction as a site for multinational technology and capital.

CONCLUSION

In examining city evolution under different phases of capitalism, this thesis has demonstrated how industry, environment and community are interrelated. As there was no theoretical approach that encompassed qualitative changes in physical and social environment as cities evolved, this thesis has adapted Soja's interpretation of changes in the interrelationship between industrialisation and urban form as its basic framework. The framework's usefulness has been illustrated with reference to environmental changes within three prototypical cities: Manchester — the competitive industrial city (1840s-1910s); Chicago — the corporate-monopoly city (1920s-1940s); and Tokyo — the state-managed city (1950s-1970s). Its application in interpreting the transformation of Bangkok, however, has had to be adjusted to recognise qualitative changes in the nature of Thailand's capitalism that differs from Western experience. This has resulted in recognition of the post-*Sakdina* city (1850s-1920s) directed by Western capitalists; the bureaucrat-managed city (1930s-1950s) dominated by military and bureaucrats or state enterprises; and the privatised city since the 1960s influenced by domestic and multinational enterprises. Shifts from one city-type to another was not marked by Soja's economic turbulence and social upheaval but by a political struggle between Thai interest groups seeking to control Bangkok's key functions.

Most attention in this study has been concentrated on Bangkok as a 'privatised' city. In 1973, the people's uprising, coupled with the first oil 'shock' and world economic recession, almost brought the privatised city to an end. After a spell of uncertainty lasting some three years the forces driving the privatised city recovered. They were able to benefit from the resurgence of the Thai economy in the mid-1980s brought about by the revived world economy and direct foreign investment. The privatised city expanded and spilled outside the metropolitan area prompting recognition of a Greater Bangkok. This expanded area of urbanisation brought about by rapid industrialisation has become the focus of direct foreign investment since the mid-1980s.

As it is difficult to examine the impact of this investment on Greater Bangkok, attention is focused on Samut Prakan. Interest in this case study was centred on: (a) selected industrial processes (e.g. chemicals and chemical products, fabricated metal products, plastic and allied products, and food processing industries) to demonstrate the differing nature and volume of hazardous waste; (b) the rapid deterioration in surface water quality to the detriment of the local economy; and (c) the varying impacts of these developments on different segments of the community (e.g. fish and paddy farmers, other peasants, and individuals).

These isolated processes are drawn together to demonstrate how direct foreign investment and other forms of assistance and development schemes have transformed a pristine environment (e.g. Amphoes Bang Pli and Bang Bo) (Figure C.1). Profit is generated for foreign investors, joint venturers and elements of the state. Copious waste, however, has resulted. In the process the existing peasant society has been transformed and supplanted by a new industrial society. While the former is reduced to a residual status and affected by environmental pollution, the latter enjoys most of the tangible benefits of rapid industrialisation. Unquestionably, the investors have continued to accumulate capital by reshaping the built environment for new production and consumption or by transferring investment to more profitable area whereas the communities survive to battle environmental deterioration.

This analysis highlights the fact that the privatised city is spinning out of control. Institutional mechanisms — the Royal Thai Government, provincial administration and local government — are inadequate for the task. The flood of policy reports have not produced any action on pressing pollution problems. Analysis of Thailand's political economy has underlined the fact that vested interests have prevented effective action. The struggle between investors to exploit urban resources,

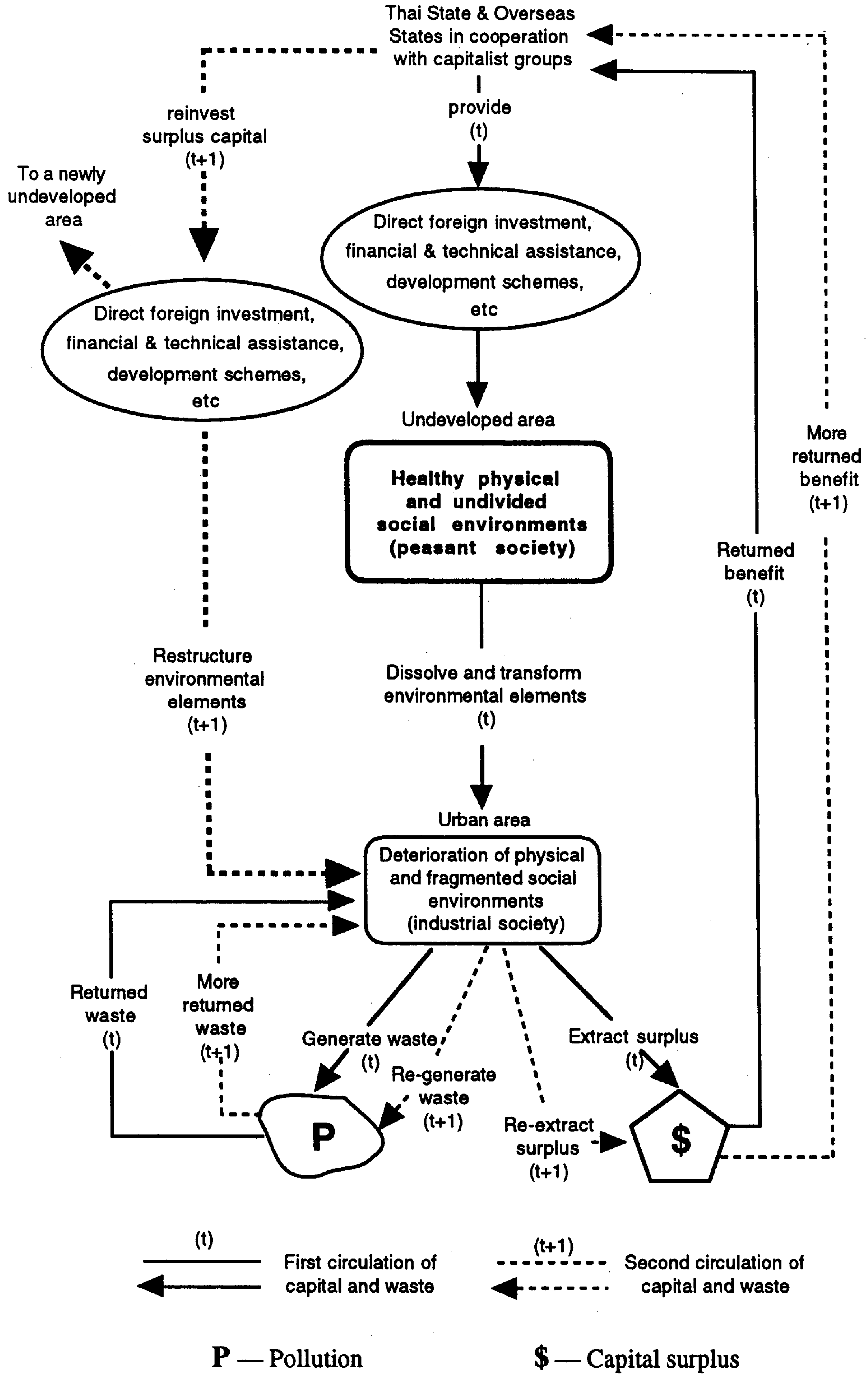


Figure C.1 Value Extraction Process on Urban Resources

the residents and the labour force goes on ceaselessly. If the environmental crisis is ignored, Greater Bangkok's future as a privatised city will be in jeopardy. Investors may search for new profit making in other mega-cities by abandoning Bangkok's physical and social environment.

Looking forward, the Eighth National Economic and Social Development Plan (1997-2001) should incorporate stricter environmental guidelines for urban areas. These guidelines must cover both Greater Bangkok and regional cities such as Chiang Mai and Nakhon Ratchasima. This will avoid shifting environmental problems from Bangkok to its periphery and to the regional cities. New research, therefore, must build on the approach demonstrated in this study and examine the interrelationship between industrial development, water quality and community in regional centres. Inevitably, this will raise further questions about how government can control environmental degradation. This research agenda awaits exploration.

LESSONS

This study has investigated the interrelationship between industry, water and community in Greater Bangkok. It has demonstrated how industrial water quality has affected water quality and, in turn, the welfare of communities. As this situation is occurring in other Southeast Asian cities attention needs to be focused on the lessons that can be drawn from studying industrialisation, water quality and community in Greater Bangkok.

As demonstrated in Singapore a well-organised bureaucracy operating under stable political conditions does not find it difficult to manage industrial waste by improving the production process and upgrading the waste treatment system (though some noxious industries have been moved outside its borders). Government intervention and master planning work (Yeung, 1987: 258; Hiok, 1990: 90-97; Yue, 1990: 251). Clearly, efficient management protects the urban natural environment and the community's livelihood. In the same vein, legal action is employed to safeguard the environment and human rights in the community. Any city can follow Singapore's lead and employ industrial management techniques and legal sanctions. Why did they not succeed in Greater Bangkok? The answer lies in important lessons about political constraints in achieving and managing a sustainable economy and urban development in the absence of a strong state and strong leadership.

Greater Bangkok's experience highlights the need for researchers to employ broad ranging institutional approaches to identify the crucial role of collaboration between foreign investors, domestic capitalists and political élites which allowed industrialisation to proceed irrespective of costs. The study has also pinpointed the ineffectual role of the bureaucracy and government administrative units in acquiescing in the process of environmental deterioration. In some respects, Metro-Manila has surpassed Greater Bangkok in the unequal distribution of urban services, housing shortages, pollution and high crime rates — the legacy of the corrupt Marcos Administration between the 1980s and the 1990s and the survival of highly personalised, centralised and inefficient urban administration into the 1990s (Caoili, 1988; Neher, 1994). Jakarta, however, has restructured its institutions to improve urban management. The Indonesian government has established a new corps of civil servants in the 1970s (*Korpri*) to create a more efficient bureaucratic system. While the corps has had success in managing the macro-economy they failed to provide adequate urban service in Jakarta — there was no integration between the overall national economy and urban management (Nas, 1986; Richardson, 1987; Neher, 1994).

Clearly, there is no universal prescription for managing Southeast Asian cities. Arguably, political administration is the most significant constraint affecting the provision of adequate urban services and maintenance of a solid environment. Cultural values are important. They prevent Greater Bangkok, Metro Manila and Jakarta from following Singapore's lead or learning from each other. It follows, therefore, that lessons from Bangkok should be targeted on Thailand's provincial cities.

Three types of provincial cities can be recognised in Thailand: those which are being swallowed up in the Bangkok Extended Metropolitan Area (e.g. Nonthaburi); those in the Eastern Seaboard region (e.g. Chonburi and Rayong); and free-standing provincial cities (e.g. Chiang Mai, Khon Kaen and Nakhon Ratchasima) (Table C.1). Without constraints on foreign investors, domestic capitalists and political elites the provincial cities in the Extended Bangkok Metropolitan Area and the Eastern Seaboard region are already experiencing some of the worst environmental aspects of accelerated industrialisation — traffic congestion and water pollution. There are greater opportunities, however, for safeguarding the environments in free-standing provincial cities (ONESDB, 1991; United Nations, 1993).

Table C.1 Existing and Forecast Urban Populations in the Bangkok Extended Metropolitan Region, Eastern Seaboard and Free-Standing Provincial Cities between 1990 and 2000

City	1990	2000
Bangkok Extended Metropolitan Region (BEMR):		
Bangkok	6,161,789	7,149,299
Nonthaburi	407,248	657,789
Pathumtani	197,727	333,880
Nakhon Pathom	133,841	209,008
Samut Sakhon	126,290	167,146
Samut Prakan	451,475	657,617
Ayutthaya	225,061	292,348
Saraburi	206,900	302,781
Ratchaburi	255,266	341,607
Petchaburi	157,843	195,363
Eastern Seaboard:		
Chonburi	452,711	603,594
Chachoengsao	115,390	201,190
Rayong	149,284	253,461
Free-standing:		
Nakhon Ratchasima	593,226	892,190
Chiang Mai	413,106	593,546
Khon Kaen	337,972	503,603
Nakhon Sawan	284,289	388,211
Ubon Ratchathani	318,863	481,953
Udon Thani	481,746	718,676
Songkhla	325,241	507,723
Phitsanulok	151,232	182,013
Nakhon Si Thammarat	192,225	254,177
Yala	96,124	128,590

Source: ONESDB, 1991.

Since the mid-1980s free-standing provincial cities have experienced growth rates between 30 and 50 per cent. Chiang Mai has become an important tourist centre inflated at holiday times and weekends by second homes dwellers from Bangkok. Nakhon Ratchasima, Songkla and Khon Kaen have developed as new manufacturing sites. These provincial cities are already experiencing similar urban problems to Greater Bangkok — the spread of ribbon development along major routes leading out of these cities, insufficient infrastructure and deterioration of the environment. Without a resolution of these problems the free-standing provincial cities are in danger of becoming mini-Bangkoks.

REFERENCES

Adul Adulyapichet (ed.), 1990. *The Siam Directory 1990-91*, Bangkok, Tawanna Holdings Ltd.

Amstead, B. H., Ostwald, P. F. and Begeman, M. L., 1979. *Manufacturing Processes*, New York, John Wiley & Sons.

Anek Laothamatas, 1992. *Business Associations and the New Political Economy of Thailand: from Bureaucratic Polity to Liberal Corporatism*, Boulder, Westview Press.

APHA, AWWA and WPCF, 1985. *Standard Methods for the Examination of Water and Wastewater (16th ed.)*, Washington D. C., American Public Health Association.

Australian Environment Council, 1983. *Management and Disposal of Hazardous Industrial Wastes: Report No. 9*, Canberra, Australian Government Publishing Service.

Bangkok Post, 9 July 1992: 1-3.

Bangkok Post, 10 August 1992: 5.

Bangkok Post, 17 November 1992: 20.

Baskin, B., Giffels, D. J. and Willoughby, E., 1971. 'Pollution control in metal fabricating plants', in H. F. Lund (ed.). *Industrial Pollution Control Handbook*, New York, McGraw-Hill: 13/1-13/22.

Boonyaratpalin, S., Supamataya, K., Kunsawan, M., Reungprach, H., Kasornchan, J., and Saduakdee, J. 1983. 'Species and clinical signs of diseased fish', in S. Boonyaratpalin and colleagues (eds.), *Technical Paper # 19: Fish Diseases Outbreak in Thailand Late 1982 - Early 1983*, Bangkok, Department of Fisheries: 6-15.

BOT, 1989-90. *Annual Economic Report*, Bangkok, Bank of Thailand.

Bowring, J., 1857. *The Kingdom and People of Siam*, London, John W. Parker and Son, West Strand.

Brown, I., 1988. *The Elite and the Economy in Siam C. 1890-1920*, Singapore, Oxford University Press.

Bupphanat Suwannamat, 1982. 'Bangkok urbanization', *Thammasat University Journal*, 11 (1): 18-45.

Caoili, M. A., 1988. T*he Origins of Metropolitan Manila: A Political and Social Analysis*, Quezon City, New Day Publishers.

Carter, H., 1983. *An Introduction to Urban Historical Geography*, London, Edward Arnold.

CCRDPL and FPDPC, 1990. *Phœnpattana Changwat Ha Pi (2535-2539): Changwat Samut Prakan*, Samut Prakan, Cooperation Centre of Rural Development at Provincial Level and Five-Year Provincial Development Planning Committee.

Chai-anan Samudavanija and Kusuma Sanitwongse-Na-Ayuttaya, 1992. *Singwatlom Kap Kaommankong*, Bangkok, Sathaban Kaommankong Læ Nanachat.

Chai-anan Samudavanija, 1982. 'The bureaucracy', in Somsakdi Xuto (ed.), *Government and Politics of Thailand*, Singapore, Oxford University Press: 75-109.

Chatthip Nartsupha and Suthy Prasartset, 1981. *The Political Economy of Siam 1851-1910*, Bangkok, The Social Association of Thailand.

Cherry, K. F., 1982. *Plating Waste Treatment*, Michigan, Ann Arbor Science Publishers.

Choo, H. and Ali, I., 1989. 'The newly industrialising economies and Asian development: issues and options', *Asian Development Review*, 7 (2): 1-25.

Considine, D. E. and Considine, G. D. (eds.), 1984, *Van Nostrand Reinhold Encyclopedia of Chemistry*, New York, Van Nostrand Reinhold.

Crenson, M. A., 1971. *The Un-Politics of Air Pollution*, Baltimore, The John Hopkins Press.

Cybriwsky, R., 1991. *Tokyo*, London, Belhaven Press.

DIP, 1989. *Annual Report 1989*, Bangkok, Department of Industrial Promotion.

DIW, 1990. *Satthiti Chamnuan Rongngan Utsahakam Nai Tæla Changwat Chamnak Tam Prapet Nai Po Ro Bo Rongngan Pi Po So 2527 - 2532*, Bangkok, Department of Industrial Works.

DL, 1990. *Labour Studies and Planning Division*, Bangkok, Department of Labour.

Donner, W., 1978. *The Five Faces of Thailand*, London, C. Hurst & Company.

Douglas, I., 1983. *The Urban Environment*, London, Edward Arnold.

Douglass, M., 1991. *Poverty and the Urban Environment in Asia: Access, Empowerment and Community-Based Management*, Paper presented in the International Meeting and Workshop on Urban Community-Based Environmental Management in Asia, October 22-25, 1991, Bangkok, Institute for Population and Social Research, Mahidol University.

Douglass, M., 1988. 'The transnationalization of urbanization in Japan', *International Journal of Urban and Regional Research*, 12 (3): 425-454.

DPP, 1992. *Panha Singwatlom Changwat Samut Prakan*, Samut Prakan, Provincial Office of Samut Prakan.

DTCP, 1991. 'Kanchaithidin nai changwat Samut Prakan', unpublished report to the Department of Town and Country Planning, Bangkok, Department of Town and Country Planning.

Duangkamol Chaimongkol, 1991. The Evolution of Phrapradaeng Industrial Area and Its Development Guidelines, MA Thesis, Department of Urban and Regional Planning, Graduate School, Chulalongkorn University.

Engels, F., 1892. *The Condition of theWorking-Class in England in 1814*, London, Swan Sonnenschein & Co.

Esser, J. and Hirsch, J., 1989. 'The crisis of Fordism and the dimensions of a post-Fordist regional and urban structure', *International Journal of Urban and Regional Research,* 13 (3): 417-437.

Far Eastern Economic Review, 30 January 92: 46.

Freeman, T. W., 1959. *The Conurbations of Great Britain*, Manchester, Manchester University Press.

Fukuoka, Y. and Yamashita, S., 1970. 'Air pollution in Japanese Cities', in The Association of Japanese Geographers (ed.), *Japanese Cities: A Geographical Approach*, Tokyo, The Association of Japanese Geographers: 227-235.

Gilpin, A., 1976. *Dictionary of Environmental Terms*, St. Lucia, University of Queensland.

Girling, J. L. S., 1981. *Thailand: Society and Politics*, Ithaca, Cornell University Press.

Grit Permtanjit, 1982. *Political Economy of Dependent Capitalist Development: Study on the Limits of the Capacity of the State to Rationalize in Thailand,* Bangkok, Social Research Institute, Chulalongkorn University.

Groundwater Division, 1991. Poriman Kanchai Nam Badarn Tam Wattuprasong Nai Changwat Samut Prakan, unpublished report presented to the Groundwater Division, Bangkok, Department of Mineral Resources.

GSI, 1977. *The National Atlas of Japan*, Tokyo, Geographical Survey Institute.

Harvey, D., 1985. *The Urbanisation of Capital,* Baltimore, The Johns Hopkins University Press.

Harvey, D., 1989. *The Urban Experience*, Oxford, Basil Blackwell.

Hewison, K. 1987. 'National interests and economic downturn: Thailand,' in R. Robison, K. Hewison and R. Higgott, (eds.) *Southeast Asia in the 1980s the Politics of Economic Crisis*, Sydney, Allen & Unwin: 52-79.

Hewison, K., 1989. *Power and Politics in Thailand: Essays in Political Economy,* Manila, Journal of Contemporary Asia Publishers.

Hiok, L. B., 1990. 'The bureaucracy', in K. S. Sandhu and P. Wheatley (eds), *Management of Success: The Moulding of Modern Singapore,* Boulder, Westview Press: 90-101.

Holum, J. R., 1977. *Topic and Terms in Environmental Problems*, New York, John Wiley and Sons.

IEAT, 1990. 'Sapab puchaitidin nai nikom utsahakam tang tang na 31 thanwakom 2533', unpublished report presented to the IEAT, Bangkok, Industrial Estate Authority of Thailand.

Ingram, J. C., 1971. *Economic Change in Thailand 1850-1970*, Stanford, Stanford University Press.

Irwan, A., 1989. 'Business patronage, class struggle, and the manufacturing sector in South Korea, Indonesia, and Thailand', *Journal of Contemporary Asia*, 19 (4): 398-434.

Johnson, W. C., 1989. *The Politics of Urban Planning*, New York, Paragon House.

Jones, G., Robertson, A., Forbes, J. and Hollier, G., 1990. *Dictionary of Environmental Science*, London, Collins.

Jones, S., 1985. 'The analysis of depth interviews', in R. Walker (ed.), *Applied Qualitative Research*, Hants, Gower: 56-70.

Kana Kammakan Chapokit Kækhaipanha Rokrabat Satnam, 1983. *Rai-ngan Pholkan Patibat Kong Kana Kammakan Chapokit Kækhaipanha Rokrabard Satnam 2525-2526*, Bangkok, Rongphim Khaopanit.

Keating, A. D., 1988. *Building Chicago*, Columbus, The Ohio State University Press.

Klein, L., 1959. *River Pollution: I Chemical Analysis*, London, Butterworths Scientific Publications.

Klein, L., Jones, I. R. E., Hawkes, H. A. and Downing, A. L., 1962. *River Pollution: II Causes and Effects*, London, Butterworths.

Korff, R., 1986. *Bangkok: Urban System and Everyday Life*, Saarbrücken, Verlag Breitenbach Publishers.

Kornhauser, D., 1976. *Urban Japan: its Foundations and Growth*, London, Longman.

Kraisak Choonhavan, 1984. 'The growth of domestic capital and Thai industrialisation', *Journal of Contemporary Asia*, 14 (2): 135-146.

Krenkel, P. A., 1974a. 'Sources and classification of water pollution', in N. I. Sax (ed.), *Industrial Pollution*, New York, Van Nostrand Reinhold: 197-219.

Krenkel, P. A., 1974b. 'Waste treatment methodology', in N. I. Sax (ed.), *Industrial Pollution*, New York, Van Nostrand Reinhold: 220-243.

Krungthep Thurakit Sutsupda, 21-27 July 1990: 7.

Langeweg, F., 1989. 'Is prevention of pollution more economical?: The Dutch situation', in S. P. Maltezou, A. K. Biswas and H. Sutter (eds.), *Hazardous Waste Management*, London, Tycooly: 120-129.

Lee, Yok-shiu F., Nickum, J. E. and Gregory, R., 1992. *Urban environment in Asia and the Pacific*, Paper prepared for the Division of Industry, Human Settlements and Environment, United Nations Economic and Social Commission for Asia and the Pacific, Honolulu, East-West Center.

Lysa, H., 1984. *Thailand in the Nineteenth Century: Evolution of the Economy and Society*, Singapore, Institute of Southeast Asian Studies.

Machimura, T., 1992. 'The urban restructuring process in Tokyo in the 1980s: transforming Tokyo into a world city,' *International Journal of Urban and Regional Research*, 16 (1): 114-128.

Marshall, C. and Rossman, G. B., 1989. *Designing Qualitative Research*, Newbury Park, SAGE Publications.

Mayer, H. M. and Wade, R. C., 1969. *Chicago: Growth of a Metropolis*, Chicago, The University of Chicago Press.

McGee, T. G., 1967. The *Southeast Asian City*, London, G. Bell and Sons, Ltd.

Messinger, G. S., 1985. *Manchester in the Victorian Age*, Manchester, Manchester University Press.

Middlebrooks, E. J., 1979. *Industrial Pollution Control: Vol. 1—Agro-Industries*, New York, John Wiley & Sons.

Migdal, J. S., 1988. *Strong Societies and Weak States*, Princeton, Princeton University Press.

Morell, D. and Chai-Anan Samudavanija, 1981. *Political Conflict in Thailand: Reform, Reaction, Revolution*, Cambridge, Oelgeschlager, Gunn & Hain, Publishers, Inc.

Moss, B., 1980. *Ecology of Fresh Waters*, Oxford, Blackwell Scientific Publications.

Murray, D., 1992. *The Coup d'etat in Thailand, 23 February, 1991: Just Another Coup?*, Perth, Indian Ocean Centre for Peace Studies.

Nakamura, H. and White, J. W., 1988. 'Tokyo', in M. Dogan, and J. D. Kasarda (eds.), *The Metropolis Era Vol. 2: Mega-Cities*, Newbury Park, SAGE Publications: 123-156.

Narong Phetprasert, 1983. 'Kankhayaitua kong thunniyom nai prathetthai tangtæ po so 2488 thu'ng patchuban', in Sompop Manarungsan (ed.), *Kankhayaitua Kong Rabopthunniyom Nai Prathetthai (Po So 2488 - Patchuban)*, Bangkok, Sangsan Press: 67-124.

Nas, P. J. M., 1986. 'Introduction: a general view on the Indonesian town', in P. J. M. Nas (ed.), *The Indonesian City*, Dordrecht, Foris Publications: 1-17.

Neher, C. D., 1994. *Southeast Asia in the New International Era*, Boulder, Westview Press.

Nemerow, N. L. and Dasgupta, A., 1991. *Industrial and Hazardous Waste Treatment*, New York, Van Nostrand Reinhold.

Nemerow, N. L., 1974. *Scientific Stream Pollution Analysis*, New York, McGraw-Hill.

NESDB/UNDP/TDRI, 1991. *National Urban Development Policy Framework: Final Report*, 2 vols, Bangkok, Office of the National Economic and Social Development Board.

NSO, 1990. *Bangkok Metropolitan and Vicinity,* Bangkok, National Statistical Office.

OBSCSP, 1991. *Changwat Samut Prakan*, Samut Prakan, Ongkan Borihan Suan Changwat Samut Prakan.

ONEB, 1991. *Mattratan Khunnapap Nam Prathetthai*, Bangkok, Samnakngan Kana Kammakan Singwatlom Hang Chat.

ONESDB, 1986. *Bangkok Metropolitan Regional Development Proposals: Recommended Development Strategies and Investment Programmes for the Sixth Plan (1987-1991)*, Bangkok, Office of National Economic and Social Development Board.

ONESDB, 1991. *National Urban Development Policy Framework: Vol. 1*, Bangkok, NESDB/UNDP/TDRI.

Overholt, W., 1988. 'Thailand: a moving equilibrium' in A. Ramsay and Wiwat Mungkandi (eds.), *Thailand-US Relations Changing Political Strategic, and Economic Factors*, Berkeley, Institute of East Asian Studies: 155-194.

Paitoon Wiboonchutikula, 1987. *Second Phase Import Substitution in Thailand,* Bangkok, Thailand Development Research Institute.

Pakhon Unprasert, 1987. *Kan Po Liang Pla Namchu't*, Bangkok, Mahawitthayalai Krasetsat.

Phaithun Kunchai, 1990. 'Kan kækai panha namsia kong krungthep mahanakhon', in *Proceedings of Policy and Planning for Waste Water Treatment*, Bangkok, Samnakngan Kana Kammakan Singwatlom Hang Chat Læ Borisat Ai Bi Em Chamkat: 47-58.

Phang Muang, 16-30 November 1990: 7.

Phang Muang, 1-15 January 1991: 5

Phisit Pakkasem, 1988. *Leading Issues in Thailand's Development Transformation 1960-1990*, Bangkok, National Economic and Social Development Board.

Phuchatkan, 2-8 July 1990: 59, 67.

Phuchatkan, 9-15 September 1991: 66.

Phuchatkan Raiwan, 30 August 1991.

Phuchatkan Raiwan, 15 December 1992.

Phuchatkan Raiwan, 16 December 1992.

Phuchatkan Raiwan, 28 December 1992.

POI, 1988. *Komun Sadaeng Prapet Rongngan Utsahakam Nai Changwat Samut Prakan*, Samut Prakan, Provincial Office of Industry.

POI, 1990. *Komun Sadaeng Prapet Rongngan Utsahakam Nai Changwat Samut Prakan*, Samut Prakan, Provincial Office of Industry.

POI, 1991a. *Komun Sadaeng Prapet Rongngan Utsahakam Nai Changwat Samut Prakan Pi 2533*, Samut Prakan, Provincial Office of Industry.

POI, 1991b. *Thamniap Rongngan Utsahakam Changwat Samut Prakan: Po So 2534*, Samut Prakan, Provincial Office of Industry.

POPH, 1989. *Raingan Prachampi 2532*, Samut Prakan, Provincial Office of Public Health.

POPH, 1991. *Paomai Kanpatthana Dan Satharanasuk Nai Chuang Phanpatthana Satharanasuk Chabap Ti 7*, Samut Prakan, Provincial Office of Public Health.

POSP, 1991. *Changwat Samut Prakan*, Samut Prakan, Provincial Office of Samut Prakan.

Pramote Nakornthab, 1986. Urbanisation and National Development: A Study of Thailand's Local Urban Government, PhD Thesis, Cornell University.

Prathan Khongritthisu'sakon, 1986. *Kanborihan Læ Kanchatrabiap Borihan Ratkanthai*, Bangkok, Samnakphim Odien Store.

Prayat Hongthongkham, 1976. *Kanphatthana Thang Kanmu'ang*, Bangkok, Nam Aksorn.

Ramalho, R. S., 1983. *Introduction to Waste Water Treatment Process*, New York, Academic Press.

Rangkrit Sayamanon, 1976. *Nayobai Ratthaban Thai 2475-2519,* Bangkok, Khana Ratthasat Chulalongkorn Mahawitthayalai.

Rangsan Thanaphonphan, 1989. *Krabuan Kankamnot Nayobai Setthakit Nai Prathetthai: Bot Wikro Chuang Prawatsat Setthakit Kanmu'ang Po So 2475-2530,* Bangkok, Samakom Sangkomsat Hang Prathedthai.

RD, 1989. *Annual Report in Fiscal Year 1988,* Bangkok, The Revenue Department, Ministry of Finance.

Richardson, H. W., 1987. 'The goals of national urban policy: the case of Indonesia', in R. J. Fuchs, G. W. Jones and M. Pernia (eds.), *Urbanisation and Urban Policies in Pacific Asia*, Boulder, Westview Press: 277-300.

RID, 1984. *Khrongkan Rabainam Thungfang Tawan-ok Krungthep: Tamphraratdamri,* Bangkok, the Royal Irrigation Department.

Rimmer, P. J., 1992. 'Urbanisation problems in Thailand's rapidly industrialising economy', unpublished paper presented to the Conference on the Making of a Fifth Tiger?: Thailand's Industrialisation and Its Consequences held at the ANU 7-9 Dec 1992, Canberra, the Department of Economics, RS Pac S and the National Thai Studies Centre, ANU and the Faculty of Economics, Thammasat University.

Robison, P., 1989. 'Structures of power and the industrialization process in Southeast Asia', *Journal of Contemporary Asia*, 19 (4): 371-397.

Rodricks, J. V., 1992. *Calculated Risks*, Cambridge, Cambridge University Press.

Rosit Samithisawad, 1988. 'Housing: an ever-growing business', *Bangkok Bank Monthly Review*, 29 (5): 213-16.

RTSD, 1984. *Phanti Krungthep Po So 2431-2474,* Bangkok, The Royal Thai Survey Department.

Saman Rangsiyokrit and Suthi Sutthisombun, 1990. *Kanborihan Ratkan*, Bangkok, Sawatdikan Samnakngan Ko Po.

Sarawut Chayowan, 1989. *Utsahakam Kap Panha Singwatlom Nai Anakot,* Bangkok, Sapha Utsahakam Hang Prathetthai.

Sarkar, N. K., 1974. *Industrial Structure of Greater Bangkok*, Bangkok, United Nations Asian Institute for Economic Development and Planning.

Savage, V. R., 1992. 'Landscape change: from kampung to global city', in Gupta, A. and Pitts, J. (eds.), *Physical Adjustments in A Changing Landscape: The Singapore Story*, Singapore, Singapore University Press: 5-31.

Seidenfaden, E., 1932. *Guide to Bangkok*, Bangkok, The Royal State Railways of Siam.

Seidensticker, E., 1990. *Rising Tokyo*, New York, Alfred A. Knopf.

Sem Pringphuangkæo, 1983. 'Rokrabat nai pla nam chu't', in Palap Singhaseni, Rabin Ratthanapani and Chirasak Tangtrongpairot (eds.), *The Symposium on Fresh Water Fish Epidemic: 1982-1983: 23-24 June 1983*, Bangkok, Chulalongkorn University: 1-11.

Shaw, G., 1989. 'Industrialization, urban growth and the city economy', in R. Lawton (ed.), *The Rise and Fall of Great Cities,* London, Belhaven Press: 55-79.

Silcock, T. H., 1967a. 'Outline of economic development 1945-65', in T. H. Silcock (ed.), *Thailand: Social and Economic Studies in Development*, Canberra, Australian National University Press: 1-26.

Silcock, T. H., 1967b. 'Promotion of industry and the planning process', in T. H. Silcock (ed.), *Thailand: Social and Economic Studies in Development*, Canberra, Australian National University Press: 258-288.

Sinclair, U., 1907. *The Industrial Republic*, London, William Heinemann.

Soja, E. W., 1989. *Postmodern Geographies*, London, Verso.

Sompop Manarungsan, 1989. *Economic Development of Thailand*, 1850-1950, Bangkok, Pimsuai.

Somsak Tambunlertchai, 1989. 'Economic prospects and external economic relations of Thailand', *Asian Development Review*, 7 (2): 88-112.

Son Bangyikan and Witthaya Napasirikunkit, 1983. *Local Politics in Thailand*, Bangkok, Ramkamhang University.

Sternstein, L., 1976. *Thailand: The Environment of Modernisation*, Sydney, McGraw-Hill Book.

Storper, M., 1990. 'Industrialization and the regional question in the third world: lessons of postimperialism; prospects of post - Fordism', *International Journal of Urban and Regional Research*, 14 (3): 423-444.

Stubbs, R. C., 1981. *Environmental Administration in Thailand*, Honolulu, East-West Center.

Suchit Bunbongkarn, 1982. 'Political institution and processes', in Somsakdi Xuto (ed.), *Government and Politics of Thailand*, Singapore, Oxford University Press: 41-74.

Suehiro, A., 1989. *Capital Accumulation in Thailand*, Tokyo, The Centre for East Asian Cultural Studies.

Sun Komun Changwat Samut Prakan, 1990. *Komun Samut Prakan Chabupyo Po So 2533,* Samut Prakan, Samnakngan Changwat Samut Prakan.

Supasak Ngamrussamiwong, 1988. The Study for Guideline of Planning in Samut Prakan Province: MA Thesis, Department of Urban and Regional Planning, Graduate School, Chulalongkorn University.

Suraphon Sudara, Siriwan Silapacharanan, Yaowarat Pattimanaradikun and Matthaya Chittirat, 1984. *Prawatpanha Saphawa Watlom Nai Samai Rattanakosin*, Bangkok, Samnakngan Khana Kammakan Wichai Hang Chat.

Sutter, H., 1989. 'Review of hazardous waste management systems as applied by the government and private sectors', in S. P Maltezou, A. K. Biswas and H. Sutter (eds.), *Hazardous Waste Management*, London, Tycooly: 3-23.

Suwit Paithayawat, 1980. 'Wiwatthanakan Setthakit Muban Nai Pak Klang 1851-1910', in Chatthip Nartsupha (ed.), *Wiwatthanakan Thunniyom Thai*, Bangkok, Fai Wichakan Khana Setthasat Chulalongkorn Mahawitthayalai Læ Klum Setthasu'ksa Khana Setthasat Mahawitthayalai Thammasat: 49-75.

Tabb, W. K. and Sawer, L. (eds.), 1978. *Maxism and the Metropolis*, New York, Oxford University Press.

Taylor, S. J. and Bogdan, R., 1984. *Introduction to Qualitative Research Methods*, New York, John Wiley & Sons.

TDRI, 1988. *Development of Framework for Water Quality Management of Chao Phraya and Thachin Rivers,* Bangkok, Office of the National Environment Board.

TDRI, 1991. *National Urban Development Policy Framework — Draft Final Report Area 7: Improving the Urban Environment*, Bangkok, Office of National Economic and Social Development Broad.

The Bank of Thailand Monthly Bulletin, 1964, 4.

The Bank of Thailand Monthly Bulletin, 1969, 9.

The Bank of Thailand Monthly Bulletin, 1974, 14.

The Bank of Thailand Monthly Bulletin, 1979, 19.

The Bank of Thailand Quarterly Bulletin, 1982, 22.

The Bank of Thailand Quarterly Bulletin, 1987, 27.

The Bank of Thailand Quarterly Bulletin, 1991, 31.

Theera Punthumwanich, Panu Krittiporn and Krikpong Chanprathip, 1990. 'Kan patthana utsahakam læ khunnapap singwatlom patchuban', in *Proceedings of Policy and Planning for Waste Water Treatment*, Bangkok, Samnakngan Kana Kammakan Singwatlom Hang Chat Læ Borisat Ai Bi Em Chamkat: 68-81.

Thomas, R., 1989. *Japan: The Blighted Blossom*, London, I. B. Tauris & Co.

TISTR, 1988. *Panlak Rabop Pongkan Namtuam Læ Rabainam Changwat Samut Prakan Fang Tawan Ok (Vol 2: Report)*, Bangkok, Department of Public Works, Ministry of Interior.

TMG, 1971. *Tokyo Fights Pollution*, Tokyo, Tokyo Metropolitan Government.

Train, R. E., 1979. *Quality Criteria for Water*, Guildford, Castle House Publications.

United Nations, 1993. *1992 Demographic Yearbook*, New York, United Nations Publication.

United Nations, 1992. *1991 Demographic Yearbook*, New York, United Nations Publication.

United Nations, 1984. *1983 Demographic Yearbook*, New York, United Nations Publication.

United Nations, 1975. *1974 Demographic Yearbook*, New York, United Nations Publication.

United Nations, 1963. *1962 Demographic Yearbook*, New York, United Nations Publication.

Vicharat Vichit-Vadakan and Thinapan Nakata (eds.), 1976. *Urbanization in the Bangkok Central Region*, Bangkok, Thai University Research Association.

Walker, R., 1985. 'An introduction to applied qualitative research', in R. Walker (ed.) *Applied Qualitative Research*, Hants, Gower: 1-27.

Ward, D. 1983. 'The place of Victorian cities in developmental approaches to urbanization', in J. Patten (ed.) *The Expanding City*, London, Academic Press: 355-379.

Watson Hawksley and SISAT, 1987. *Samut Prakan Industrial Pollution Control and Management (Vol. 2)*, Bangkok, Office of National Environment Board.

World Bank, 1991. *World Development Report 1991*, New York, Oxford University Press.

Yeung, Y. M., 1987. 'Cities that work: Hong Kong and Singapore', in R. J. Fuchs, G. W. Jones and M. Pernia (eds.), *Urbanisation and Urban Policies in Pacific Asia*, Boulder, Westview Press: 257-274.

Yue, C. S., 1990. 'The character and progress of industrialization', in K. S. Sandhu and P. Wheatley (eds.), *Management of Success: The Moulding of Modern Singapore*, Boulder, Westview Press: 250-279.

APPENDICES

APPENDIX 1.1

SURFACE WATER ASSESSMENT

1. MONITORING AND ANALYSIS OF WATER POLLUTION

The programme of monitoring surface water quality of the canal network of Amphoes Bang Pli and Bang Bo, Samut Prakan Province occurred between April and June-July, 1991. Its major aim was to investigate the distribution of water pollution in both districts. As the water flow of the canal network was interfered by the non-harmonised control of water gates, the evaluation of pollution distribution was to design all sampling points evenly — every four kilometres. Thirty sample sites covered the whole study area. In analysing physical, chemical and biological properties of water samples, water parameters that indicate surface water quality were as follows:

1. Temperature
2. pH value
3. Dissolved oxygen
4. Biochemical oxygen demand within 5 days
5. Nitrate-Nitrogen
6. Ammonia-Nitrogen
7. Total suspended solids
8. Arsenic
9. Cadmium
10. Chromium (hexavalent)
11. Copper
12. Lead
13. Manganese
14. Mercury (Total)
15. Nickel
16. Zinc
17. Faecal coliforms bacteria

2. ORGANISATION OF THE WATER QUALITY SURVEY

The researcher organised the water quality survey in Amphoes Bang Pli and Bang Bo, Samut Prakan Province by forming a team from members of the Faculty of Environment of Resource Studies, Mahidol University. The team's responsibilities were to collect water samples and analyse specific water parameters at sites and at the Faculty's laboratory. Public organisations also assisted the survey team in analysing other water parameters.

2.1 The researcher's contribution

Besides the researcher, the survey team consisted of three experienced technicians namely Miss Chutinthon Munthongnoi, Mr. Wirot Kaewduang and Mr. Loetrit Unchit. At the chosen sites, the researcher with the survey team measured temperature, pH and dissolved oxygen and collected water samples for further laboratory analysis. The team analysed some water parameters (i.e. biochemical oxygen demand, nitrate, ammonia and total suspended solids) at Mahidol University. As the Faculty of Environment and Resource Studies did not have all the necessary scientific equipment, other water parameters were measured by outside laboratories.

2.2 Assistance from individuals and organisations

The Department of Science Service, Ministry of Science, Technology and Environment and the Faculty of Public Health, Mahidol University offered assistance to analyse heavy metals, arsenic and faecal coliform in their laboratories. Their expertise guaranteed reliable results.

3. EQUIPMENT USED & TECHNIQUES EMPLOYED

The examination techniques employed in this study for assessing water quality followed the recommendations of the Office of National Environment Board (ONEB) and the Department of Industrial Works (DIW). However, their recommendations are based on standard methods for examining of water and waste water approved by the American Public Health Association (APHA), the American Water Works Association (AWWA) and the Water Pollution Control Federation (WPCF) (APHA, AWWA and WPCF, 1985). All equipment used and techniques employed in water analysis are described in sub-sections 3.1 and 3.2.

3.1 Tests undertaken by the researcher

The tests undertaken by the researcher are listed in Table 1.1.A. Summaries of each test used by the researcher are then given. Further details on these tests can be found in APHA, AWWA and WPCF (1985).

Table 1.1.A Equipment and Techniques for Measuring Temperature, pH, Dissolved Oxygen, Biochemical Oxygen Demand within 5 Days, Nitrate, Ammonia and Total Suspended Solids

Test	Equipment	Techniques
1. Temperature	Mercury-filled Celsius thermometer	Recorded in field (Manual measurement)
2. pH	pH meter	Recorded in field (pH value)
3. Dissolved oxygen	Membrane electrodes	Recorded in field (Membrane method)
4. Biochemical oxygen demand within 5 days	Incubation bottles and air incubator	Laboratory analysis (Membrane method)
5. Nitrate	Reduction column and spectrophotometer	Laboratory analysis (Cadmium reduction)
6. Ammonia	Spectrophotometer, nessler tubes and pH meter	Laboratory analysis (Distillation nesslerization)
7. Total suspended solids	Evaporating dishes, muffle furnace, steam bath, desiccator, drying oven, analytical balance, glass-fibre disks, filtration apparatus and suction flask	Laboratory analysis (drying at 103-105°C)

TEST 1: TEMPERATURE

1. Technique (referred to as 212 in APHA, AWWA and WPCF, 1985):

Manual measurement of temperature.

2. General discussion:

Temperature measurement were made by using a good mercury-filled Celsius thermometer with markings etched on the capillary glass for every 0.1°C. The thermometer had a minimal thermal capacity to permit rapid equilibration.

3. Apparatus:

A mercury-filled Celsius thermometer as stated above.

4. Procedure:

The thermometer was dipped into canal water for one minute and the temperature value was read and recorded.

TEST 2: pH

1. Technique (referred to as 423 in APHA, AWWA and WPCF, 1985):

pH value

2. General discussion:

The basic principle of electrometric pH measurement is determination of the activity of the hydrogen ions by potentiometric measurement.

3. Apparatus:

A pH meter.

4. Procedure:

Instrument calibration: Glass electrodes of a pH meter were standardised with buffer solutions. Afterwards they were rinsed thoroughly with distilled water and dried.

Sample analysis: An equilibrium between electrodes and sample was established by gently stirring sample to ensure homogeneity. After one minute, the pH value was read and recorded.

TEST 3: DISSOLVED OXYGEN

1. Technique (referred to as 421 F in APHA, AWWA and WPCF, 1985):

Membrane electrode method

2. General discussion:

Membrane electrodes have been used for dissolved oxygen measurements at the sites. Their portability and ease of operation and maintenance make them particularly convenient for field applications.

3. Apparatus:

Oxygen-sensitive membrane electrode with appropriate meter.

4. Procedure:

Calibration: membrane electrodes were calibrated by distilled water with saturated oxygen — 14 mg/l.

Sample measurement: membrane electrodes were dipped into water sample for one minute. Afterwards the oxygen value could be read and recorded.

TEST 4: BIOCHEMICAL OXYGEN DEMAND

1. Technique (referred to as 507 in APHA, AWWA and WPCF, 1985):

Biochemical oxygen demand (BOD)

2. General discussion:

Principle: A full, air-tight bottle of sample is incubated under specific temperature and time. It is necessary to dilute the sample before incubation to bring the oxygen demand and supply into appropriate balance. Nutrients required for bacterial growth are added to the dilution sample. Then it is buffered to ensure the suitable growth conditions of bacteria. In order to determine the acceptability of a particular batch of dilution water, a dilution water check is conducted before the analysis of BOD. A quality control on dilution water at the time of analysis as well as on the cleanliness of apparatus is provided by the preparation of a dilution water blank.

3. Apparatus:

Incubation bottles of 300-mL capacity with ground-glass stoppers and air incubator.

4. Procedure:

Preparation of dilution water: Volume of water was placed in a suitable bottle and 1 mL each of phosphate buffer, $MgSO_4$, $CaCl_2$, and $FeCl_3$ solutions/L of water were added.

Dilution water check: This procedure was used as a rough check on quality of dilution water. A BOD bottle full of dilution water was incubated for 5 days at 20°C. Initial and final DO were determined. The DO uptake should not be more than 0.1 mg/L. Before use, temperature of dilution water was lowered to 20°C and the water was saturated with DO by shaking in a partially filled bottle.

Glucose-glutamic acid check: The results of BOD can be influenced greatly by the presence of toxicants such as copper from distilled water. Therefore, BOD measurements on pure organic compounds was conducted by using 2% dilution of the glucose-glutamic acid as a standard check solution.

Seeding: It is necessary to have a population of micro-organisms capable of oxidising the biodegradable organic matter in the sample. In making tests, enough seed was used to assure satisfactory numbers of micro-organisms but not so much that the oxygen demand of the seed itself was a major part of the oxygen used during incubation. Therefore, the seed must be controlled. A sample DO uptake was determined by subtracting the seed DO uptake from the total DO uptake. However, the DO uptake of the seeded dilution water should be between 0.6 and 1.0 mg/L.

Dilution technique: Dilutions were prepared in cylinders by carefully siphoning dilution water and they were seeded into a 1- to 2-L-capacity cylinder. Then mixed dilutions were siphoned into two BOD bottles. Initial DO was determined on one of these bottles. The second bottle was stoppered tightly and incubated for 5 days at 20°C, then final DO was determined.

Determination of DO: The membrane electrode method was used to determine DO.

5. Calculation:

When dilution water is seeded: $\text{BOD, mg/L} = \{(D_1 - D_2) - (B_1 - B_2)\}f/P$

where: D_1 = DO of diluted sample immediately after preparation, mg/L,

D_2 = DO of diluted sample after 5 d incubation at 20°C, mg/L

P = decimal volumetric fraction of sample used,

B_1 = DO of seed control before incubation, mg/L,

B_2 = DO of seed control after incubation, mg/L, and

f = ratio of seed in sample to seed in control = (% seed in D_1)/(% seed in B_1)

TEST 5: NITRATE

1. Technique (referred to as 418 C in APHA, AWWA and WPCF, 1985):

Cadmium reduction method.

2. General discussion:

Principle: Nitrate (NO_3^-) is reduced almost quantitatively to nitrite (NO_2^-) in the presence of cadmium (Cd). This method uses commercially available Cd granules treated with copper sulfate ($CuSO_4$), to form a Cu coating. The NO_2^- produced thus is determined by diazotising with sulfanilamide and coupling with N-(1-naphthyl)-ethylenediamine to form a highly coloured azo dye that is measured calorimetrically.

3. Apparatus:

Reduction column and spectrophotometer.

4. Procedure:

Preparation of reduction column: Sufficient Cu-Cd granules were added to produce a column 18.5 cm long. The column, then, was activated by passing 7 to 10 mL/min, 100 mL of a solution composed of 25 mL of a 1.0 mg NO_3^--N/L standard and 75 mL NH_4Cl-EDTA solution through the column.

Treatment of sample: Before developing and measuring colour, turbidity of water sample was removed. Then pH of the sample was adjusted to between 7 and 9. Seventy-five millilitres of NH_4Cl-EDTA solution were mixed to 25 mL sample in order to have sample reduction. Around 15 minutes after the reduction, 2 mL sulfanilamide reagent were added to 50 mL sample. Let reagent react for 2 to 8 minutes. Two millilitres of NED-dihydrochloride solution were mixed immediately. Between 10 minutes and 2 hours afterward, absorbance was measured at 540 nm against a distilled water-reagent blank.

Standard: The standard NO_3^--N solution was diluted and used to prepare standard curve.

5. Calculation:

A standard curve was obtained by plotting absorbance of standards against NO_3^--N concentration. Sample concentrations were computed directly from standard curve.

TEST 6: AMMONIA

1. Technique (referred to as 417 B in APHA, AWWA and WPCF, 1985):

Nesslerization method (Direct and following distillation)

2. General discussion:

The graduated yellow to brown colours produced by the nessler-ammonia reaction absorb strongly over a wide wavelength range. The yellow colour characteristic of low ammonia nitrogen concentration (up to 5 mg/L) can be measured with acceptable sensitivity in the wavelength region from 400 to 425 nm when a 1-cm light path is available. Pretreatment before direct nesslerization with zinc sulfate and alkali precipitates calcium, iron, magnesium, and sulfide, which form turbidity when treated with nessler reagent. The floc also removes suspended matter and sometimes coloured matter. Addition of sodium salt of ethylenediaminetetraacetic acid (EDTA) inhibits precipitation of residual calcium and magnesium ions in the presence of the alkaline nessler reagent.

3. Apparatus:

Spectrophotometer, nessler tubes and pH meter.

4. Procedure:

Treatment of undistilled samples: Firstly 1 mL $ZnSO_4$ solution was added to 100 mL sample and mixed thoroughly. Then 0.4 to 0.5 mL 6*N* NaOH solution was added to obtain a pH of 10.5 and mixed gently. A heavy flocculent precipitate should fall after standing the treated sample for a few minutes. The sample would be a clear and colourless supernate.

Colour development: There were three steps in colour development:

a) Undistilled samples — In order to precipitate interference ions, one drop (0.05 mL) EDTA reagent was added to 50.0 mL sample. When the sample was well mixed, 2.0 mL nessler reagent was added.

b) Distilled samples — The boric acid was neutralised for using to absorb the ammonia distillate by adding 2 mL nessler reagent.

c) Samples were mixed by capping nessler tubes with rubber stoppers and then inverting tubes at least six times. Such conditions as temperature and reaction time were kept the same in blank, samples and standards. The reaction proceeded for at least 10 minutes before the nessler reagent was added. Colour in sample and standards were measured photometrically.

Photometric measurement: Absorbance was measured by a spectrophotometer. The calibration curve was prepared at the same temperature and reaction time used for samples. For distilled samples, the standard curve was prepared under the same conditions as the samples.

5. Calculation:

Amount of NH_3-N in water used for diluting original sample was deducted before computing final nitrogen value. Also the reagent blank was deducted for the volumes of borate buffer and 6*N* NaOH solutions used with the sample. Then, total NH_3-N was computed by the following equation:

$$\text{mg } NH_3\text{-N/L (51 mL final volume)} = (A \,/\, \text{mL sample}) \times (B/C)$$

where:

A = µg NH_3-N/L (51 mL final volume),
B = total volume distillate collected, mL, including acid absorbent, and
C = volume distillate taken for nesslerization, mL.

TEST 7: TOTAL SUSPENDED SOLIDS

1. Technique (referred to as 209 C in APHA, AWWA and WPCF, 1985):

Total suspended solids were dried at 103-105°C

2. General discussion:

Total suspended solids were investigated using a standard drying procedure.

Principle: A well-mixed sample of water was filtered through a weighed standard glass-fibre filter. The residue retained on the filter was dried to a constant weight at 103-105°C. The increase in the filter's weight represented the total suspended solids. When the suspended material clogged the filter and prolonged filtration, the difference between the total dissolved solids provided an estimate of the total suspended solids.

Interferences: It was necessary to exclude large floating particles or submerged agglomerates of non-homogenous materials from the sample because excessive residue on the filter formed a water entrapping crust and limited the sample size to that yielding no more than 200 mg residue. Where the samples were high in dissolved solids the filter had to be thoroughly washed to ensure removal of the dissolved material. Prolonged filtration times resulting from filter clogging produced high results owing to excessive solids captured on the clogged filter.

3. Apparatus:

The apparatus used included evaporating dishes, muffle furnace, steam bath, desiccator, drying oven, analytical balance, glass-fibre disks, filtration apparatus and suction flask.

4. Procedure:

Preparation of glass-fiber filter disk: A disk was inserted with the wrinkled side up in the filtration apparatus. A vacuum and wash disk was applied with three successive 20-mL portions of distilled water. Suction was continued to remove all traces of water, and discard washings. The filter was removed from filtration apparatus and transferred to an aluminum planchet. The material was dried in an oven at 103 to 105°C for one hour. It was then cooled in a desiccator to balance temperature and weighed. The cycle of drying, cooling, desiccating, and weighing was repeated until a constant weight was obtained or until weight loss was less than 0.5 mg between successive weighings. The filter was stored in the desiccator until needed. It had to be weighed immediately before use.

Selection of filter and sample sizes: As a non-homogenous water sample was involved a large filter was used to permit the filtering of a representative sample.

Sample analysis: The filtering apparatus was assembled and suction commenced. The filter was moisturised with a small volume of distilled water to seat it. A measured volume of a well-mixed sample was filtered through a glass fibre filter. Three successive 10-mL volumes of distilled water were used to allow the complete drainage between washings, and suction was continued for 3 minutes after filtration. The filter was removed from filtration apparatus and transferred to an aluminum planchet. It was dried for at least one hour at 103 to 105°C in an oven, then it was cooled in a desiccator to balance temperature. Finally, the filter was weighed. The cycle of drying, cooling, desiccating, and weighing was repeated until a constant weight was obtained.

5. Calculation:

$$\text{mg total suspended solids/L} = \{(A - B) \times 1000\} / \text{sample volume, mL}$$

where: A = weight of filter + dried residue, mg, and
B = Weight of filter, mg.

3.2 Tests undertaken by outside organisations

The tests undertaken by outside organisations are summarised in Table 1.1.B. Summaries of each test undertaken by the outside organisation are then given. Further details on these tests can be found in APHA, AWWA and WPCF (1985).

Table 1.1.B Equipment and Techniques for Measuring Cadmium, Copper, Nickel, Manganese, Lead, Zinc, Mercury, Hexavalent Chromium, Arsenic and Faecal Coliform

Test	Equipment	Techniques
8. Cadmium, copper, nickel, manganese, lead and zinc	Atomic absorption spectrometer and associated equipment	Laboratory analysis (Atomic absorption-direct aspiration)
9. Mercury	Atomic absorption spectrometer, absorption cell, cell support, air pumps, flowmeter, aeration tubing, reaction flask, drying tube and connecting tubing	Laboratory analysis (Atomic absorption-cold vapour)
10. Hexavalent chromium	Spectrophotometer and separatory funnels	Laboratory analysis (Colorimetric method)
11. Arsenic	Atomic absorption spectrometer, atomizer, reaction cell for As hydride and syringe	Laboratory analysis (Atomic absorption- gaseous hydride)
12. Faecal coliform	Tubes and EC medium	Laboratory analysis (Multiple tube fermentation)

TEST 8: CADMIUM, COPPER, NICKEL, MANGANESE, LEAD AND ZINC

1. Technique (referred to as 303 A in APHA, AWWA and WPCF, 1985):

Determination of Cadmium, Copper, Lead, Manganese, Nickel, Zinc by Direct Aspiration into an Air-Acetylene Flame

2. General discussion:

Principle: As each metal has its own characteristic absorption wavelength, a source lamp composed of that element is used; this makes the method of direct aspiration into an air-acetylene flame relatively free from spectral or radiation interferences. The amount of energy of the characteristic wavelength absorbed in the flame is proportional to the concentration of the element of the sample.

2. Apparatus:

Atomic absorption spectrometer and associated equipment

3. Procedure:

Instrument operation: A hollow-cathode lamp was installed for the desired metal in the atomic absorption spectrometer and roughly set the wavelength dial. Slit width was set for the element being measured. Instrument was, then, turned on and applied to the hollow-cathode lamp the current. It was warmed up until energy source stabilised, generally about 10 to 20 minutes. The current was readjusted as necessary after warming up. The wavelength was optimised by adjusting wavelength dial until optimum energy gain was obtained.

A suitable burner head was installed and its position adjusted. Acetylene was turned on, its flow rate adjusted, and the flame was ignited. A standard solution was aspirated and the aspiration rate of the nebuliser was adjusted to obtain maximum sensitivity. The standard solution was atomised. Absorbance of this standard was recorded when freshly prepared and with a new hollow-cathode lamp. Now the instrument was ready to operate.

Standardisation: At least three concentrations of each standard metal solution were selected to bracket the expected metal concentration of a sample. Each in turn was aspirated into flame and absorbance recorded. A blank between samples was used to verify baseline stability.

Analysis of samples: The nebuliser was rinsed by aspirating water containing 1.5 mL concentrated HNO_3/L. Blank was atomised and then instrument was adjusted to zero. A sample was atomised and its absorbance was determined. When determining Mn, 100 mL sample were mixed with 25 mL of Ca solution before aspirating.

4. Calculation:

Concentration of each metal ion was calculated in micrograms per litre for trace elements by referring to the prepared calibration curve.

TEST 9: MERCURY

1. Technique (referred to as 303 F in APHA, AWWA and WPCF, 1985):

Atomic absorption-cold vapour method

2. General discussion:

The cold vapour atomic absorption method was the method used for all samples [other methods such as the dithizone method can be used for determining high levels of mercury (>2 µg/L) in potable water].

3. Apparatus:

The apparatus included are atomic absorption spectrometer, absorption cell, cell support, air pumps, flowmeter, aeration tubing, reaction flask, drying tube and connection tubing.

4. Procedure:

Instrument operation: The absorption cell was installed and aligned in the light path to give maximum transmission. Associated equipment was connected to the absorption cell with vinyl plastic tubing. Air was turned on to flow continuously by adjusting flow rate to 2 L/minute.

Standardisation: The 100 mL of each of the 1.0, 2.0, and 5.0 µg/L Hg standard solutions and a blank of 100 mL water were transferred to 250-mL erlenmeyer reaction flasks. The 5 mL concentrated H_2SO_4 and 2.5 mL concentrated HNO_3 were added to each flask. The 15 mL $KMnO_4$ solution was added to each flask and let stand at least 15 minutes. The 8 mL $K_2S_2O_8$ solution was added to each flask and heated for 2 hours in a water bath at 95°C.

Each flask was treated individually, NaCl-hydroxylamine sulfate solution was added to reduce excess $KMnO_4$, then 5 mL $SnCl_2$ solution was immediately added and flask was attached to aeration apparatus. As the Hg is volatilised and carried into the absorption cell, the absorbance will increase to a maximum within a few seconds. As soon as the recorder returned approximately to the base line, the stopper was removed by holding the frit from the reaction flask, and replacing with a flask containing water. The system was flushed for a few seconds and the next standard was run in the same manner. A standard curve was constructed by the plotting peak height versus micrograms Hg.

Analysis of samples: The 100 mL sample was transferred to 100 mL containing not more than 5.0 µg Hg/L to a reaction flask. During oxidation step, chlorides were converted to free chlorine absorbing at 253 nm. All free chlorine was removed before the Hg was reduced and swept into the cell by using an excess (25 mL) of hydroxylamine sulfate reagent.

5. Calculation:

Peak height of sample was determined from recorder chart and mercury value was read from the prepared standard curve.

TEST 10: HEXAVALENT CHROMIUM

1. Technique (referred to as 312 B in APHA, AWWA and WPCF, 1985):

Colorimetric method

2. General discussion:

Principle: Total chromium is converted to the hexavalent state by oxidation with potassium permanganate. The hexavalent chromium is determined calorimetrically by reaction with diphenylcarbazide in acid solution. A red violet colour of unknown composition is produced.

Interferences: The reaction with diphenylcarbazide is nearly specific for chromium. Hexavalent molybdenum and mercury salts will react to form colour with the reagent. Interfering amounts of molybdenum, vanadium, iron, and copper can be removed by extraction of the cupferrates of these metals into chloroform ($CHCl_3$). Therefore, follow the extraction by additional treatment with acid fuming to decompose these compounds.

3. Apparatus:

Spectrophotometer and separatory funnels.

4. Procedure:

Preparation of calibration curve: Colour was developed as for samples. Then a suitable portion of each coloured solution was transferred to a 1-cm absorption cell and absorbance was measured at 540 nm. Distilled water was used as reference. Absorbance readings of standards were corrected by subtracting absorbance of a reagent blank carried through the method. A calibration curve was constructed by plotting corrected absorbance values against micrograms chromium in 102 mL final volume.

Colour development and measurement: The 0.2*N* H_2SO_4 and a pH meter were used to adjust solution to pH 1.0 ± 0.3. Then the solution was transferred to a 100-mL volumetric flask, diluted to 100 mL, and mixed. The 2.0 mL diphenylcarbazide solution was added, mixed, and let stand 5 to 10 minutes for full colour development. An appropriate portion was transferred to a 1-cm absorption cell and its absorbance at 540 nm was measured. Distilled water was used as reference. Absorbance reading of the sample was corrected by subtracting absorbance of a blank carried through the method. From the corrected absorbance, micrograms chromium present were determined by reference to the calibration curve.

TEST 11: ARSENIC

1. Technique (referred to as 303 E in APHA, AWWA and WPCF, 1985):

Determination of Arsenic by Conversion to Its Hydride by Sodium Borohydride Reagent and Aspiration into an Atomic Absorption Atomizer

2. General discussion:

Arsenous acid, the As(III) oxidation state of arsenic is instantaneously converted by sodium borohydride reagent in acid solution to its volatile hydride. The hydride is purged continuously by argon or nitrogen into an appropriate atomizer of an atomic absorption spectrometer and converted to the gas-phase atoms. By rapid generation of the elemental hydrides in an appropriate reaction cell, the sodium borohydride reducing agent minimises dilution of the hydrides by the carrier gas and provides rapid, sensitive determination of arsenic.

3. Apparatus:

The apparatus included are atomic absorption spectrometer, a boling-type burner head (as atomizer), and a reaction cell for producing As hydride and syringe.

4. Procedure:

Apparatus setup: An aqueous solution of As was aspirated directly into the flame to facilitate atomizer alignment. Purging gas flow, concentration and rate of addition of sodium borohydride reagent, solution volume, and stirring rate were established for optimum instrument response for the chemical species to be analysed.

Instrument calibration standard: Standard solutions of 0, 1, 2, 5, 10, and 20 g As/L were prepared by transferring 0.00, 1.00, 2.00, 5.00, 10.00, 15.00, and 20.00 mL standard solutions of As(III) to 100-mL volumetric flasks and bringing to volume with water containing 2 to 5 mL concentrated HNO_3/L.

Preparation of samples and standards for total recoverable arsenic: Firstly 50 mL sample or As(III) standard were added to 200-mL Berzelius beaker. Then 7 mL 18*N* H_2SO_4 and 5 mL concentrated HNO_3 were added to the beaker. SO_3 fumes were evaporated. Oxidising conditions were maintained at all times by adding small amounts of HNO_3 to prevent solution from darkening. An excess of HNO_3 was maintained until all organic matter were destroyed. A light-coloured solution usually indicated complete digestion. Cool slightly, 25 mL water and 1 mL concentrated $HClO_4$ were added and again SO_3 fumes were evaporated to expel oxides of nitrogen. Effectiveness of digestion procedure was monitored by adding 5 mL of standard organic arsenic solution to 50 mL sample and recovery was measured. After final evaporation of SO_3 fumes, the residue was diluted to 50 mL for arsenic measurements.

Preparation of samples and standard for total arsenic: Fifty millilitre sample or standard were added to a 200-mL Berzelius beaker. One millilitre 2.5*N* H_2SO_4 and 5% $K_2S_2O_8$. were added to the beaker. All substances were boiled gently on a pre-heated hot plate for approximately 30 to 40 minutes or until a final volume of 10 mL was reached. After manual digestion, the residue was diluted to 50 mL for subsequent arsenic measurements.

Determination of arsenic with sodium borohydride: Five millilitre concentrated HCL were added to 50 mL digested standard or sample in a 200-mL Berzelius beaker. After adding and mixing 5 mL NaI prereductant solution the mixture was let lie for 30 minutes. One Berzelius beaker was attached at a time to the rubber stopper containing the gas dispersion tube for the purging gas, the sodium borohydride reagent inlet, and the outlet to the atomizer. Strip-chart recorder was turned on until the base line was established by the purging gas and all air was expelled from the reaction cell. The 0.5 mL sodium borohydride reagent was added. After the instrument absorbance had reached a maximum and returned to the base line, the beaker was removed, and the dispersion tube was rinsed with water.

5. Calculation:

A standard curve was constructed by plotting peak heights of standards versus concentration of standard. Peak heights of samples were measured and concentrations were read from curve.

TEST 12: FAECAL COLIFORM

1. Technique (referred to as 908 C in APHA, AWWA and WPCF, 1985):

Faecal coliform tested by the EC medium

2. General discussion:

The faecal coliform test differentiates between coliforms of faecal origin (intestines of warm-blooded animals) and coliforms from other sources.

3. Apparatus:

Tubes and EC medium.

4. Procedure:

Transfer were made from all positive presumptive tubes and from 48 hours negative tubes showing growth, from the total coliform MPN test to EC medium. This examination was made simultaneously with the confirmatory procedure using brilliant green lactose bile broth. A sterile metal loop was used with a minimum 3-mm diameter. When making these transfers, the presumptive tube was gently shaken. The inoculated tubes in a water bath were incubated at 44.5 ± 0.2^oC for 24 ± 2 hours. All EC tubes were placed in the water bath within 30 minutes after inoculation. A sufficient depth of water was maintained in the water bath incubator to immerse tubes to the upper level of the medium.

The production of gas in a fermentation tube within twenty-four hours was considered a positive reaction indicating coliforms of faecal origin. When gas was not produced a source other than the intestinal tract of warm blooded animals was the likely organism.

5. Calculation:

The calculation of bacterial density is estimated as the Most Probable Number (MPN). The number of positive tube combination from three portion decimal dilution (five replications for each dilution) were indicated the MPN index/100 mL obtaining from the Standard Table.

4. RESULTS: ORGANIC VERSUS HEAVY METAL POLLUTION

The 1991 survey revealed the canal network in Amphoes Bang Pli and Bang Bo was affected by both domestic and industrial wastes. Most canals close to inner Samut Prakan and Bangkok were unsuitable for any human activity. Although some canals in the eastern part of the survey area were less polluted, their water quality was not recommended for general household consumption. Clearly, rapid urbanisation and industrialisation had been a major causes of uncontrolled water pollution.

Water parameters derived from surface water in these districts showed different levels of contamination. Organic pollution, especially faecal coliform bacteria, was high in many canals. Sources of faecal coliform bacteria were derived largely from households, slaughter houses, and other food processing industries. The average dry season value derived from the 1991 fieldwork was 9,600 MPN/100 ml. During the rainy season the value was about 9,520 MPN/100 ml (Appendix 1.2 and 1.3). Both values were double the maximum value analysed to the highest (fifth) class of standard surface water. Since oxygen was important to all organisms, the values of faecal coliform also reflected changing degrees of dissolved oxygen (DO) and biochemical oxygen demand within 5 days (BOD_5). In the wet season, the average DO and BOD_5 of streams were less than 2 and 10.58 mg/l respectively, while in the dry season they were around 3 and 13.90 mg/l respectively. Clearly, the average DO concentrations in both seasons were too low to support organisms, while the average BOD_5 readings were quite high — three times higher than the average standard value of the fifth Class.

Heavy metals were rarely detected. Mercury and lead within streams, however, exceeded harmful limits for both seasons in 1991 (Appendix 1.2 and 1.3). Although the presence of lead and mercury were toxic to micro-organisms, especially bacteria, they did not have the harmful effects of faecal coliform. Unquestionably, organic pollution was more serious problem than heavy metal contamination to the canal network in Amphoes Bang Pli and Bang Bo, Samut Prakan.

Appendix 1.2 Values of Specific Surface Water Quality in the Canal Network of Amphoes Bang Pli and Bang Bo, Samut Prakan, April 1991 (Dry Season)

Water Index	SR 1	SR 2	SR 3	SR 4	SR 5	PC 1
Temp (°C)	28.3	29.0	31.0	31.5	30.0	29.0
pH	7.9	7.7	7.8	8.1	6.8	7.2
DO (mg/l)	1.10	2.50	4.25	5.00	1.10	3.50
BOD_5 (mg/l)	5.00	10.00	17.00	23.00	24.00	15.00
FC (MPN/100ml)	2,400	-	-	-	>24,000	3,500
NO_3-N (mg/l)	nil	3.3	nil	nil	nil	nil
NH_3-N (mg/l)	nil	0.8	nil	nil	0.7	nil
Cu (mg/l)	0.3	-	-	nil	nil	nil
Ni (mg/l)	-	-	-	-	-	-
Mn (mg/l)	-	-	-	-	-	-
Zn (mg/l)	0.1	-	-	nil	nil	0.1
Hg (total) (mg/l)	0.001	-	-	0.025	nil	nil
Cd (mg/l)	nil	-	-	nil	nil	nil
Cr^{+6} (mg/l)	nil	-	-	nil	nil	nil
Pb (mg/l)	0.007	-	-	0.005	0.006	0.007
As (mg/l)	nil	-	-	nil	nil	nil
TSS (mg/l)	283.0	1,001.5	84.5	63.5	18.0	509.5

(Continued next page)

Appendix 1.2 Continued

Water Index	PC 2	PC 3	BH 1	BH 2	BT 1	BT 2
Temp (^oC)	29.0	29.0	29.5	29.0	31.0	30.0
pH	7.9	6.3	7.9	7.3	8.2	7.0
DO (mg/l)	3.20	4.10	8.00	2.50	1.25	2.50
BOD_5 (mg/l)	6.00	11.00	10.00	31.00	24.00	14.00
FC (MPN/100ml)	-	-	-	7,800	6,700	-
NO_3-N (mg/l)	nil	nil	nil	nil	nil	nil
NH_3-N (mg/l)	nil	nil	nil	nil	nil	nil
Cu (mg/l)	-	-	-	0.2	nil	-
Ni (mg/l)	-	-	-	-	-	-
Mn (mg/l)	-	-	-	-	-	-
Zn (mg/l)	-	-	-	0.1	0.1	-
Hg (total) (mg/l)	-	-	-	0.200	1.850	-
Cd (mg/l)	-	-	-	nil	nil	-
Cr^{+6} (mg/l)	-	-	-	nil	0.04	-
Pb (mg/l)	-	-	-	0.023	0.047	-
As (mg/l)	-	-	-	nil	nil	-
TSS (mg/l)	237.5	404.5	57.0	224.5	1,109.0	455.5

(Continued next page)

Appendix 1.2 Continued

Water Index	BT 3	PY 1	PY 2	HK 1	HK 2	HK 3
Temp (°C)	31.0	30.0	30.0	31.0	30.5	31.0
pH	7.4	7.6	7.5	7.6	8.3	7.9
DO (mg/l)	1.50	4.50	3.10	3.00	3.50	3.50
BOD_5 (mg/l)	7.00	10.00	18.00	9.00	16.00	3.00
FC (MPN/100ml)	-	-	1,750	680	-	-
NO_3-N (mg/l)	3.3	nil	nil	1.4	0.7	1.8
NH_3-N (mg/l)	0.6	nil	nil	0.3	0.2	0.2
Cu (mg/l)	-	-	nil	nil	-	-
Ni (mg/l)	-	-	-	-	-	-
Mn (mg/l)	-	-	-	-	-	-
Zn (mg/l)	-	-	nil	0.1	-	-
Hg (total) (mg/l)	-	-	nil	0.001	-	-
Cd (mg/l)	-	-	nil	nil	-	-
Cr^{+6} (mg/l)	-	-	nil	nil	-	-
Pb (mg/l)	-	-	0.011	0.009	-	-
As (mg/l)	-	-	nil	nil	-	-
TSS (mg/l)	1,226.0	66.5	100.5	586.0	232.0	256.5

(Continued next page)

Appendix 1.2 Continued

Water Index	PR 1	PL 1	PL 2	PP 1	PP 2	TN 1
Temp (°C)	31.0	30.5	31.0	31.0	34.0	30.5
pH	6.8	8.4	8.5	6.4	6.8	8.2
DO (mg/l)	5.00	4.00	4.00	3.40	2.50	1.00
BOD_5 (mg/l)	21.00	23.00	31.00	17.00	11.00	19.00
FC (MPN/100ml)	6,700	-	3,500	840	-	-
NO_3-N (mg/l)	nil	nil	0.1	nil	0.4	0.6
NH_3-N (mg/l)	nil	nil	1.8	nil	2.6	2.6
Cu (mg/l)	nil	-	nil	nil	-	-
Ni (mg/l)	-	-	-	-	-	-
Mn (mg/l)	-	-	-	-	-	-
Zn (mg/l)	nil	-	nil	nil	-	-
Hg (total) (mg/l)	0.135	-	0.001	nil	-	-
Cd (mg/l)	nil	-	nil	nil	-	-
Cr^{+6} (mg/l)	nil	-	nil	nil	-	-
Pb (mg/l)	0.003	-	0.002	0.007	-	-
As (mg/l)	nil	-	nil	nil	-	-
TSS (mg/l)	242.0	291.0	211.5	37.5	19.5	39.5

(Continued next page)

Appendix 1.2 Continued

Water Index	TN 2	LB 1	LB 2	LB 3	NH 1	NH 2
Temp (°C)	31.0	31.0	35.0	34.0	34.5	35.0
pH	7.4	8.4	7.5	7.2	8.1	7.2
DO (mg/l)	0.80	2.56	3.00	4.40	3.30	3.60
BOD_5 (mg/l)	14.00	4.00	3.00	8.00	4.00	9.00
FC (MPN/100ml)	>24,000	17,500	-	-	7,800	-
NO_3-N (mg/l)	0.3	nil	nil	nil	nil	nil
NH_3-N (mg/l)	1.8	nil	nil	nil	nil	nil
Cu (mg/l)	nil	nil	-	-	nil	-
Ni (mg/l)	-	-	-	-	-	-
Mn (mg/l)	-	-	-	-	-	-
Zn (mg/l)	nil	nil	-	-	0.1	-
Hg (total) (mg/l)	nil	nil	-	-	nil	-
Cd (mg/l)	nil	nil	-	-	nil	-
Cr^{+6} (mg/l)	nil	nil	-	-	nil	-
Pb (mg/l)	0.008	0.005	-	-	0.014	-
As (mg/l)	nil	nil	-	-	nil	-
TSS (mg/l)	23.0	18.0	32.0	41.5	80.5	111.5

Note:
SR - Samrong
PC - Phraongchaochaiyanuchit
BH - Banghia
BT - Bangsaothong
PY - Panya
HK - Huacharake
PR - Plara
PL - Pla
PP - Palatpriang
TN - Tabnang
LB - Latkrabang
NH - Nongnguhao

Temp - Temperature
DO - Dissolved oxygen
BOD_5 - Five-day biochemical oxygen demand
FC - Faecal coliform
NO_3-N - Nitrate-Nitrogen
NH_3-N - Ammonia-Nitrogen
Cu - Copper
Ni - Nickel
Mn - Manganese
Zn - Zinc
Hg - Mercury
Cd - Cadmium
Cr^{+6} - Chromium (hexavalent)
Pb - Lead
As - Arsenic
TSS - Total suspended solids

Appendix 1.3 Values of Specific Surface Water Quality in the Canal Network of Amphoes Bang Pli and Bang Bo, Samut Prakan, June-July 1991 (Wet Season)

Water Index	SR 1	SR 2	SR 3	SR 4	SR 5	PC 1
Temp (°C)	30.6	30.5	29.5	30.5	30.0	30.5
pH	7.1	6.5	5.9	7.1	7.3	6.2
DO (mg/l)	1.50	5.10	1.30	1.80	0.30	3.00
BOD_5 (mg/l)	5.00	6.00	8.00	5.00	20.00	6.00
FC (MPN/100ml)	2,225	-	-	1,420	17,500	590
NO_3-N (mg/l)	4.7	3.9	3.3	5.2	5.8	4.0
NH_3-N (mg/l)	0.2	0.2	0.1	nil	0.3	0.2
Cu (mg/l)	nil	-	-	nil	nil	nil
Ni (mg/l)	0.18	-	-	0.01	0.08	0.16
Mn (mg/l)	nil	-	-	nil	nil	nil
Zn (mg/l)	nil	-	-	nil	nil	nil
Hg (total) (mg/l)	0.002	-	-	0.010	0.062	0.002
Cd (mg/l)	nil	-	-	nil	nil	nil
Cr^{+6} (mg/l)	nil	-	-	nil	nil	nil
Pb (mg/l)	0.055	-	-	0.150	0.015	0.039
As (mg/l)	nil	-	-	nil	nil	nil
TSS (mg/l)	21.5	67.0	117.5	55.0	10.5	95.5

(Continued next page)

Appendix 1.3 Continued

Water Index	PC 2	PC 3	BH 1	BH 2	BT 1	BT 2
Temp (^oC)	29.7	30.0	31.0	31.0	30.5	29.3
pH	5.3	5.9	6.7	6.0	7.1	5.6
DO (mg/l)	2.60	3.40	3.30	2.00	4.70	2.75
BOD_5 (mg/l)	6.00	11.00	13.00	12.00	10.00	4.00
FC (MPN/100ml)	-	-	-	680	6,700	-
NO_3-N (mg/l)	4.8	2.8	4.3	4.0	3.8	2.9
NH_3-N (mg/l)	0.8	nil	nil	nil	0.7	nil
Cu (mg/l)	-	-	-	nil	nil	-
Ni (mg/l)	-	-	-	0.02	0.02	-
Mn (mg/l)	-	-	-	nil	nil	-
Zn (mg/l)	-	-	-	nil	nil	-
Hg (total) (mg/l)	-	-	-	0.156	0.002	-
Cd (mg/l)	-	-	-	nil	nil	-
Cr^{+6} (mg/l)	-	-	-	nil	nil	-
Pb (mg/l)	-	-	-	0.041	0.053	-
As (mg/l)	-	-	-	nil	nil	-
TSS (mg/l)	62.5	12.0	34.5	35.0	102.5	3.0

(Continued next page)

Appendix 1.3 Continued

Water Index	BT 3	PY 1	PY 2	HK 1	HK 2	HK 3
Temp (^oC)	29.3	29.5	30.5	30.5	29.6	29.5
pH	7.0	6.0	8.2	7.5	6.4	6.5
DO (mg/l)	3.00	1.20	2.50	1.70	2.40	2.25
BOD_5 (mg/l)	6.00	8.00	8.00	7.00	8.00	8.00
FC (MPN/100ml)	-	-	7,800	11,000	-	-
NO_3-N (mg/l)	3.0	5.6	4.8	3.5	5.2	3.6
NH_3-N (mg/l)	nil	nil	nil	0.7	nil	nil
Cu (mg/l)	-	-	nil	nil	-	-
Ni (mg/l)	-	-	0.01	0.04	-	-
Mn (mg/l)	-	-	nil	nil	-	-
Zn (mg/l)	-	-	nil	nil	-	-
Hg (total) (mg/l)	-	-	0.009	0.015	-	-
Cd (mg/l)	-	-	nil	nil	-	-
Cr^{+6} (mg/l)	-	-	nil	nil	-	-
Pb (mg/l)	-	-	0.048	0.016	-	-
As (mg/l)	-	-	nil	nil	-	-
TSS (mg/l)	41.0	91.0	84.0	163.5	80.5	90.5

(Continued next page)

Appendix 1.3 Continued

Water Index	PR 1	PL 1	PL 2	PP 1	PP 2	TN 1
Temp (^{o}C)	30.0	29.5	30.0	29.6	30.0	28.0
pH	7.0	6.7	4.3	6.9	8.3	7.3
DO (mg/l)	1.80	2.30	1.10	0.50	0.30	0.50
BOD_5 (mg/l)	14.00	14.00	22.00	19.00	26.00	10.00
FC (MPN/100ml)	4,600	-	>24,000	>24,000	-	-
NO_3-N (mg/l)	5.9	5.8	3.9	5.8	6.8	8.6
NH_3-N (mg/l)	nil	nil	0.3	0.9	1.0	nil
Cu (mg/l)	nil	-	nil	nil	-	-
Ni (mg/l)	0.09	-	0.05	0.21	-	-
Mn (mg/l)	nil	-	nil	nil	-	-
Zn (mg/l)	nil	-	nil	nil	-	-
Hg (total) (mg/l)	0.064	-	0.002	0.003	-	-
Cd (mg/l)	nil	-	nil	nil	-	-
Cr^{+6} (mg/l)	nil	-	nil	nil	-	-
Pb (mg/l)	0.030	-	0.205	0.154	-	-
As (mg/l)	nil	-	nil	nil	-	-
TSS (mg/l)	19.5	69.0	22.5	8.0	20.0	44.0

(Continued next page)

Appendix 1.3 Continued

Water Index	TN 2	LB 1	LB 2	LB 3	NH 1	NH 2
Temp (^oC)	29.8	30.0	30.8	30.0	30.5	29.7
pH	7.1	7.6	8.0	6.5	4.5	5.2
DO (mg/l)	1.10	0.80	2.60	1.00	2.30	2.30
BOD_5 (mg/l)	10.00	10.00	5.00	8.00	11.00	8.00
FC (MPN/100ml)	7,800	5,970	-	-	1,220	-
NO_3-N (mg/l)	4.9	4.0	3.8	5.6	5.6	3.0
NH_3-N (mg/l)	0.1	1.0	nil	nil	1.0	nil
Cu (mg/l)	nil	nil	-	-	nil	-
Ni (mg/l)	0.24	0.17	-	-	0.25	-
Mn (mg/l)	nil	nil	-	-	nil	-
Zn (mg/l)	nil	nil	-	-	nil	-
Hg (total) (mg/l)	0.006	0.052	-	-	0.084	-
Cd (mg/l)	nil	nil	-	-	nil	-
Cr^{+6} (mg/l)	0.03	nil	-	-	nil	-
Pb (mg/l)	0.084	0.073	-	-	0.217	-
As (mg/l)	nil	nil	-	-	nil	-
TSS (mg/l)	27.0	26.0	44.0	23.0	84.0	129.5

Note:

SR - Samrong
PC - Phraongchaochaiyanuchit
BH - Banghia
BT - Bangsaothong
PY - Panya
HK - Huacharake
PR - Plara
PL - Pla
PP - Palatpriang
TN - Tabnang
LB - Latkrabang
NH - Nongnguhao

Temp - Temperature
DO - Dissolved oxygen
BOD_5 - Five-day biochemical oxygen demand
FC - Faecal coliform
NO_3-N - Nitrate-Nitrogen
NH_3-N - Ammonia-Nitrogen
Cu - Copper
Ni - Nickel
Mn - Manganese
Zn - Zinc
Hg - Mercury
Cd - Cadmium
Cr^{+6} - Chromium (hexavalent)
Pb - Lead
As - Arsenic
TSS - Total suspended solids

APPENDIX 2

In-depth Interview with Local People

Purposive sampling technique is employed for selected interview. While the water sample was being collected in each spot, local people who were living there were interviewed informally. Therefore, the sample distribution of interviewee's households is similar to those of water sampling. This sampling design helped us to know how the distance from the factories was significant to the locations of households and to the quality of life.

Key questions asked in the interview were:

Household background: numbers of family members, age, sex, occupation, length of stay, migration of each member in the family.

Water consumption: from the well, the canal and/or rain water; any problems from their usage - what were their mitigation?

Observation of aquatic plants and fish in the canal: changes in aquatic plant and fish in the canal — when and how did it happen and how often and how many fish do they catch?

Health: health problem after consuming water from the canal — what were the symptoms, what were methods of treatment?

Others: other environmental problems — what, when and how often did they occur, how did you solve the problems?

APPENDIX 3

In-depth Interview with Entrepreneurs

Purposive interview was employed by aiming at dominant types of industries, especially chemicals and chemical products, fabricated metal products, plastic and allied products, and food industries. Each type of these industries was selected as case studies.

Key questions asked:

Investment and production process:

Is this industry domestic, joint venture, or multinational enterprise? What is the size of investment? Is this your first plant? Where is your first plant and why did you move to this place? Is there any technological production transfer from abroad? Do you develop your own technology in production? What are the plans for future expansion?

Energy, Raw Materials, Waste and Infrastructure:

What is your energy management for your factories? How did you manage your water demand? What are the raw materials — used and where do they come from? What types of waste did you generate and how did you handle it? Did you have to build your own infrastructure, especially roads to the factory? In what ways did the government help you? Any problems from the above and how did you solve them?

Appendix 4.1 Household Information on Local People in Amphoes Bang Pli and Bang Bo, Samut Prakan, 1991

Case no.	Household code	Family member	back. age	former	place	Occupation now	place	reason of change	House ownership	Plan to move
1	WUP 1	F	77	RF (20 y)	here	shop owner	here	in debt	rent	no plan
	(14/5/91)	M	65	RF (20 y)	here	shop owner	here	in debt		
		S	?	LF	nearby	LF	nearby	-		
		L	?							
2	WUP 2	F	50	a small rice milling owner before	Uttaradit Province	fish farming	here	in debt (first change)	rent	back to Uttaradit when present land lease expired
	(14/5/91)	M	45					expired land lease (second change)		
		L			close to main road					
		L		fish farming	nearby here					
		L								
		L								
		L								
3	WUP 3	F	50	-	-	Plant nursery & employee of Japanese firm (Lake Side & Green Valley)	here (nursery) nearby here (Japanese firm)	He may give up nursery if the firm move to Bangpakong	the firm lent him this house	follow the firm
	(20/5/91)	M	?							
		L?								
4	WUP 4	F	46	LF (1988)	Thonburi	LF	nearby here	looked for a new job	rent	go somewhere if the landlord cancel the rent
	(20/5/91)	M	38	-	-	-	-			
		L	22	-		LF	nearby here			
		L	10	-		student				
		L	8	-		student				

(Continued next page)

Appendix 4.1 (Continued)

Case no.	Household code	Family back. member	age	former	place	Occupation now	place	reason of change	House ownership	Plan to move
5	WLT 1 (14/5/91)	F	50	FF	here	FF	here	no change	rent	just bought a house near here
		M	48			FF (assistant)				
		SP	>30			?				
		SP	?			?				
		SP	?			?				
		SP	?			?				
		SP	?			?				
		L	22			LF				
6	WLT 2 (23/5/91)	F	64	FF	close to Wat Narndeang	FF	here	Landlord asked him to look after his land.	He paid nothing. Landlord lent him this house.	If landlord asks the house back, he has to move - but does not know where.
		M	50			FF (assistant)				
		SP	?			?				
		SP	?			?				
		S	?			Monk				
		S	?			Soldier				
		D	?			FF (assistant)				
7	WLT 3 (23/5/91)	M	49	LD	around here	LD	around here	-	rent	no plan
		L	?			Her eitght children have never worked in factories.				
		L	?							
		L	?							
		L	?							
		L	?							
		L	?							
		L	?							
		L	?							

(Continued next page)

Appendix 4.1 (Continued)

Case no.	Household code	Family back. member	age	former	place	Occupation now	place	reason of change	House ownership	Plan to move
8	WUL 1 (14/5/91)	Si	45	no job	-	no job	-	His family looked after him.	His family gave him this house.	no plan
9	WUL 2 (14/5/91)	F M L L L	45 ? ? ? ?	VH	here	Land leasing for fish farm and other business.	here	end of term	own	no plan
10	WUL 3 (14/5/91)	F M D	32 29 8	FF	Ladkrabang district, BANGKOK	FF	here	got married and moved to here in 1986.	rent	to other place nearby because pond was too shallow and water was dirty.
11	WUL 4 (23/5/91)	F M L L L L	65 51 18 ? ? 14	boat driver	this district	shop owner and LA	here	too old to drive boat and children asked him to stop	own	no plan

(Continued next page)

Appendix 4.1 (Continued)

Case no.	Household code	Family back. member	age	former	place	Occupation now	place	reason of change	House ownership	Plan to move
12	WUL 5 (23/5/91)	F	60	bus driver	?	bus driver	-	-	rent	just bought a house nearby, so he's leaving soon
		M	56	housewife		housewife				
		S	?			LF				
		S	35			LF*				
		L	?			OF				
		L	?			OF				
		L	?			OF				
		L	?			OF				
13	WUL 6 (23/5/91)	F	50	BD	here	BD	here	-	rent, but landlord will sell this land soon	just bought a house nearby
		M	47			housewife				
		L	?			FF				
		L	?			FF				
		L	?			FF				
		L	?			student				
14	WSR 1 (20/5/91)	F	29	LF	here	LF	here	-	rent for nine years	no plan
		M	24			housewife				
		D	5							
		D	3							
15	WSR 2 (20/5/91)	F	50	OF	the school near here	OF and room renter	the school near here or near his land	-	own	no plan
		M	44			housewife				
		S	23			OF				
		S	21			student				
		S	19			OF				
		D	18			student				
		D	?			student				

(Continued next page)

Appendix 4.1 (Continued)

Case no.	Household code	Family back. member	age	former	place	Occupation now	place	reason of change	House ownership	Plan to move
16	WLP 1 (20/5/91)	U	69	RF	Chonburi Province	LD	here	low productivity	rent	having a house nearby, leaving soon
		NS	58			FF				
		ND	37							
17	WLP 2 (20/5/91)	U	70	FF	Ladwai, Bang Pli	LD	here	too old	rent	no plan
		NS	?			student				
		ND	?			student				
18	WLp 1 (20/5/91)	F	42	?	?	FF & OF	here	got married and moved here	stay here with father-in-law	no plan
		M	33			FF (assistant)				
		L	13			student				
		L	12			student				
		L	11			student				
19	ELP 1 (24/5/91)	F	44	?	?	FF & LD	here	got married and moved here	rent	no plan
		M	37			FF (assistant)				
		S	22			LF				
		D	?			student				
		D	?			student				

(Continued next page)

Appendix 4.1 (Continued)

Case no.	Household code	Family member	back. age	former	place	Occupation now	place	reason of change	House ownership	Plan to move
20	ELP 2 (24/5/91)	M	55	housewife	here	housewife	here	-	own	no plan
		S	?			LF				
		S	?			LF				
		S	?			LF				
		S	27			LF				
		L	?			?				
		L	?			?				
		L	?			?				
21	ELD 1 (24/5/91)	G (F?)	51	LD	around here	LD	around here	-	living without pay on land of Royal Irrigation Department	no plan and does not know where to go if RID ask him to leave
		M	48							
		L	?							
		L	?							
		L	?							
		L	?							
		S	21							
		L	?							
22	ELD 2 (24/5/91)	F	40	?	?	FF	here	got married	stay with father-in-law	no plan
		M	33			FF (assistant)				
		S	14			student				
		L	?			student				
		L	?			student				
23	ESR 1 (24/5/91)	F	45	FF (2 times)	?	LF	Siam Motor	First - got married Second - pollution	own	no plan
		M	37			housewife				
		D	14			student				
		S	10			student				

(Continued next page)

Appendix 4.1 (Continued)

Case no.	Household code	Family back. member	age	former	place	Occupation now	place	reason of change	House ownership	Plan to move
24	ESR 2 (24/5/91)	F	26	LD	here	LD	here	got married	stay in his brother's house	to rent room from the temple beside here
		M	26			LF				
		S	7							
		S	1.5							
25	ESR 3 (15/5/91)	F	59	WF	Bangkok	WF	Bangkok	-	rent	does not know
		M	43			housewife				
		D	10			student				
		D	7							
26	ESR 4 (15/5/91)	F	50	CT	here	CT	here	-	rent for 20 years	-
		M	45			housewife				
		D	20			LF				
		L	?			LD				
		L	?			student				
		L	?			student				
27	ESR 5 (15/5/91)	F	78	?	?	no work	-	retired	rent	no plan
		M	77			looked after kid				
		D	45			housewife				
		Son-in-law	60			LD				
		ND	12			student				

(Continued next page)

Appendix 4.1 (Continued)

Case no.	Household code	Family back. member	age	former	place	Occupation now	place	reason of change	House ownership	Plan to move
28	ESR 6 (15/5/91)	F	61	RF	here	LA	here	-	own	-
		M	53			housewife				
		D	35			?				
		L	30			LF				
		L	?			LF				
		L	27			LF				
29	WUN 1 (23/5/91)	F	50	?	Samut Sakhon	selling bamboo	here	more construction here	own	-
		M	47			help her husband				
		L	?			FF				
		L	?			student				
		L	?			student				
		L	?			student				
30	WUN 2 (23/5/91)	F	50	LD	here	LD	here	-	own	no plan
		M	50			housewife				
		L	?			student				
		L	?			student				
31	WUN 3 (23/5/91)	F	37	FF	Klong Plue	FF	here	got married then moved to here	own	The gov. claimed this land in 1969, he'll move when the gov. ask
		M	34							
		L	?							
		L	?							
		L	?							
		L	?							

(Continued next page)

Appendix 4.1 (Continued)

Case no.	Household code	Family back. member	age	former	place	Occupation now	place	reason of change	House ownership	Plan to move
32	WUN 4 (23/5/91)	M	47	FF	here	FF & own shop at Pakklongtarad, BKK	here	-	own	The gov. claimed this land in 1969, he'll move when the gov. ask
		D	?							
		D	?							
		D	?							
		D	?							
		D	?							
		S	?							
		S	?							
		S	?							
33	WUH 1 (15/5/91)	F	54	boat driver	here	boat driver	here	-	rent	no plan
		M	45			housewife				
		L	?			shop*				
		L	?			LF				
		L	?			LF				
		L	?			LF				
		L	?			LF				
34	WUH 2 (4/5/91)	F	37	LF	somewhere in Bang Pli	LF	Siam Motor for 15 years	got married here	own	no plan
		M	32							
		S	9							
35	EUB 1 (15/5/91)	M	65	housewife	here	housewife	here	-	?	-
		L	?			LF				
		L	?			LF				
		L	?			LF				
		L	?			LF				
		L	?			LF				

(Continued next page)

Appendix 4.1 (Continued)

Case no.	Household code	Family back. member	age	former	place	Occupation now	place	reason of change	House ownership	Plan to move
36	EUB 2 (15/5/91)	F	56	RF	here	unemployed	here	he just sold his land	own	he wanted to leave the house to his sons and to go to Chonburi or Chanthaburi
		M	50			housewife				
		S	?			LF				
		S	?			LF				
		L	?			LF				
		L	?			student				
		L	?			student				
37	EUB 3 (4/7/91)	M	54	?	?	FF & LD	here	got married here	own	no plan
		S	28			?				
		D	26			?				
		S	24			FF				
38	EUO 1 (15/5/91)	F	55	?	?	shop owner	here	-	own	no plan
		M	52			shop owner				
		S	30			bank employee				
		D	?			nurse				
		L	?			student				
		L	?			student				
		D	?			help her parents				
39	EUO 2 (15/5/91)	F	60	RF	near here	monk	nearby temple	landlord sold land to *Bang-Na Garden*	own (just bought this house)	no plan
				CT	around here			-		
		M	58			housewife				
		L	?			all worked as LF				

(Continued next page)

Appendix 4.1 (Continued)

Case no.	Household code	Family back. member	age	former	place	Occupation now	place	reason of change	House ownership	Plan to move
40	EUO 3	F	28	?	Petchaboon	RF for three years	here	got married here	rent	-
	(31/5/91)	M	23			RF (assistant)				
		D	2							
41	EUO 4	F	49	RF	here	RF	here	-	rent	no plan
	(31/5/91)	M	49			RF (assistant)				
		L	29			RF (assistant)				
		L	?			RF (assistant)				
		L	?			RF (assistant)				
		L	12			student				
42	EUO 5	F	40	RF	?	shop owner	here	low productivity	?	-
	(31/5/91)	M	39			shop owner				
		D	?			student				
		NS	?			LF				

(see next page for abbreviation used in Appendix 3.1)

Note:

Household code:

WUP - Palatpriang
WUL - Latkrabang
WUN - Nongnguhao
WLT - Tabnang
WLP - Pla
WLp - Plara
WSR/ESR - Samrong
EUO - Phraongchaochaiyanuchit
EUB - Bangsaothong
ELD - Banghia
ELP - Panya

Family background:

Si - single
F - father
M - mother
U - uncle
S - son
D - daughter
NS - niece or nephew, male
ND - niece or nephew, female
L - unknown sex of dependents
SP - son or daugther was living somewhere else.

Occupation:

BD - boat driver
LF - labourer in factory around here
LF* - labourer in factory in other provinces
LD - a day labourer
LA - room or accommodation leasing
RF - rice or paddy farmer
FF - fish farmer
CT - carpenter
OF - government officials
WF - white collar in private firm
VH - village headman
Shop - sales of food, coffee, beverage, groceries, etc.

Appendix 4.2 Information on Water Use and Observation of Flora and Fauna in Amphoes Bang Pli and Bang Bo, Samut Prakan, 1991

Case no.	Household code	Water use				Living organisms in the canals					
		drink	cook	wash	bath	flora	occur	reason	fauna	occur	reason
1	WUP 1 (14/5/91)	X	X	X	X	-	-	-	decreasing in number	10 years ago	too many people
2	WUP 2 (14/5/91)	T	T	T	T	-	-	-	decreasing in number & size was smaller	6 years ago	does not know
3	WUP 3 (20/5/91)	T	T	T	T	-	-	-	decreasing in number	-	pollution
4	WUP 4 (20/5/91)	T	T	T	T	-	-	-	decreasing in number, malformed and died	1990	does not know
5	WLT 1 (23/5/91)	R	W	W	W	-	-	-	decreasing in number, malformed and crazy	1988-1991	waste water from Bangpu' Industrial Estate, esp. at night
6	WLT 2 (23/5/91)	R	W	W	W	-	-	-	decreasing in number, malformed and crazy	1988-1991	waste water from Bangpu' Industrial Eatate, esp. at night

(Continued next page)

Appendix 4.2 (Continued)

Case no.	Household code	Water use drink	cook	wash	bath	Living organisms in the canals flora	occur	reason	fauna	occur	reason
7	WLT 3 (23/5/91)	R+B	R+B	C	C	totally disappeared	1988	water pollution from a nearby factory	decreasing in number, sometimes malformed, disappeared	1988	water pollution from a nearby factory
8	WUL 1 (14/5/91)	W	W	W	W	-	-	-	-	-	-
9	WUL 2 (14/5/91)	R	R	C*	C*	-	-	-	no big fish, found only few small fish	-	waste water from upstream
10	WUL 3 (14/5/91)	R +W	R +W	C	C	-	-	-	-	-	-
11	WUL 4 (23/5/91)	R+T	R+T	T	T	-	-	-	decreasing in number	1987	waste water from upstream
12	WUL 5 (23/5/91)	R+T	R+T	T	T	decreasing	1985-1986	pollution	decreasing in number, sometimes malformed, disappeared	1985-1986	increasing number of people and factory
13	WUL 6 (23/5/91)	R	R	T	T	few species left	?	pollution and salinity intrusion	decreasing in number, sometimes malformed, died	during the 1980s, but it was worst in 1989	pollution and salinity intrusion

(Continued next page)

Appendix 4.2 (Continued)

Case no.	Household code	Water use				Living organisms in the canals					
		drink	cook	wash	bath	flora	occur	reason	fauna	occur	reason
14	WSR 1 (20/5/91)	R	T	C	C	water lily and weed sometimes died	dry season	too many people	decreasing in number	?	too many people
15	WSR 2 (20/5/91)	R	W	W	W	-	-	-	decreasing in number, sometimes malformed, died from Klong Pla till Bang Bo	?	water polluton
16	WLP 1 (20/5/91)	R	T+C	T+C	T+C	-	-	-	sometimes malformed and died	dry season	sea intrusion
17	WLP 2 (20/5/91)	R +W	R +W	T+C	T+C	few species left	1984-1985	too many people	decreasing in number	1984-1985	too many people
18	WLp 1 (20/5/91)	R	R	C	C	few species left	-	pollution and sea intrusion	found malformed fish	1990	pollution and sea intrusion
19	ELP 1 (24/5/91)	R+B	R+B	C	C	nothing left	-	waste water	decreasing in number	dry season	pollution and sea intrusion

(Continued next page)

Appendix 4.2 (Continued)

Case no.	Household code	Water use drink	cook	wash	bath	Living organisms in the canals flora	occur	reason	fauna	occur	reason
20	ELP 2 (24/5/91)	R	R	W	W	-	-	-	found malformed fish	dry season	pollution and sea intrusion
21	ELD 1 (24/5/91)	R+B	R+B	W+C	W+C	normal, but sometimes disappeared	dry season	-	never notice	-	-
22	ELD 2 (24/5/91)	R	R	W	W	normal, but sometimes disappeared	dry season	too many people	decreasing in number and malformed	dry season	too many people
23	ESR 1 (24/5/91)	R+B	R+B	T	T	-	-	-	decreasing in number	?	water pollution
24	ESR 2 (24/5/91)	R+B	R+B	T	T	few species left	?	-	decreasing in number	?	water pollution
25	ESR 3 (15/5/91)	R	R	T	T	-	-	-	decreasing in number	?	sea intrusion
26	ESR 4 (15/5/91)	R	R	T	T	-	few species left	when it was salty	decreasing in number	when it was salty	sea intrusion
27	ESR 5 (15/5/91)	R	C	C	C	-	-	-	decreasing in number	?	too many people

(Continued next page)

Appendix 4.2 (Continued)

Case no.	Household code	Water use: drink	Water use: cook	Water use: wash	Water use: bath	Living organisms in the canals: flora	occur	reason	fauna	occur	reason
28	ESR 6 (15/5/91)	R	R+C	C	C	-	-	-	decreasing in number	?	too many people
29	WUN 1 (23/5/91)	W	W	W	W	does not know	-	-	does not know	-	-
30	WUN 2 (23/5/91)	R	R	C	C	few species left	?	-	decreasing in number and some fish stink of oil	?	nearby factories flushed grease & oil
31	WUN 3 (23/5/91)	R	R	C	C	-	-	-	-	-	-
32	WUN 4 (23/5/91)	R+B	R+B	C	C	-	-	-	decreasing in number, sometimes malformed, died	some years	does not know
33	WUH 1 (15/5/91)	R	R	W	W	-	-	-	decreasing in number	-	too many peopole & water pollution
34	WUH 2 (15/5/91)	R	R	C	C	-	-	-	decreasing in number and malformed	-	too many people

(Continued next page)

Appendix 4.2 (Continued)

Case no.	Household code	Water use drink	cook	wash	bath	Living organisms in the canals flora	occur	reason	fauna	occur	reason
35	EUB 1 (15/5/91)	R	W	W	W	-	-	-	decreasing in number	?	too many people
36	EUB 2 (15/5/91)	R	R	W	W	not much left	20 years ago	sea intrusion or industrial pollution	not much left	20 years ago	sea intrusion or industrial pollution
37	EUB 3 (4/7/91)	R	C	C	C	-	-	-	found malformed fish	dry season around 1-2 months	does not know
38	EUO 1 (15/5/91)	W	W	W	W	-	-	-	decreasing in number	dry season	sea intrusion
39	EUO 2 (15/5/91)	W	W	W	W	-	-	-	decreasing in number	?	sea intrusion or chemicals from agriculture
40	EUO 3 (31/5/91)	R	R	C	C	normal but sometimes disappeared	dry season	sea intrusion	found malformed fish	Nov-Dec or when sea intruded	does not know
41	EUO 4 (31/5/91)	R	R	C	C	few species left	-	-	found malformed fish	past few years	does not know
42	EUO 5 (31/5/91)	R	R	C	C	few species left	dry season	too many people	decreasing in number and malformed	dru season	too many people

(see next page for abbreviation used in Appendix 4.2)

Note:

Household code:

WUP - Palatpriang
WUL - Latkrabang
WUN - Nongnguhao
WLT - Tabnang
WLP - Pla
WLp - Plara
WSR/ESR - Samrong
EUO - Phraongchaochaiyanuchit
EUB - Bangsaothong
ELD - Banghia
ELP - Panya

Water use code:

R - rain
T - tap
C - canal
C* - water from canal is pumped into pond for deposition before use
W - well or bore
B - bottles of fresh water from a shop
X - rain and tap

Appendix 4.3 Detailed Information on Impacts of Industrialisation and Waste Water from Local People in Amphoes Bang Pli and Bang Bo, Samut Prakan, 1991

Case no.	Household code	Details
1	WUP 1 (14/5/91)	Nearby land was sold to developers reducing areas of rice and fish farming. Land price was between 1.4-1.5 million baht per rai.
2	WUP 2 (14/5/91)	He was afraid that surrounding factories may pollute water in canals which is harmful to his farm (pop-eyed goldfish).
3	WUP 3 (20/5/91)	Many factories create employment but they also produce pollution. Land price here was 22 million baht per rai; the opposite side (Bangkok Metropolitan Area) cost 48 million baht per rai.
4	WUP 4 (20/5/91)	There was a flood every year. However, canal was filthy, when water level was low. He used to consume water from canal but it was too dirty (due to too many houses).
5	WLT 1 (23/5/91)	Canal water sometimes caused malformed fish in his ponds. He used to complain to village head, but it was hopeless. He usually noticed waste water from Bangpu' Industrial Estate being flushed at night. Some months the canal was so dry, the official did not open the water gate to let fresh water in. Every October till December there was a flood here. If Sanitary Area of Amphoe Bang Pli has flood, the water gate will be opened to let water flood here. Groundwater was a bit salty but clear. His family stopped using canal water because it was very dirty. If there are more factories, his farm will be damaged. *Pla Salid* is popular for fish farming here.
6	WLT 2 (23/5/91)	Landlord let his family stay here without charge. If the landlord wanted his properties back, he had to move — but did not know where. Usually, there was a controversy between local people and industrial entrepreneurs. He wanted to have a negotiation but there was no middle man. Land price here was 2.5 million baht per rai.
7	WLT 3 (23/5/91)	She had no plan to move or to have a new house. Many villagers were working in factories. Some were employed to do in miscellaneous work such as digging soil and cleaning house. Sometimes it was very itchy when she took a bath in canal. This is because plastic factory has flushed waste water all year, especially dye. This bad situation was worse in dry season. If the water gate was controlled well, the situation may be better.

Appendix 4.3 (Continued)

Case no.	Household code	Details
8	WUL 1 (14/5/91)	He has stayed here for seven years noticing industrial waste (white substance) coming from upstream. He has never had fish from the canal.
9	WUL 2 (14/5/91)	He was a former village head some time ago. So he owned many pieces of land around here. He had no plan to have a new house or to move out. His three relatives who were staying with him never worked in factory. He just had a well, 60 metres deep. The water was clear but brackish. Villagers used to demonstrate on noise from nearby factory. Once villagers around here were paddy farmers. Later they were fish farmers due to its higher value. Now most of them, especially the young generation, have worked in factories.
10	WUL 3 (14/5/91)	Sometimes canal water was very dirty. He could not use it for fish farming. In addition, the canal was very dry this year. He could not take canal water for bathing because he felt itchy. He then consumed water from well provided by the nearby factory. If ther are more factories, they will certainly affect fish farming. It is noticeable that Klong Kingkeaw (parallel to Klong Ladkrabang) has been very dirty.
11	WUL 4 (23/5/91)	Industry was good for him to earn more income from room renting; but its waste caused environmental problems. Last year, there was a flood because of water gate. His family used to bathe in canal but everyone felt itchy due to waste water from houses and factories. Noticeably, different waste water had distinct colours. The villagers once complained about water pollution to Amphoe, but there was no response. Many land developers bought land around here between 12-15 million baht per rai.
12	WUL 5 (23/5/91)	There was a flood every year during the past 4-5 years — two feet high. Bang Pli's water gate was two years old. His family had stopped using water from canal for 4-5 years because it's inky, especially it's worse in the dry season. Land price here was 2.5 million baht per rai.

(Continued next page)

Appendix 4.3 (Continued)

Case no.	Household code	Details
13	WUL 6 (23/5/91)	Factories were good for employment. Labour wage here was 100 baht per day. Land price around here was 2.5 million baht per rai. His family had stopped using canal water since 1979 because of industrial waste water — green or black as he could notice. In the dry season, the canal was brackish and greenish. He paid for tap water, four baht per cubic metre.
14	WSR 1 (20/5/91)	Industry created employment. But he did not like it because most businessmen were not responsible for pollution. There were so many labourers who were working here came from the northeast of Thailand. It was itchy when he took a bath in canal. He sometimes noticed green oily patches, especialy during wet season which annually flooded the village for one month. Golf course on the opposite bank of the canal usually flushed waste water mixed with pesticides and fertiliser into the canal. Land price around this area was 10 million baht per rai.
15	WSR 2 (20/5/91)	He could make profit from room renting, but he did not like alien culture. Almost every year, there was a flood here. Golf course in the opposite side usually released black waste water. He did not care much about water pollution, but he thought of asking permission to use groundwater. Few years ago the villagers complained to the Province (the Provincial Office of Samut Prakan) about waste water from sugarcane factory. Land price around here was 10 million baht per rai.
16	WLP 1 (20/5/91)	It was itchy when he took a bath in canal. He noticed black and smelly floating materials from Samrong canal whenever water gate at Banghear canal was opened. This situation sometimes lasted 3-4 days. During the dry season, the canal was brackish.
17	WLP 2 (20/5/91)	There was a flood every 2-3 years due to mismanagement of water gate. Sometimes canal was salty causing itchiness. He usually noticed black floating materials or red and white oily patches which were filthy. They came from factories upstream when ever water gate at Banghear was opened.
18	WLp 1 (20/5/91)	Flood rarely occurred here due to short distance to water gate. Villagers used to complain to officials about waste water from sugarcane factory. If there are more factories, fish farming will disappear within a few years. Land price here was 2.5 million baht per rai.

Appendix 4.3 (Continued)

Case no.	Household code	Details
19	ELP 1 (24/5/91)	Everytime water gate at Klong Dan (Banghear canal) was opened, waste water flowed downstream. The water gate did not open during dry season. He was scared of water pollution damaging his fish farm. If he can not do farming, he has to find another job. Since fish canning (ROSA) and paint industry have been set up near here, his farm had less productivity to 1/3 of former yield. He used to get 100,000 baht, now he received only 60,000 baht. He felt itchy when taking a bath in canal because of salt water intrusion from Klong Dan and greeny/filthy oily patches or blackish substances from fish canning. The factory uncertainly flushed it — sometimes every 2-3 weeks.
20	ELP 2 (24/5/91)	Tap service came from nearby factory — it cost 5 baht per cubic metre. He took a bath in canal especially during wet season. Sometimes he had skin rash due to waste water and salinity intrusion. Last year, large volumes of waste water came from the national housing and Bang Pli Industrial Estate, especially during wet season as well as flood was so serious. Royal Irrigation Department dredged the canal every 2-3 years. Industry was good for employment but he did not like water pollution. Land price around here was 2-3 million baht per rai. Room rent at the national housing was 1,200 baht per month while it was between 700-800 baht around here.
21	ELD 1 (24/5/91)	Canal water near his place was often brackish and greenish because it was close to 'Nanghong' water gate where salt water could penetrate. The gate will open only when water level in the canal was high. Industry was good for employment. Land price was one million baht per rai. Some places around here were sold for golf courses.
22	ELD 2 (24/5/91)	Industry was good for employment but he believed within ten years water pollution will destroy all fish farms in this district. There were floods in 1983 and 1990 due to landfill for new built environments such as private housing, factories and golf courses. Between February and June the canal was brackish — water became red or green. Waste water from two fish canning industries upstream (ROSA and Hi-Q) was black. They had flushed it for two years, especially during dry season.
23	ESR 1 (24/5/91)	More factories, more pollution. As he noticed that the canal has been inky and filthy for more than ten years or since there were factories around here. His family has never had fish from the canal. The villagers used to complain about water pollution and noise, but there was no feedback from the local government. Formerly closest bore was brackish. The officials just dug a new well at the temple. Its quality was clear and fresh — cost four baht per cubic metre.

(Continued next page)

Appendix 4.3 (Continued)

Case no.	Household code	Details
24	ESR 2 (24/5/91)	Factories generated waste water. His family just stopped using canal 6-7 months ago because of water pollution. Last year, the problem became critical because waste water, black and filthy, came from the west (from Thai-Agri Food factory) together with sea intrusion. He now used tap water — eight baht per cubic metre. His wife has been working in the factory (producing watch) for more than a year. There were many local people who were working with Siam Motor because its factory has been estaplished before others. Other factories had alien labourers mainly from the northeast of Thailand. These workers rented rooms around here. Land price around here was 2-3 million baht per rai.
25	ESR 3 (15/5/91)	He did not like noise and other pollution from factories. Formerly his family used canal for bathing and washing. After fish canning industry (ROSA) has been here for 10 years, canal became inky and filthy. Tap or groundwater around here was brackish. Sometimes tap water was rusty. There was a flood every year which lasted 3-4 months because of landfill from new activities.
26	ESR 4 (15/5/91)	He was afraid of water pollution. His family has stopped using canal because fish canning industry (ROSA) released waste water. The situation may be better now because the factory just built deposit pond after residents here made a complaint to the officials. Tap water of the Metropolitan Waterworks Authority (MWA) has been brackish for 7-8 years. During dry season, tap water was red and salty. Water fee was 4.15 baht per cubic metre. Land price around here was three million baht per rai. There were so many developers wanted to buy land.
27	ESR 5 (15/5/91)	Paddy field around here has been declining, there were many fish and prawn farming near the coast. Industry provided good employment. He did not care about water pollution. He never noticed it. He knew only brackish water which occurred twice a year — February-March and April-May. He used to bathe in canal and sometimes felt itchy becauseof brackish water. There was an attempt to bore well but it was brackish. When villagers faced with fresh water shortage, there was a truck selling water at 8-10 baht per gallon.

(Continued next page)

Appendix 4.3 (Continued)

Case no.	Household code	Details
28	ESR 6 (15/5/91)	Nissan Motor has bought land from Bang Na-Trad road to here for 3-4 million baht per rai. Nissan Motor's factories were close to here but they did not generate water pollution. He sometimes felt itchy when taking a bath in canal. This was because of sea intrusion. The canal was seldom red — perhaps there was a leakage of water gate at Klong Dan. It has happened for ten years. There was no tap water here.
29	WUN 1 (23/5/91)	Last year there was a flood that lasted for two months. Factories provided employment but they generated water pollution. He did not like alien labourers because they usually quarrel with each other. He paid for tap water (from nearby private housing) at 6 baht per cubic metre. Land price was 25 million baht per rai.
30	WUN 2 (23/5/91)	Nearby factories flushed grease and oil causing smelly fish. This has stopped his family catching fish for consumption. There were two floods here in 1983 and 1987 — it happened because smaller canals were filled with soil from new developments.
31	WUN 3 (23/5/91)	His land was claimed 20 years ago by the government for new international airport. However, the project has not started yet, he still did fish farming by paying rent to the government. The government now did not ask for rent. So he stayed here free of charge. During dry season, he bought water from a truck because canal was salty. Sometimes he noticed black and red water flowing from upstream. He thought it was household waste. His farm productivity was declining.
32	WUN 4 (23/5/91)	There were two floods here in 1983 and 1990 because of flood mitigation scheme for Bangkok. Canal used to be green and brackish - did not know its cause. Her land was proclaimed by the government for new international airport. She just bought a house in other place. If the government ask her to leave this land, she will sell fish at Pakklongtalad, Bangkok.
33	WUH 1 (15/5/91)	Many fish farmers here rented land. Paint industry (TOA plant) near here generated water pollution. His skin was itchy when he took a bath in canal. The canal water was better during wet season. Minimum wage for labourer here was lower than other places, 75-85 baht per day. There was no welfare and no overtime.

(Continued next page)

Appendix 4.3 (Continued)

Case no	Household code	Details
34	WUH 2 (4/7/91)	Industry created jobs, but its pollution was not good. He has never had any problem about using canal water, though it was brackish for 4-5 days. Siam Motor bought many pieces of land (thousands of rai) around here at 3-4 million baht per rai.
35	EUB 1 (15/5/91)	He has never noticed water pollution, but he did not like factory. He used tap water — three baht per cubic metre. It was fresh but it sometimes was mixed with sand. He took a baht in canal during wet season. Sometimes it was itchy due to sea intrusion.
36	EUB 2 (15/5/91)	There was a flood almost every year. Landfill from new factories may cause the problem. He has never seen waste water here. He thought he may notice it soon. However, he stopped using canal because it was brackish causing skin rash, especially during dry season. He used tap water coming from nearby temple. Its quality was bad, sometimes it was red. He was planning to bore his own well.
37	EUB 3 (4/7/91)	She owned another fish farm in Bang Bo. Few years ago, fish in her farm were malformed or dead. She did not know its cause. She never noticed brackish water here. Not pessimistic against industry.
38	EUO 1 (15/5/91)	Their children were having good jobs — nurse and bank employee. The youngest was helping her parents in shop. No one worked in factory. His family have not used canal for three years because it was brackish, especially during dry season — February till March. In addition, it was contaminated by insecticides and industrial waste. He bought tap water, five baht per cubic metre, from the village head. Capitalists have bought land around here and left it idle.
39	EUO 2 (15/5/91)	Land price in this village used to be 640,000 baht per rai, now it was 1,600,000 baht per rai. Sea water usually intruded between March and April, but this year it happened till May. He also bought tap water, five baht per cubic metre, from the village head. More paddy field has been being converted to fish farm.

(Continued next page)

Appendix 4.3 (Continued)

Case no.	Household code	Details
40	EUO 3 (31/5/91)	Canal sometimes was salty for few weeks. His family grew rice twice a year. Its productivity was normal — 80-90 tung per rai (1 tung = 15 kg). Land along the canal bank belonged to Royal Irrigation Department. Landlord sold some piece of land at 700-800 thousand baht per rai, in some areas at one million baht per rai. Rich Japanese bought land in the opposite bank for golf course. Some farmers overthere had to work in factories. At present, many housewifes and teenagers in this village worked in nearby factories.
41	EUO 4 (31/5/91)	Landlord may sell this land affecting his family. He did not like factory. There were capitalists who bought land in the opposite bank for industry. Rice productivity was 70-80 tung per rai. He has never noticedwaste water, except salinity intrusion (which has occurred for few years). Brackish water occurred 2-3 times a year, each time lasted for ten days. This may be because of old water gate. However, he never felt itchy from bathing in canal. Since he found malformed fish (damaged skin — red tissue), his family stopped eating it.
42	EUO 5 (31/5/91)	Industry was good for employment but it generated waste water. However, he has never noticed pollution. Brackish water has occurred for few years, especially in May. Last time it happened for a month. Cause of the problem was leakage of water gate. The nearby temple was going to bore a well as to help people have fresh water. Flood happened in 1983 and 1990. He thought roads and landfill blocked drainage system. Land price here was 800,000 baht per rai.

Note:

WUP - Palatpriang
WUL - Latkrabang
WUN - Nongnguhao
WLT - Tabnang
WLP - Pla
WLp - Plara

WSR/ESR - Samrong
EUO - Phraongchaochaiyanuchit
EUB - Bangsaothong
ELD - Banghia
ELP - Panya

Appendix 5 Summary of Entrepreneurial Attitudes on Investment Incentive, Industrial Management, Production Processes, and Waste Handling from Three Major Industries in Amphoes Bang Pli and Bang Bo, Samut Prakan, 1991

Types of Industry	Investment and Production Processes								Energy, Raw Materials, Wastes and Infrastructure				
	Holding	M. of baht	Employee	Establishment time	Establishment reason	Technology	Sale of product	Future plan	Energy inputs	Water usages	Raw materials	Waste handling	Infrastructure & other problems
Chemmin Co.	Thai	50	35 LL 30 ST	1979 F1 1982 F2	A, B, C	SD	80% GB 19% OP 1% OS	to other provinces for wet processes	electricity but gas in the future	1 well for cooling machine & office use	75% im. 25% do.	only dust	Tel Acc Nar
Eternal Petrochemical Co. Ltd.	?% Thai ?% Taiwan	220	103 LO	1989 F2	D	BT	70% WC 30% OS		electricity	supply from the industrial estate	mainly imported	under control by IEAT	Qwa Elc Cmp
Eternal Resin Co.	51% Thai ?% Taiwan ?% Japan		1000 LO	1978 F2	F	MT	80% OS 20% WC	to cheaper land price and less env. dispute	electricity & kerosine		50% im. 50% do.	high investment	Tel Elc Slb
Asawin Superman Co. Ltd.	Thai	3	8 LL	1983 F2	G	BT	100% WC	has not thought about it	electricity	1 well for consumption only	20% im. 80% do.	non	R&D
Kosu Chemical Co. Ltd.	70% Japan 30% Thai	5	10 LL	1989 F2	F	MT	100% WC	to indus. estate due to better env. control	electricity	1 well	mainly imported	no answer	Tel

(Continued next page)

Appendix 5 (Continued)

Types of Industry	Investment and Production Processes								Energy, Raw Materials, Wastes and Infrastructure				
	Holding	M. of baht	Employee	Establishment time	Establishment reason	Technology	Sale of product	Future plan	Energy inputs	Water usages	Raw materials	Waste handling	Infrastructure & other problems
Drissen Aircraft Interior System (Asia) Co.	Ducth	20	80 LO	1987 F2	E	MT	100% OS	to other export processing zone	electricity	supply from the industrial estate and buy from other sources	mainly imported	under control by IEAT	Elc Qwb Tel Acc Slb
Sahalohakarn Co. Ltd.	Thai	16	200 LO	1987 F2	?	BT	?	expand the factory in this area	electricity	1 well	mainly imported	only sedimentation tank	Tel
K. Thai Metal Plating Co.	Thai	8.3	80 LL	1981-2 F2	F H	SD		has not thought about it but there's avail. space in this land		1 well	70% im. 30% do.	send to Samaedum	Tel Nar
Hoover Industry Co.	Thai	60	700 LO		G	SD	60% WC 40% OC	has not thought about it but there's avail. space in this land	electricity	1 well	70% im. 30% do.	-	Tel

(Continued next page)

Appendix 5 (Continued)

Types of Industry	Investment and Production Processes								Energy, Raw Materials, Wastes and Infrastructure				
	Holding	M. of baht	Employee	Establishment time	Establishment reason	Technology	Sale of product	Future plan	Energy inputs	Water usages	Raw materials	Waste handling	Infrastructure & other problems
Gaidum Mahakit Co. Ltd.	Thai	8	19 LO	1984	F1-2	SD			electricity	buy from other sources	mainly domestic	under control by IEAT	Qwa Tel Fld
Kaochong 1979 Co.	Thai	100	100 LL	1988	F2 F, H	BT SD	mainly WC	now expanding	electricity & gas	1 well	mainly domestic	-	Qwa Tel

Note: All abbreviations used in this table are as follows:

A - The entrepreneur wants to self-produce rather than import goods only.
B - There has already been a road that is passing through cheap land.
C - It is closed to the sea port where raw materials are easily conveyed to the factory.
D - The government persuade them to invest here.
E - The entrepreneur cannot find available land in other industrial estates.
F - To avoid environmental dispute in the city.
G - The former land rent was completed and this land price/rent is cheaper rent.
H - The former factory, some cases were a shop-house, was too small.
MT - Production process from mother firm (MNEs) or the partners.
BT - Buy patent of production processes from overseas or hire foreign technician.
GB - Product sale in Greater Bangkok.
OP - Product sale in other provinces outside Greater Bangkok.
WC - Product sale within the country.
OS - Product sale in overseas.
LL - Local labourers.
LO - Labourers from local and other areas
ST - Official staff.

SD - Self-developed production processes based on Western technologies.
Acc - Worry about accident, especially fire from neighbouring fatories.
Cmp - Complains from the local people about noise and smell.
Fld - Flood
Elc - Electricity is sometimes low voltage or gone.
Nar - Narrow road.
Qwa - Water quality is not suitable for the production process.
Qwb - Water quantity is inadequate and its quality is not suitable for the production process.
R&D - Need help from the government in research and development.
Slb - Shortage of skilled labourers.
Tel - inadequate number.
do - domestic goods.
im - import goods.

APPENDIX 6

Major Political Groups in the Thai Cabinet

Since 1932 there have been ten successful military coups, an average of one every six years. The first coup was aimed at overthrowing the absolute monarchy; another four coups (1947, 1957, 1971 and 1976) were intended to overthrow civilian governments and elected National Assemblies; the rest (June 1933, 1951, 1958 and 1977), staged by the ruling groups themselves, were intended to consolidate their own power. In addition, there have been seven unsuccessful coups, in 1933, 1948, 1951, 1977, 1981, 1985 and 1991. The first, in October 1933 was mounted by Prince Boworadet, a grandson of King Chulalongkorn (Rama V), with the support of some army garrisons, and was the one and only attempt to restore some direct measure of royal influence. The other attempted coups were all staged by military factions dissatisfied with the ruling clique and were put down by more powerful military elements. The latest coup d'état occurred on 23 February 1991. It overthrew the elected government of Prime Minister Chatchai Choonhawan because his government attempted to break up the balance between the traditional elements, especially the roles of military and bureaucracy, in the Thai political system (Murray, 1991: 1-2).

Between 1932 and 1945, military (including policemen) and bureacrats occupied almost all seats in the cabinet. Between 1945 and 1975, businessmen and civilians had been invited as cabinet members or around 6 to 30 per cent of all members. Since 1976, there has been a high fluctuation of these four major groups depending upon when the coup d'état or the social uprising occurred (Figure A 6.1).

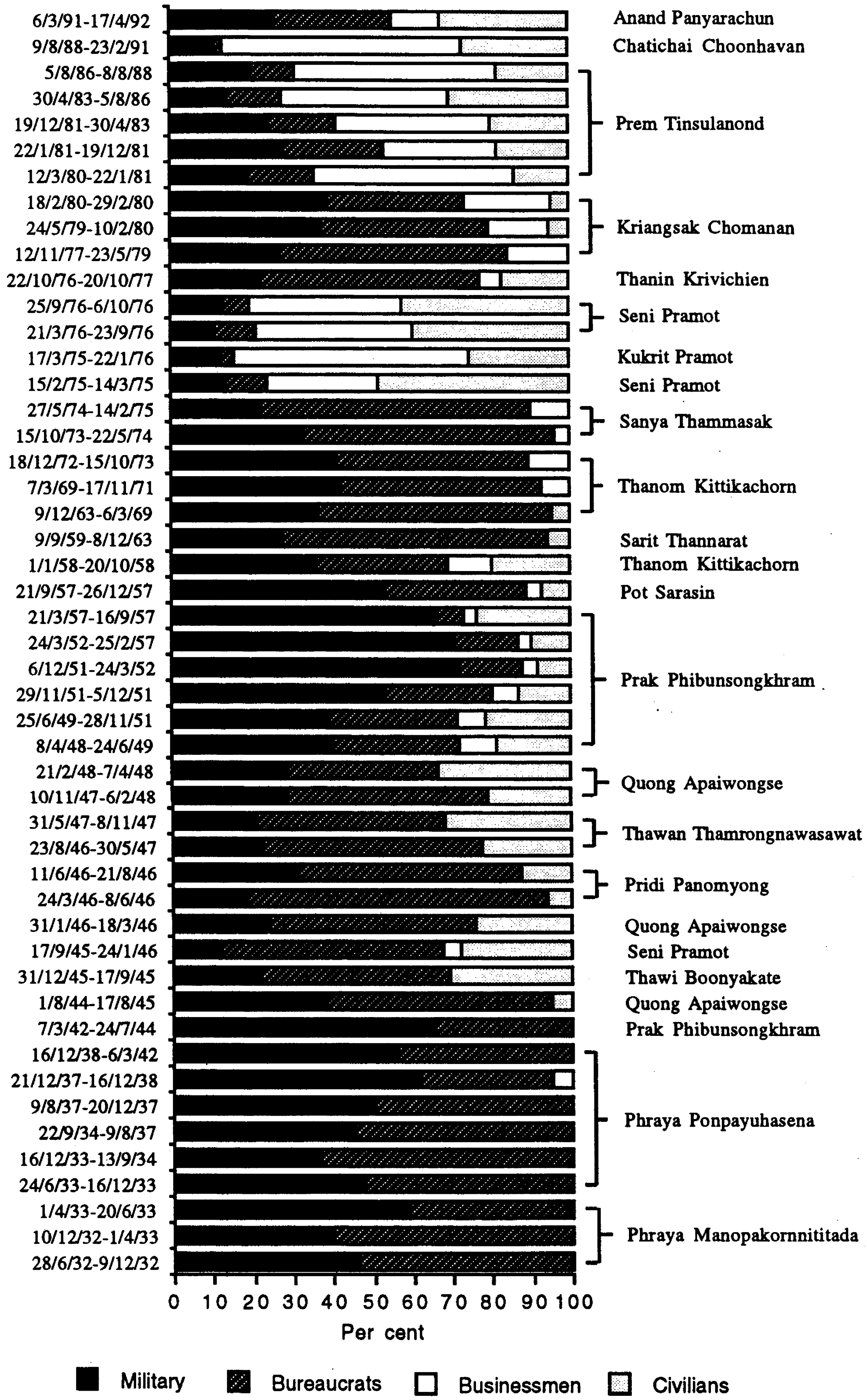


Figure A 6.1 Percentage of Background of Members in the Thai Cabinet, 1932-1991

APPENDIX 7

Investment Incentives under

the *Investment Promotion Act B.E. 2520 (1977)*

The *Investment Promotion Act of 1977* has preferably supported export-oriented industry. Its detail can be classified into 6 sections as follows:

1. Guarantees:

- against nationalisation
- against competition of new state enterprises
- against state monopolisation of the sale of products similar to those produced by promoted person
- against price controls
- permission to export
- against imports by government agencies or state enterprises with taxes exempted

2. Protection measures (subject to justifications and needs):

- imposition of surcharge on foreign products at a rate not exceeding 50 per cent of the CIF value for a period not more than 1 year at a time.
- import ban on competitive products
- authority by the Chairman to order any assisting actions or tax relief measures for the benefit of promoted projects

3. Permission:

- to bring in foreign nationals to undertake investment feasibility studies
- to bring in foreign technicians and experts to work under promoted projects
- to own land for carrying out promoted activities
- to take or remit abroad foreign currency

4. Tax incentives

- exemption of business taxes on imported machinery
- fifty per cent import duty reduction on machinery which is subject to import duty greater than or equal to 10 per cent
- reduction of import duties and business taxes of up to 90 per cent on imported raw materials and components
- exemption of corporate income taxes 3 to 8 years with permission to carry forward losses and deduct them as expenses for up to 5 years

- exemption of up to 5 years on withholding tax on goodwill, royalties or fees remitted aboard
- exclusion from taxable income of dividends derived from promoted enterprises during the income tax holiday

5. Additional incentives for enterprises in the special investment promotion zones:

- maximum reduction of 90 per cent of business tax on the sales of products for a period up to 5 years
- reduction of 50 per cent of corporate income tax for 5 years after the termination of a normal income tax holiday or from the date of income earning
- allowance to double the cost of transportation, electricity and water supply for deduction from taxable corporate income
- allowance to deduct from the taxable corporate income up to 25 per cent of the investment costs of installing infrastructure facilities for 10 years from the date of income earning

6. Additional incentives for export enterprises:

- exemption of import duties and business taxes on imported raw materials and components
- exemption of import duties and business taxes on re-exported items
- exemption of export duties and business taxes
- allowance to deduct from taxable corporate income the amount equivalent to 5 per cent of an increase in income derived from exports over the previous years, excluding costs of insurance and transportation

APPENDIX 8

Investment Promotion Zones

In March 1991, Office of the Board of Investment under the Office of the Prime Minister issued a policy of investment promotion zones based on the *Investment Promotion Act of 1977*. Details of this new regulation can be given as follows.

All provinces throughout the country, including Laem Chabang and Map Ta Phut industrial estates, except those provinces in Zones 1 and 2 (Figure A 5.1), are designated as Special Investment Promotion Zones.

Criteria for granting tax ad duty privileges for promoted projects (effective from October 30, 1991)

a) Projects located in Bangkok, Samut Prakan, Samut Sakhon, Nakhon Pathom, Nonthaburi, and Pathumthani (Zone 1):

1. No tax exemption or reduction on machinery, except projects which:

- export not less than 80 per cent or are classified under category 5.49 or
- locate their factories in industrial estates or promoted industrial zones.

The following tax privileges on machinery will be granted:

(i) Business tax exemption on imported machinery; and
(ii) Fifty per cent import duty reduction on machinery which is not included in the tariff reduction notification of the Ministry of Finance (Notification No. C 13/2533) and which is subject to import duty more than or equal to 10 per cent.

2. No corporate income tax exemption, except for projects which export not less than 80 per cent or are classified under category 5.49 and locate their factories in industrial estates or promoted industrial zones, in which case a three year exemption will be granted.

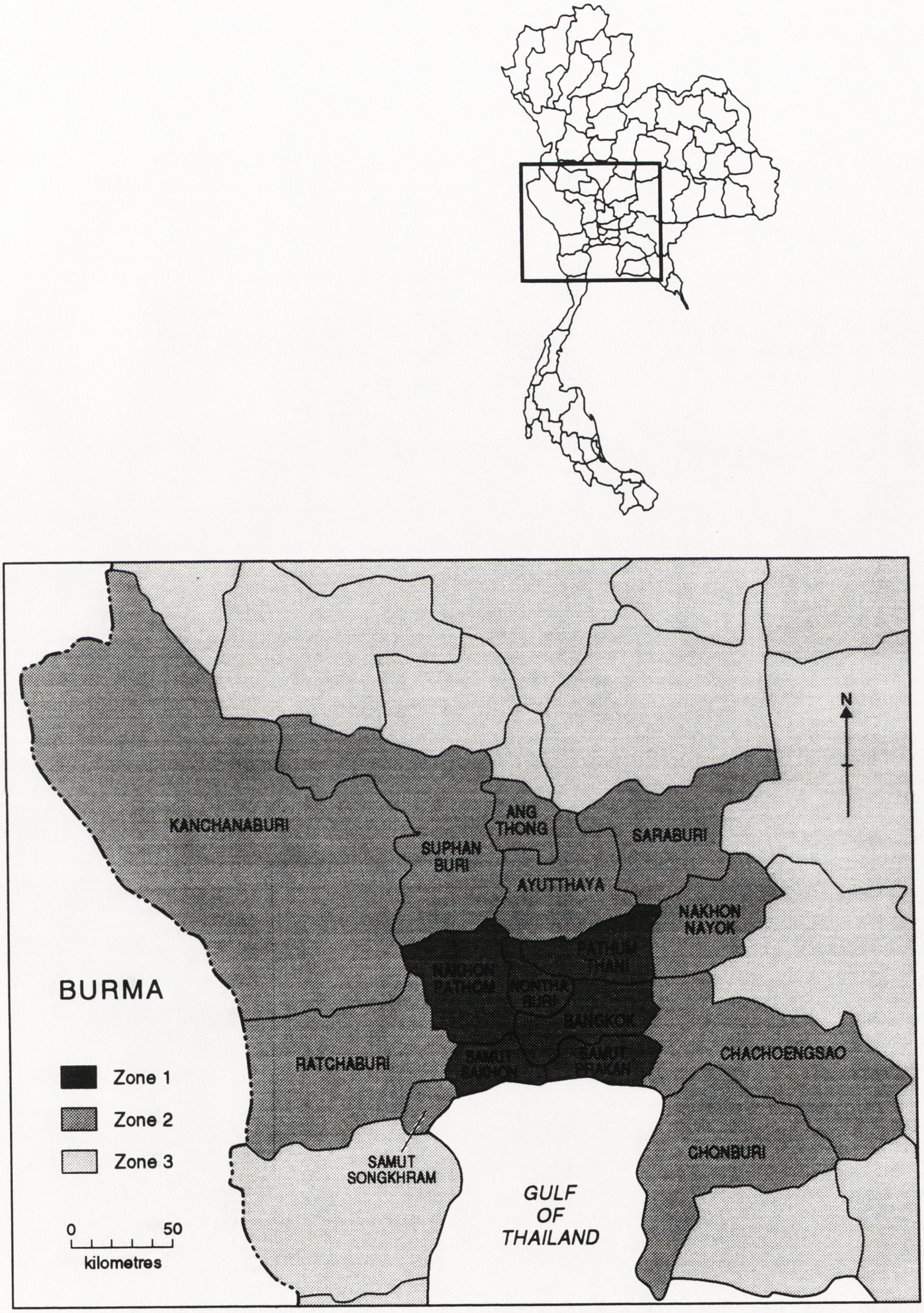


Figure A8.1 **Investment Promotion Zones under the *Investment Promotion Act* 1977**

b) Projects located in Samut Songkhram, Ratchaburi, Kanchanaburi, Suphanburi, Angthong, Ayutthaya, Saraburi, Nakhon Nayok, Chachoengsao, and Chonburi (Zone 2):

1. The following tax privileges on machinery will be granted:

(i) Business tax exemption on imported machinery; and

(ii) Fifty per cent import duty reduction on machinery which is not included in the tariff reduction notification of the Ministry of Finance (Notification No. C 13/2533) and which is subject to import duty more than or equal to 10 per cent.

2. Corporate income tax exemption will be granted for 3 years, extendable up to 5 years for projects which locate their factories in industrial estates or promoted industrial zones.

c) The remaining 57 provinces plus Laem Chabang Industrial Estate (Special Investment Promotion Zones or Zone 3):

1. The following tax privileges on machinery will be granted:

(i) Business tax exemption on imported machinery; and

(ii) Fifty per cent import duty reduction on machinery which is not included in the tariff reduction notification of the Ministry of Finance (Notification No. C 13/2533) and which is subject to import duty more than or equal to 10 per cent.

2. Corporate income tax exemption will be granted for 6 years, extendable up to 8 years for projects which locate their factories in industrial estates or promoted industrial zones.

3. Exemption of import duty and business tax on raw or essential materials for a period of 5 years for the manufacture of exports.

4. Special privileges, under Section 35 of the Investment Promotion Act B.E. 2520, as follows:

4.1 reduction of business tax by 90 per cent on sales of products for 5 years from the date of the first sales;

4.2 reduction of corporate income tax by 50 per cent for 5 years after the exemption period;

4.3 the following will be granted on a case-by-case basis:

- double deduction from taxable income of water, electricity, and transport costs for 10 years from the date of the first sales;

- deduction from net profit of 25 per cent of the costs of installation or construction of the project's infrastructure facilities.