

# Impact of Urbanization on the Water Resources and Public Health in Pathumthani Province, Thailand

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**Abstract:** *This study attempts to analyze and describe the trend and pattern of urbanization, its impact on water resources as well as public health in Pathumthani province, which is an adjacent province of Bangkok Metropolitan. This province has good canal (klong) network system. These khlongs have their own cultural and historical values. But the province has been promoted as a location for industrial development policy reforms introduced in Thailand in 1977. The study was carried out, using GIS as a tool, to identify the land use change. Major chemical parameters were selected to analysis water quality and cases registered data on water born diseases were analyzed to identify the impact on public health. The study reveals that growths have mainly occurred along the highways, river and khlongs sections. The findings highlight the situation of water quality in river and khlongs arising out of the process of urbanization in the province and its affect on public health.*

**Keywords:** Urbanization, water, sanitation, *klong*, public health, pollution, planning, migration

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## 1 INTRODUCTION

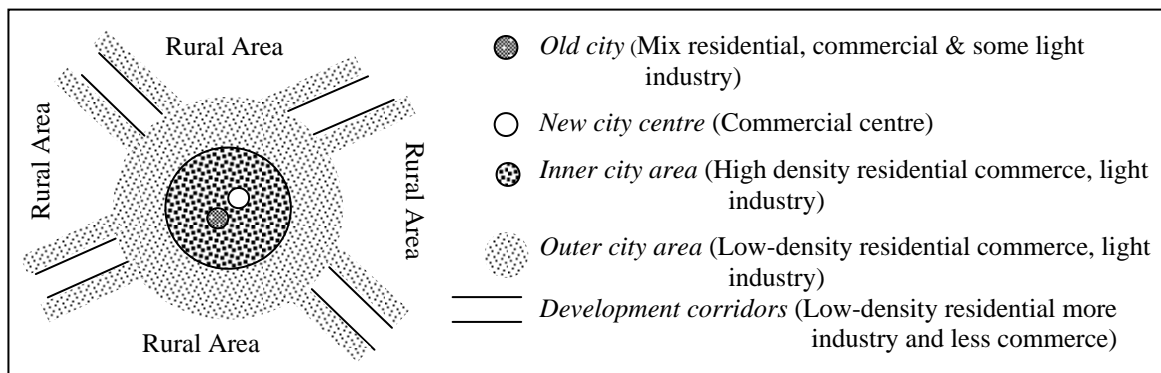
The cities of Asia are growing rapidly due to the rural-urban migration and high urban population growth rates. UN Population Division (2006) estimates 49 per cent of the world's population are living in the urban areas. The rate of growth is increasing, with much of the growth occurring in developing or low to middle income countries. By 2007, more people will live in urban areas than rural areas for the first time ever in human history (UN-HABITAT, 2003). Population and industrial growth have been the major driving forces to spread out the urban center to its peri-urban area that affects social, economic and ecological condition such as flood, pollution, traffic jams, shortage of drinking water and electricity, population migration, change in agricultural culture, etc. (Vibulsrestha *et al.*, 1992; Limjirakan, 2001).

Most of the settlements in peripheries of the mega-cities<sup>1</sup> include both urban and rural elements, relying on a combination of agricultural and non-agricultural income sources. Often there

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<sup>1</sup> The United Nations created the term mega-cities in the 1970s to designate all urban agglomerations with a population of eight million or more. In the 1990s, this threshold was raised to 10 million.

is no sharp distinction between the rural and urban activities (Figure 1). It is the pattern of development which includes an intensive mix of agricultural activities and non-agricultural activities, occurring side-by-side (McGee, 1991). These areas are the central points for important activities like trade, commerce and industry, where poor people can get chance to improve their earning opportunities. They provide access to large markets for goods and services and communication with the rest of the world (ADB, 2004). It has also indicated that in developing or low-income countries the peri-urban areas are often characterized by high density, poor quality housing, a low level of health and social services, and limited access to basic services such as water and sanitation. The social and often unsanitary environmental conditions that prevail in these areas are conducive to the emergence and rapid spread of infectious disease (WHO, 2003). The highest impacts are upon poor communities, who often inhabit low lying and marginal land (Parkinson and Tayler, 2003).



**Figure 1. Typical Asian city** (Source: CITYNET, 1995)

In the context of Thailand, existing patterns of urban developments have followed a radial pattern based on major transportation corridors and canal sections leading out from main core city centers (Rabinson, 1995). In addition, developers are buying cheap land for making housing complexes, industrial premises and golf courses. These developments are happening without proper planning and government interventions. ADB (2001) indicates that more than three quarters of the nation's industries are located in Bangkok and vicinity such as Samut Prakan, Pathumthani, Samut Sakhon, Nakhon Pathom, and Nonthaburi provinces. However, this development has led to urban problems, and has created serious environmental degradation such as water pollution, air pollution, solid and hazardous waste problems, land subsidence, noise pollution and loss of prime agricultural land in these areas (ERTC and JICA, 1994).

Although water pollution causes damage to fisheries and agriculture, and impact on human health and economic costs, it has disproportionate affects on the poor. Regular use of polluted water results in numerous disease including diarrhea, hepatitis, typhoid, trachoma and hookworm infection. More toxic water pollutants may lead to other health effects including skin disease, liver cancer, birth defects and death (WB, 2001). According to the World Health Organization (WHO) (2006a & b), 1.8 million people die every year from diarrhea (including cholera); 90 per cent are children under 5, mostly in developing country. In 1995, more than 1,500,000,000 episodes of diarrhea occurred in children under five years of age in the developing world (excluding China). It has also estimated that every year 4 million children die as a result of diarrhea caused by water-borne infection or

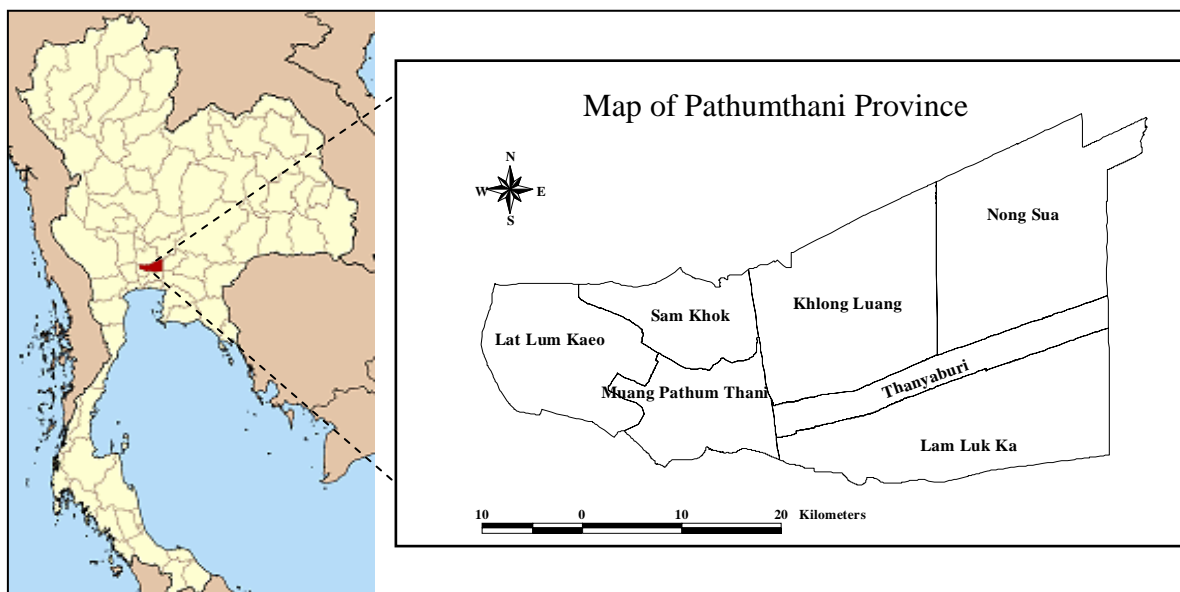
contaminated food and 2 million people die from malaria and 267 million are infected in developing countries. Besides, one sixth of the world's population, approximately 1.1 billion people, do not have access to safe water and 2.4 billion lack basic sanitation (Hardoy, *et al.*, 2001).

It is estimated that 10 of the world's population eat foods produced using wastewater, which may be used either directly for irrigation or indirectly where irrigation water is drawn from natural water bodies that received wastewater flows (Parkinson and Tayler, 2003). McGranahan *et al.*, (2001) mentioned that food also has been responsible for up to 70 per cent of diarrheal episode.

The World Bank (2001) has mentioned that Thailand ranks lowest in Asia with 30 per cent of all available water not suitable for most human activities and lower than the world average in terms of annual per capita availability of water. Despite a worldwide trend of declining water pollution, Thailand witnessed an increase of water pollution. Hence, the study is mainly focused on urban growth, water pollution and public health in Pathumthani province because this province is facing unexpected urban sprawling everywhere, and spoils its traditional clean water sources, which directly or indirectly affect the public health.

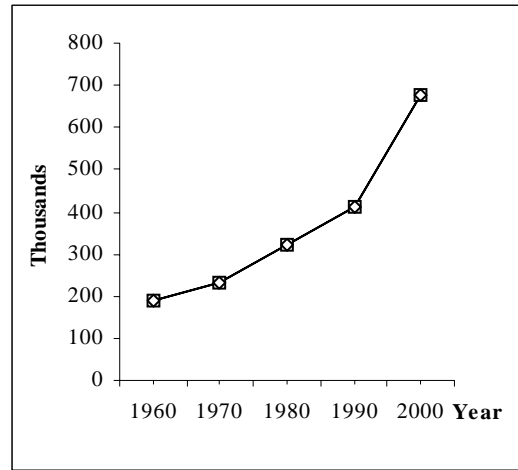
## 1.2 General Background of the Study Area

Pathumthani province is situated on the Chao Phraya basin with plenty of canal networks. Pathumthani Town is only 45 km from Bangkok. It covers 1,525 square kilometers, and is administratively divided into 7 districts: Muang Pathumthani, Khlong Luang, Thanyaburi, Lat Lum Kaeo, Lam Luk Ka, Sam Khok and Nong Sua. It is bounded in the East by Nakhon Nayok and Chachoengsao provinces, in the west by Phra Nakhon Si Ayutthaya, in the North by Saraburi province and in the South by Bangkok and Nonthaburi (Figure 2).



**Figure 2. Location map of the study area**

Most of the land was used for agriculture purpose before urban development in the province. Urban and Industry sectors are rapidly increasing in the province after government has made strict policy to restrict the new industries in Bangkok Metropolitan Area (BMA). The existing location of urban development in Pathumthani is concentrated along Vipawadee Road from the Rangsit intersection to the northern part along the Paholyothin Highway of the province. It also extends west to the railroad tracks, to the east along the Chao Phraya River, the Rangsit-Nakhon Nayok Road, and the Pathumthani- Lad Lum Kao Road. In addition, mostly poor migrants are encroaching the area of canal in the province.



**Figure 3: Population growth**

The province is consisted of a highly artificial systematic dense canal networks. In the North Rangsit part, there are 14 main drainage canals, each run north-south, and is spaced at intervals of 2.5 km. These canals are intersected by several more canals running east-west direction. In the west part of the province, the drainage canals are also running roughly northwest- southeast direction and spaced at intervals of 3.0 km, and intersected by small canals running northeast direction. The water sources of the west part are Chao Phraya and Suphan rivers.

The total population of Pathumthani is 677,649 of which 348,141 are female. The people of working ages are 62.8 per cent of total population, and dependency ratio is 37.2 per cent. (NSO, 2000). The trend of population growth in the province is shown in figure 3. This population growth is due to heavy population migration from other provinces with expectation of employment opportunity. This growth has also happened because of closeness to Bangkok Metropolitan Area (BMA). Mostly, people want to stay in this province because of lower land value and availability of open spaces in comparison to Bangkok. The population has concentrated in the non-municipal areas rather than in municipal areas. But density of household in municipal areas is higher than non-municipal areas.

Majority of the population are engaged in agricultural activities. Most of the agricultural lands are close by their houses, and mostly are adjacent to the *khlongs* that are part of their life. There are other types of residents that have come during the early 1970's, and introduced to urban life style. As a result, the traditional houses that have been along the routes with their large compounds have been affected. The residential growths with condominiums, shop houses and industrial development have increased the density along the Highways.

## 2 METHODOLOGY

Pathumthani is situated at the fringe area of Bangkok, and is experiencing rapid urbanization due to the industrial growth. The primary objective of the paper is to study the impact of urbanization on water resources and public health, and draw inferences on policy issues for guiding sustainable urban development in the province. The study is based on the comparison of developments that have occurred over three decades (1980-1990-2000). For evaluation, the year of 1980 was treated as the baseline year that was not-yet-affected by urbanization, which was then used to compare the effects of urbanization over the next two decades.

The study was carried out on both primary and secondary data. Primary data were collected from observation method (by field visit) and secondary data were collected from Provincial Office, Pathumthani. Other ancillary data were collected from published and unpublished reports, research studies and articles by different researchers, line agencies, non-governmental organizations and individuals.

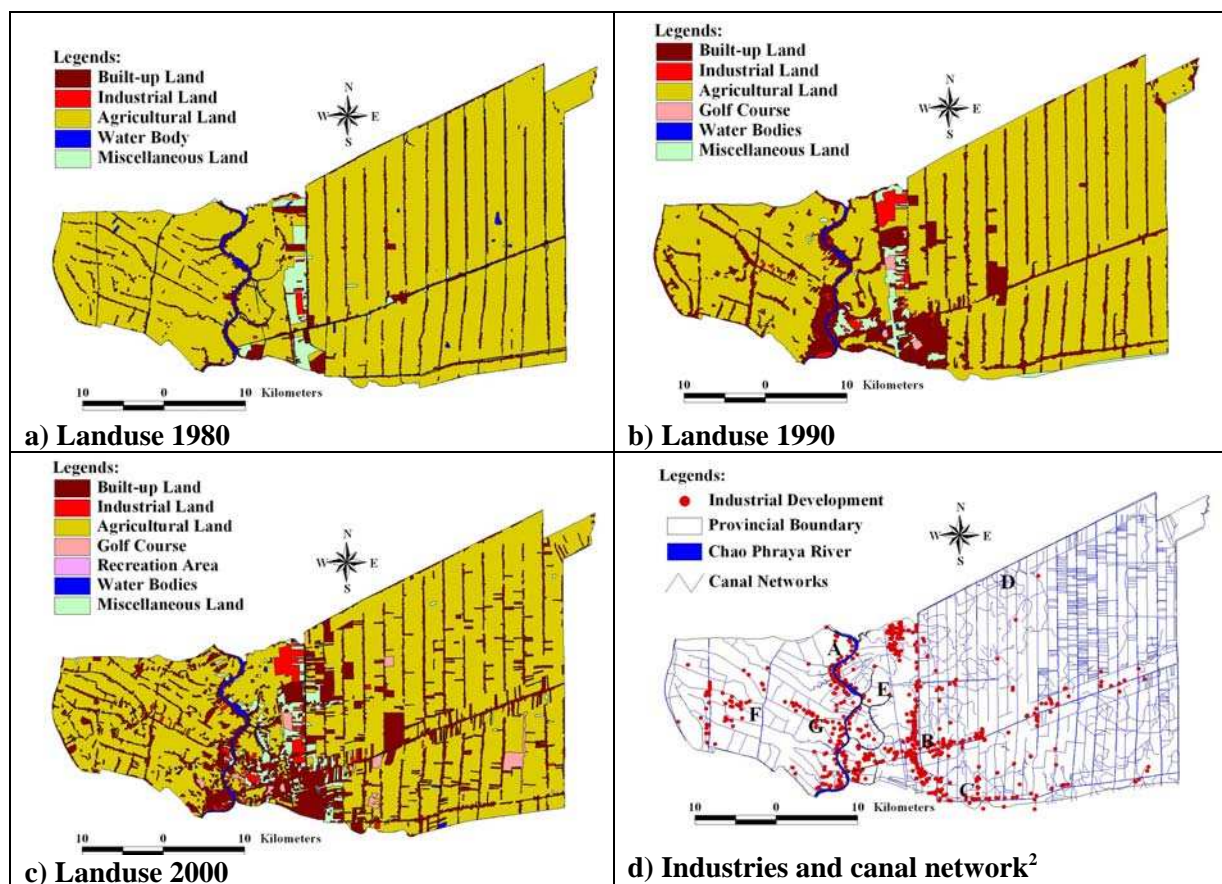
*Spatial Data Sources:* The most important source for time line (1980-1990-2000) spatial data were collected from the Department of Land Development, Ministry of Agriculture and Cooperative, Chulalongkorn University, and Department of Industrial Works, Ministry of Industry, Pollution Control Department, Ministry of Natural Resources and Environment.

*Non-spatial Data Sources:* Mostly, the district level data were collected from Department of Industry, Department of Agriculture and National Statistics Offices at Pathumthani Provincial Office in Muang Pathumthani district. Some relevant previous researches on study area were also sighted in Asian Institute of Technology library. Most of the city planning information on study area was collected from the Department of Public Work and Town & Country Planning in the Provincial level and Department of City and Town Planning in Bangkok. Surface water quality data was collected from the Environmental Research and Training Centre, Pathumthani. Public health related data was collected from Pathumthani Provincial Health Office.

## 3 RESULT AND DISCUSSION

In the past, most of the lands have been used for agricultural purpose in the Pathumthani province. The settlements originated from small communities on the bank of Chao Phraya River and slowly it expanded along the canals. These settlements rapidly grew and changed into urban form after expansion of road networks in the province that was more prominent in the Khlong Luang, Thanyaburi, Lam Luk Ka and Muang Pathumthani Districts. The road network also provided additional support to expand the settlement in the inner part of the province after completion of Bangkok Outer Ring Road in 1996. Now, Pathumthani is urbanizing along both sides of the major roads as well as canal sections. During the process of the change, the province has lost its large portion of the agriculture land for non-agriculture use. It is presently, facing an environmental impact on surface water quality and solid waste management, especially on above-mentioned districts.

Pathumthani province has canal network system. It is confirmed from Geographical Information System (GIS) analysis that mainly, the urban settlements and industrial growths happened near the river and canal sections from 1980 to 2000 (Figure 4).



**Figure 4. Landuse pattern in 1980, 1990 and 2000, and industries and canal networks in Pathumthani province.**

It can be seen that some industries have been established in Samlar Catchment restricted zoning area (200 to 350 km<sup>2</sup>) as recommendation by National Environment Board in 1988. According to the industrial factory Act 1992, government has also mentioned that industries should be established at least 50 to 100 meters far from the sensitive places like temples, river, schools, government offices, institutions etc. In practice, these rules are not properly being followed by the concern parties. Anybody can observe the direct connections of drainages and sewerages from the industries and the buildings to the river and canals sections (Figure 5). As a result, urban environment

<sup>2</sup> Where A = Chao Phraya River, B = Khlong Rangsit Prayoosak, C = Khlong Hok Wah, D = Khlong Rapeepat, E = Khlong Prame Prachakor, F = Khlong Phra Udom, G = Khlong Bang Luan and 'Khlong' means Canal in Thai language, these river and canals has been selected for water quality analysis in page 11 of this paper.



in the province is getting worst day by day that has been also detected by analyzing the chemical parameters of the surface water. But, people have been using this water for irrigating their agricultural land as well as for domestic uses, which directly or indirectly affects health of the local resident. So, the river and canal's water pollution is one of the most sensitive and visible urban pollution in the province. These canals and river have their own cultural and historical values also. Still, nobody has taken responsibility to carry out promotional activities to conserve and develop the river and canal's environment.

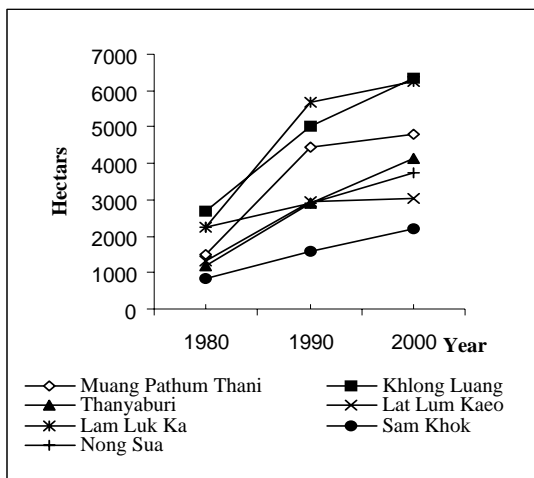


**Figure 5: Industrial effluent discharge to canal**

Considering the rapid change, the government has declared two Muang Municipalities and eleven Tambon Municipality in the province, in order to detect and analyze the urban problems and implement effective development plans for sustaining the local environment. In addition, government has established 52 Tambon Administrative Organizations to straighten the development activities in the province.

### 3.1 Urban and industrial growth

In the study area, the built-up area expanded from 12,013 hectare in 1980 to 25,868 hectare in 1990, and continued to expand to 30,729 hectare in 2000. Therefore, expansion of the built-up area was more than double from 1980 to 1990 that was slowed down from 1990 to 2000 (Figure 6). The built-up areas of Muang Pathumthani, Lam Luk Ka, Thanyaburi and Lat Lum Kaeo have been speedily increased during 1980 to 1990. Their increasing rates have been decreased during 1990 to 2000. But it has been shifted to other districts like Sam Khok and Khlong Luang. The road networks have played an important role in expansion of the built-up area in the province.



**Figure 6. Urban area expansion**

The industrialization process in the study area has been started from 1969, when only five industries have been registered in the Ministry of Industry. Now, 1,989 industries have been registered in the Ministry of Industry. Within 30 years (1970-2000) Pathumthani have become a second largest industry dominated province in Bangkok Metropolitan Region (BMR). Industrial companies are being attracted to this province, due to: a) inexpensive land price compared to Bangkok; b) cheap female labour; c) good road network and d) weaker rules and regulations.

Industrial development is being happened mainly, both sides of Paholyothin Highway and

Chao Phraya River, with lack of proper planning. Land is developed inefficiently resulting the deterioration of the quality and quantity of agricultural land, shortage of water and traffic congestion. The industrial development of the province has been rapidly increased from 466 hectare in 1980 to 2,342 hectare in 1990 and continuously increased to 3,077 hectare in 2000. Hence, more than 4 times industries have been increased from 1980 to 1990.

Figure 7 shows that the Khlong Luang, Muang Pathumthani, Thanyaburi and Lam Luk Ka were the most rapidly developing industrial areas in 1980 to 1990. Industries were continued to develop in Khlong Luang, Muang Pathumthani, Thanyaburi, Lat Lum Kaeo and Sam Khok during 1990 to 2000.

At the end of 1980, 105 industries have been operated and provided employment opportunity for some 20,862 workers. Khlong Luang, Muang Pathumthani, Thanyaburi and Lam Luk Ka districts are highlighted in this analysis because of greatest concentration of industries compared to other districts in Pathumthani. Almost 35 per cent of total industries have been concentrated in Khlong Luang and 11,840 (57% of the total) workers have been engaged in these industries where 29.5 per cent of total industries have been concentrated in Muang Pathumthani and 14.8 per cent of the total workers have been engaged in these industries. Similarly, 20 per cent of the industries have been concentrated in Thanyaburi and 25.2 per cent workers have been engaged in these industries. Nong Sue district had no industry during 1980.

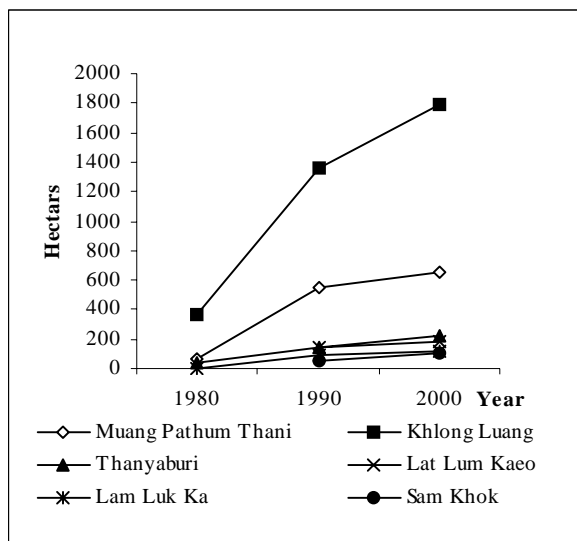


Figure 7. Industrial growth from 1980 to 2000

In 1990, the province had 492 industrial units, employing 115,372 workers. This represented an increase of 387 industries or 369 per cent and 94,510 workers or 453 per cent since 1980. Among these industries 38.8 per cent have been concentrated in Khlong Luang district, 27.2 per cent in Muang and 14.4 per cent in Thanyaburi. Nong Sua had only three industries in this year.

Industries were being established constantly in the province and reached 1,652 in number, providing employment opportunity for 188,195 workers at the end of 2000. It showed an increase of 236 per cent of industries and 63 per cent of workers since 1990. Among these industries, 28.6 per cent of industries have been concentrated in Khlong Luang, 22.7 per cent in Muang Pathumthani and 16.1 per cent in Lam Luk Ka district. It can be analyzed that from 1990 to 2000 industries have been scattered in all seven districts. Nong Sua had 23 industries established during this period.



### 3.2 Water resources and public health

Pathumthani province consists a number of irrigation canals (*khlongs*). These irrigation canals have been designed to serve water for the agricultural purpose. But after urban growth, most developers and industrialists have established buildings and industries along the river and canal section (Figure 4d) and attempted to fulfill their water requirement by pumping water from the canals and underground water. The resulting increase in land subsidence and contamination of underground aquifers could have been predicted.

It can be observed that most of the houses and industries near the rivers and the canals have directly connected their drainage and sewerage to these water bodies, and thus making water contamination. According to the government record, only few industries have taken permission to connect their discharge to the canal after performing wastewater treatment. Some industries have their own wastewater treatment plant to recycle the wastewater in their premises. But, there are number of other industries which have illegally connected their industrial discharge directly to the canal.



**Figure 8. Settlements along the canal and utilizing water for fish farming**

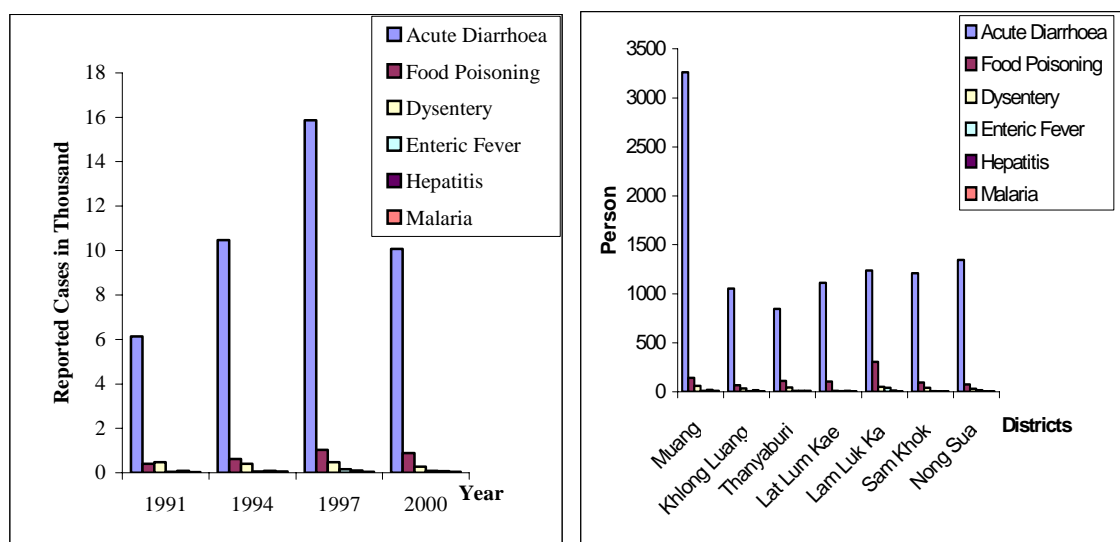
From the analysis, it has been found that largely the urban developments have been located near the river and canal sections during the 20 years time span. These unsystematic growths have been the major sources of water pollution in the study area. The local farmers have claimed that the industry has polluted the *khlongs*, and thus have made the waters unsuitable for domestic and agricultural uses. Mostly, poor migrants use to live nearby the canal banks (Figure 8), and use canal water for everyday life, but some settlements also have piped water supply connection. Domestic waste also goes directly to the *khlong*, and cause environmental pollution and health hazard. Many local inhabitants get health impacts when exposed to the canal waters, especially diarrhea, dysentery, etc. (Figure 9).

According to the health officer from Pathumthani Provincial Health Office, industries and urban growth are not the only cause of polluting canal and river water, it is also polluted by the too much use of chemical fertilizers and pesticides in the agricultural land by the farmer. Usually,

farmers use various types of chemical fertilizer, pesticides and insecticides (an average 2-3 times a year) to increase the productivity. In addition, they apply these chemicals by sprayer with using water boat. In most cases the agricultural lands are surrounded by water that makes easy access of pesticides and chemical fertilizers to mix into the canal water during the irrigation and rainy season (Figure 9). As such, it adversely affects the aquatic life as well as human life from eating contaminated fish. Some pesticides may leach into the groundwater causing human health problems from contaminated wells.



**Figure 9. Urban agriculture practice and dead fish near the waterbody**



**Figure 10. Reported cases of selected water related diseases, in the province (1991-2000) and by district in 2000** (Source: PPHO, 2000)

According to the Annual Epidemiological Surveillance Report's (Figure 10), the common water related disease in the province is acute diarrhea. It affected highest during 1997. From this data it can be predicted that unplanned urban growth intensified water born diseases in the Pathumthani. But, in the case of Nong Sua district, even though it covers a large portion of agricultural land of the province, it has higher rate of diarrhea. It reveals that urban growth is not the only cause to increase water born disease, but it also implies that too much use of pesticides (28,675 litter/year) and chemical fertilizers (4,830 ton/year) for agricultural field are another aspect which increase water related disease in the province<sup>3</sup>.

According to the local farmers, polluted canal water is more damaging for domestic and agricultural use when the water is not flowing. Community has made rules for water distribution by rotation system. They have made water gate in every canal for water distribution. When they close the water gate, the water will not flow in the closed section. But the domestic and industrial effluences continuously flow into the canal. So, the water is getting highly polluted during the gate closing time. A local farmer in Sam Khok district mentioned that the industries usually discharge their toxic effluence in the canal during the night time, and it is difficult to stop the big industries in contaminating the canal water. He also expressed his problem as follows;

*“He has a fish farm in his land. Every week, he has to add more water in the pond from the canal, unfortunately, one day his fishes died after adding water from the canal. After investigation, he identified that the adjacent industries were discharging toxic effluence directly into the canal, which he added for his pond just one day before. But he has no evidence to blame the concern industries, and the government does not take any strict action against these industries”* (Figure 9).

### 3.2.1 Government's rules and regulations to protect water resources

The main environmental legislation framework is the *Enhancement and Conservation of the Natural Environmental Quality Act of 1992 (EQA)*. It contains several progressive provisions designed to enhance the protection of the environment. The EQA, Section 6(1) entrenches the people's right to be informed and to obtain information for the purposes of public participation in the enhancement and conservation of national environmental quality. Some points related to water resources protection are mentioned below:

- the establishment of a multi-agency Pollution Control Committee to oversee pollution control matters, including the enactment of discharge standards;
- the regulation of air, noise, water and hazardous waste pollution, as well as other forms of pollution and;
- the duty to use central waste treatment facilities, the expense for which is borne by the user (pursuant to the "polluter pays" principle).

Beside this act there are number of other acts which also assist to protect water resources such as Factories Act 1992, Public Health Act 1992, Hazardous Substances Act 1992, Construction Building Control Act 1979, City Planning Act 1975, Groundwater Act 1977, etc.

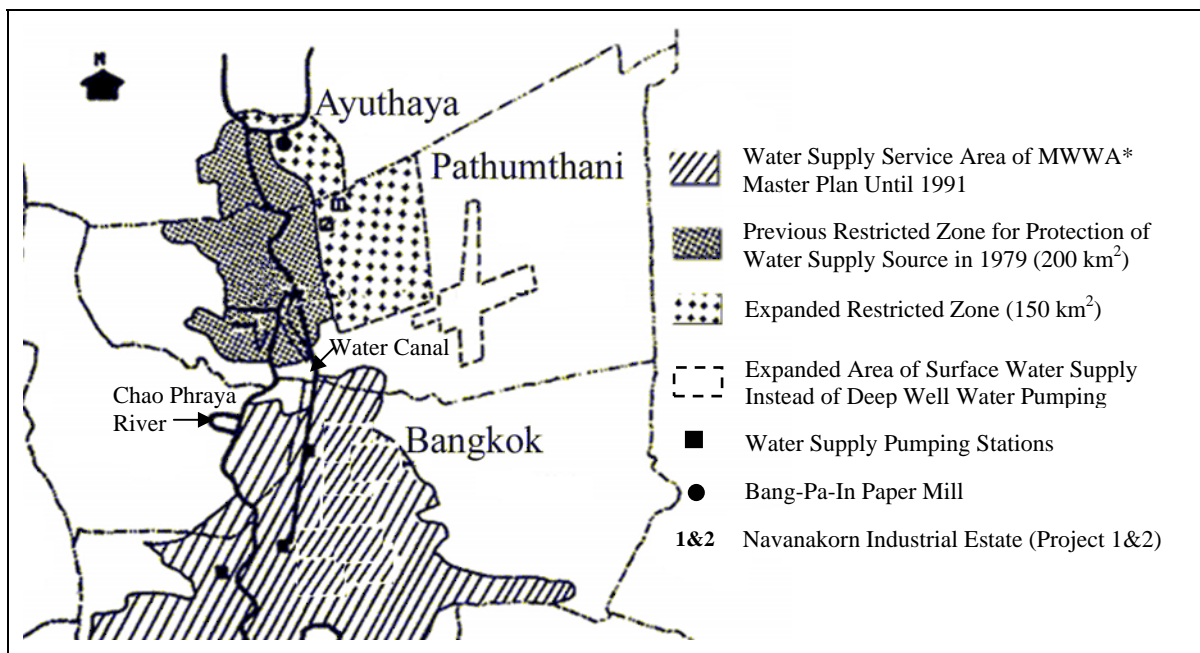
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<sup>3</sup> Data source is from Pathumthani Agricultural Extension Office, Pathumthani, Thailand.

The Ministry of Natural Resources and Environment (MNRE) conduct environmental management on a national basis. Under this ministry there are several other departments, which regularly monitor water pollution of the nation. Mainly, Pollution Control Department and Wastewater Management Authority are responsible to control water pollution in the country.

In recognition of the problems in Bangkok Metropolitan Region (BMR), the government promulgated new ground water Act in 1985, which mandated that well pumping would be phased out in the BMR by 1998. The government decided to protect the source of the BMR water supply by expanding the restricted zone of Samlar Catchment area from 200 km<sup>2</sup> to 350 km<sup>2</sup> according to the recommendation of National Environment Board in 1988 (Figure 11). This regulation indicates and explains that in the restricted zone, the building and expansion of industries which discharge wastewaters containing toxic substances listed below or organic matter exceeding one kilogram of BOD per day will not be permitted. The mentioned toxic substances include<sup>4</sup>:

- a) Heavy Metals: Zinc, Chromium, Copper, Mercury, Manganese, Cadmium, Lead, Selenium, Nickel, Barium, Iron etc.
- b) Other Toxic Substances: PCB (Polychlorinated biphenyl) Cyanide, Arsenic, Phenol etc.



**Figure 11. Restricted zone for protection of water supply source**

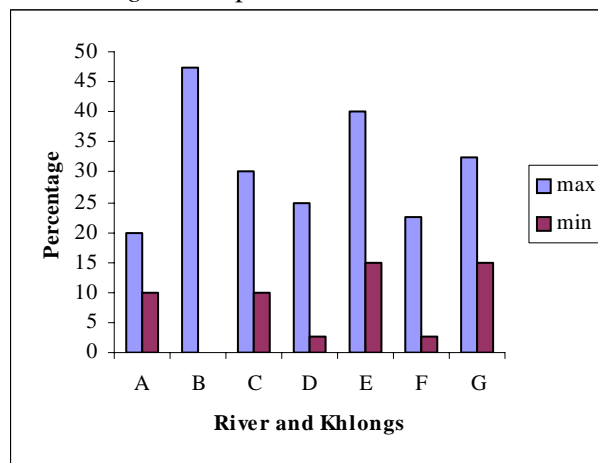
<sup>4</sup> Source: National Environment Board (Cabinet Resolution, 12/01/1988)

\*Municipality Water Works Authority

### 3.2.2 Analysis of surface water quality

Surface water quality time series data (1994-2001) of Chao Phraya River and six different canals in the study area have been collected from Environmental Research and Training Center, Pathumthani. It has been analyzed for the lowest and the highest values of important parameters of the surface water round the year i.e. pH, DO, BOD, NH<sub>3</sub>, NO<sub>3</sub>, Mn, Fe, Pb, Cd and Cr. Figure 12 is the summary of surface water quality level in the selected river and *khlongs* in the province. It shows that the water

in most of the canals is polluted. Rangsit Prayoonsak *khlong* is the most polluted compared to other *khlongs*. This *khlong* is situated in the Rangsit Municipality. It had maximum Cd (73 ppb) level during 1999. *Khlong* Prame Prachakorn is the second most polluted one, and situates just behind the Navanakorn Industrial Estate. *Khlong* Bang Luang is the third most polluted and situates in Muang Pathumthani area, where Hok Wah is the forth highest polluted *khlong* and situates in Lam Luk Ka area. It shows that most of the *khlongs* situated near the city and the industrial areas are more polluted than the *khlongs* in the other areas. In the case of Chao Phraya River, pollution level is supposed to be higher than the other *khlongs*, because housing and industrial settlements along this river are denser compared to other areas, but in contrast it has lower pollution level. It might be because of the volume and flow of water in the river, which could dilute the polluting substances.



**\*Figure 12. Water pollution level in the selected water sources**

According to the pollution control department, it has no authority to stop these kinds of problem in the water resources. There are lack of strong rules and regulations to stop the water pollution in the canals. They just inform the concern government authority about the situation. Consequently, in the absence of effective government policy and action, water pollution is growing rapidly in the province. It is also happening due to the absence of inadequate drainage and sewerage facilities in the province. But, it is necessary to take steps from the responsible government sectors to stop the canal's water pollution in the province. As a result, it would minimize the conflict between local farmers and industry, and maintain the environmental condition of the canals as well as the level of public health condition in the province.

## 4 CONCLUDING REMARKS

Uncontrolled and unplanned urban growth is the main cause of water resources pollution in the province. It also intensifies by using chemical fertilizer and pesticide in agriculture system. It is confirmed from the chemical analysis that all of the *khlongs* are polluted in the province. There are high rate of poor people migration from outer part of the province who settle illegally in canal bank areas. Most of the settlements along the *khlong* situate just above the water level. People use *khlong*'s

water also for domestic purpose, which is actually not suitable for, and cause health related diseases. In addition, developers also started to construct housing complexes and industrial premises for the public and foreign investors nearby river and canal banks, which made easy to misuse water sources and cause pollution. There are also inadequate drainage and sewerage systems that lead people to discharge their domestic waste into the *khlong* directly. Another aspect is the absence of effective government policy and action plan in the local level to control the environmental pollution. However, the government has rules and regulations to protect water resources, but it does not enforced effectively or consistently in the local level. The willingness of the general public to abide by these regulations is not strong. They illegally discharge domestic as well as industrial waste into river and *khlongs*. As a result, urban environment in the province is getting worst day by day which also adversely impacts on public health. Apart from these issues, these canals and rivers have their own cultural and historical values. Still, nobody has taken responsibility to carry out promotional activities to conserve and develop river and canal's environment.

There is a need to change and stop existing practices, which are not friendly to maintain the sustainable development in the study area. The concerned government bodies have to take sincere initiation to improve the existing situation.

*Water Bodies and Environment:* Pathumthani is rich in canal networking system in Thailand. But, nobody has taken any initiation to maintain the canals environment. In contrast, every sector is involved in destroying their standard and beauty. On the other hand, local farmers are totally dependent on canal's water for irrigating their agricultural land. Till now, large portion of the land is utilized for agricultural purpose in the province. Hence, it is essential to protect their standard and maintain the canals environment. For this, government has to take initiative role to protect environment in these canal's sections. And, government needs to execute on following programs:

1. Effective public awareness campaign for canal preservation
2. Develop cooperate and coordinate approach among the stakeholders<sup>5</sup>
3. Develop a common vision between the stakeholders to protect environment in canals.
4. It is necessary to create a responsible authority to maintain the environment of the canal. So that they can play active role in the field level.

After proper implementation of the above steps, we may get positive outcome in favor of maintaining the sustainable environment in the canal sections that also assist to minimize the health problems in the surrounding area.

*Urban Land Use Planning and Management:* Urban land use management is a part of urban environmental management as a whole. It is necessary to implement the improved land use management practices in the city area, which deal comprehensively with potential competing land requirements for agriculture, industry, transport, urban development, green spaces, preserves and other vital needs. Hence, it ensures a balance of lands for all purposes. It would be one of the best ways to resolve conflict and maintain healthy environment at the local level.

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<sup>5</sup> In this case stakeholders may be, urban and rural dwellers, industrial sectors, farmers, government sectors, ect.



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## REFERENCES

1. ADB (2001). *Asian Environment Outlook 2001*, Asian Development Bank, Manila, Philippines.
2. ADB (2004). *City Development Strategies to Reduce Poverty*, Asian Development Bank, Manila, Philippines.
3. CITYNET (1995). *Municipal Land Management in Asia: A Comparative Study*. The United Nation, New York, USA.
4. Hardoy, J., D. Mitlin and D. Satterthwaite (2001). *Environmental Problems in an Urbanizing World*, Earthscan, London.
5. Limjirakan, S. (2001). *Effect of Land Use Change on Selected Greenhouse Gas and Trace Gas Emissions: A Case Study on Map Ta Phut Industrial Estate, Rayong, Thailand*. AIT Dissertation no. RD-01-1, AIT, Thailand.
6. McGee, T. G. (1991). *The Emergence of Desakota Region in Asia: Expanding a Hypothesis*. Honolulu: University of Hawaii Press. U.S A.
7. McGranahan, G., P. Jacobi, J. Songsore, C. Surjadi and M. Kjellen (2001). *The Citizens at Risk: From Urban Sanitation to Sustainable Cities*, Earthscan, London.
8. NSO (2000). *The 2000 Population and Housing Census, Changwat Pathum Thani*, National Statistical Office, Bangkok, Thailand.
9. Parkinson, J. and K. Tayler (2003). *Decentralized Wastewater Management in Peri-urban Area in Low-Income Countries*, *Environment & Urbanization*, Vol. 15, 1, pp 75-89.
10. PPHO (2000). *Annual Epidemiological Surveillance Report 2000*. Pathumthani Provincial Health Office, Thailand.
11. Rabinson, I. M. (1995). *Emerging Spatial Patterns in ASEAN Mega-urban Regions: Alternative Strategies*. In T. G. McGee and I. W. Rabinson (eds.), *The Mega-Urban Regions of Southeast Asia*, UBC Press, pp 78-108, Canada.
12. The Environmental Research and Training Centre (ERTC) and Japan International Cooperation Agency (JICA) (1994). *Proceedings of the Seminar on the Role of ERTC in the Environmental Quality Development*, Thailand.
13. UN-Habitat (2003). *Water and Sanitation in the World's Cities: Local Action for Global Goals*, Earthscan, London.



14. United Nation (2006). *World Urbanization Prospects, The 2005 Revision*. Population Division, Department of Economics and Social Affairs, United Nations Secretariat, New York, USA. Available in the website: <http://esa.un.org/unup/> (October, 2006).
15. Vibulsresth S., *et al.* (1992). Rapid Change from Rice Paddy to other Land Uses Drastic Development in Northern Suburbs of Bangkok for Ten Years from 1979 to 1989 Remote Sensing for Environment, Tokyo, Japan.
16. WB (2001). *Thailand Environment Monitor 2001: Water Quality*, World Bank, Bangkok, Thailand.
17. WHO (2003). *Emerging Issues in Water and Infectious Disease*, World Health Organization, Geneva, Switzerland.
18. WHO (2006a). *Water and Public Health, WHO Seminar Pack for Drinking Water Quality*, World Health Organization. Available in the website: [http://www.who.int/water\\_sanitation\\_health/dwq/en/S01.pdf](http://www.who.int/water_sanitation_health/dwq/en/S01.pdf) (October, 2006)
19. WHO (2006b). *Water, Sanitation and Hygiene links to Health, Facts and Figures Updated November 2004*, World Health Organization. Available in the website: [http://www.who.int/water\\_sanitation\\_health/publications/facts2004/en/index.html](http://www.who.int/water_sanitation_health/publications/facts2004/en/index.html) (October, 2006)