Industrial Water Demand Prediction Model : The Case of Changing Industrial Market Share from Free Trade Agreements

INDUSTRIAL WATER DEMAND PREDICTION MODEL : THE CASE OF CHANGING INDUSTRIAL MARKET SHARE FROM FREE TRADE AGREEMENTS

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***ABSTRACT*:** Industrial water demand prediction model is an essential tool for industry water demand management. In study area, industrial part is the main production sector of Thailand economic growth. Industrial water demand in the future depends on water use unit per output and changing industrial structure. However, the changing market share resulted from government policy or international agreement is one of the main factors of errors in prediction of industrial structure and water demand affected to water infrastructure construction, operation and maintenance costs. This study presents development of industrial water demand prediction model by using input-output table with Thailand industrial master plan and the situation of changing industrial market share from free trade agreements or FTAs.

KEYWORDS: Industrial water demand prediction model, Input-output table, Free trade agreements (FTAs)

1. INTRODUCTION

Lower Chao Phraya River Basin (LCPRB) is one of the important areas of development in economic and industrial sector in Thailand. Development of industrial sector in Thai and regional scale need more water which used in production, utility, and other processes.

From the limitation of water supply and water protected measure such as groundwater pumpage closing policy, water shortage may be the main problem to obstruct development of economic activities in this area and Thailand also. If the policy makers cannot control the rapidly increasing water demand in this area, conflicts among each user in industrial, service, household, and agricultural sector may be the critical problem.

An interesting solution for this problem is water demand side management to decrease the amount of water demand in all sectors especially industrial part. In the past, the water demand was mostly calculated by trend analysis from historical data; however, one of disadvantages of this method is difficulty to model with the change of some conditions in the future such as government policy, industrial structure and etc.

In case of Tokyo, Japan in 2004, the water demand is less than total production capacity about 2 million cu.m./day and tends to increase in the future. This big difference of water demand prediction means that water infrastructure was constructed to supply water much more than needed demand and loss money for construction, operation and maintenance.

This paper shows the development of model to predict industrial water demand in the LCPRB with scenarios of changing industrial market share in Thailand by using input-output table model to simulate the change of industrial structure from the

economic viewpoint.

1.1 Objectives

The objectives of this study are: 1) to develop mathematical input-output table model and simulate the changing industrial market share in Thailand; 2) to develop mathematical industrial water demand model under scenarios of the changing industrial market share in Thailand.

1.2 Study area

The study area and the scatter of factories in Lower Chao Phraya River Basin are shown in figure 1. There are 7 provinces in this area; Ayutthaya, Bangkok, Nakon Pathom, Nontaburi, Pathum Thani, Samut Prakan, and Samut Sakhon.

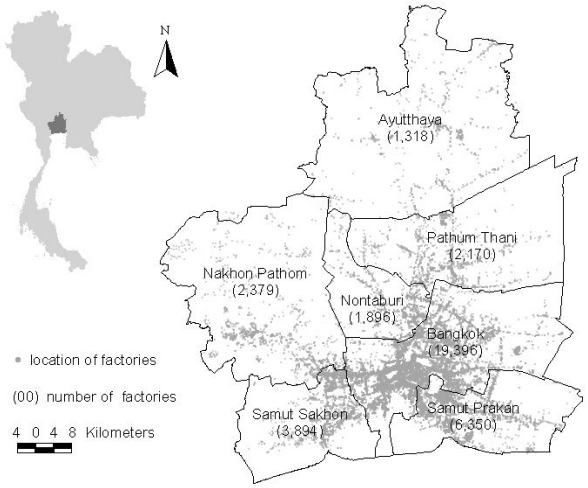


Figure1 the Study Area and Scatter of Factories.

2. METHODOLOGY

The schematic diagram of industrial water demand model is shown in figure 2. The model was divided into 2 steps; Thailand and provincial scale. In the first step, Input-Output (IO) table model was developed by using IO table data from National Economic and Social Development Board (NESDB) to produce Thailand IO table in the future.

In this step, three are two growths of gross domestic product or GDP simulated in this model. The first was normal growth analyzed from historical data of economic activities of Thailand. The generated growth about 6.2 % was calculated by using average growth of last 20 years from 1984 to 2004. The generated growth from the previous one with industrial cluster strategy in the future declared by Thai government was the second growth. (P. SUTTINON, 2006)

The scenario of changing Thailand industrial market share which used in this model was analyzed by focusing on the future plan of government agencies related to control industrial policy and possibility of movement of production base from the effect of declared policy and the world situations in free trade agreements or FTAs.

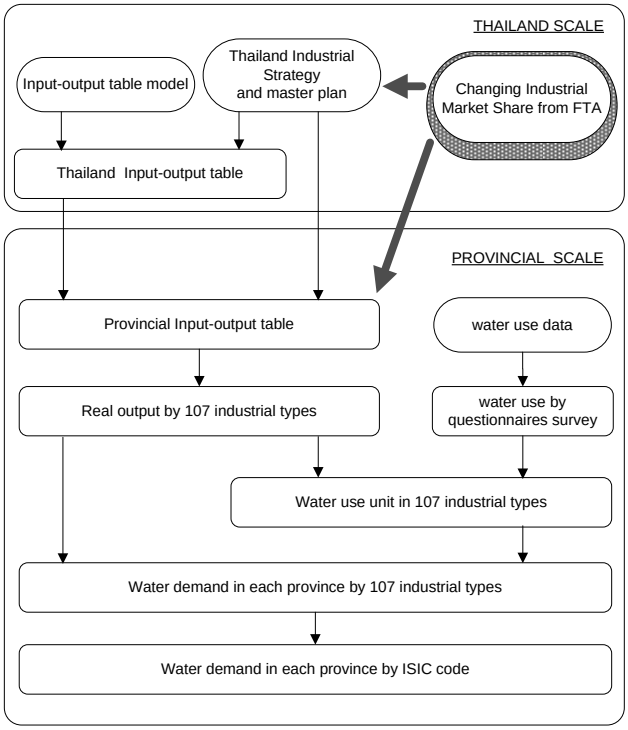


Figure2 Schematic Diagram of Industrial Water Demand Model

The developed I/O tables in this step were edited and transformed to provincial scale with the constraint of each province in the second step. In the provincial

step, provincial IO tables were generated from Thai IO table. Outputs from the generated IO tables were transformed into 107 industrial types.

Water use units in this study developed from the questionnaire survey of Kochi university of Technology (KUT) is used for forecasting (P. SUTTINON and N. SEIGO, 2006).

Finally, water demand in the study area was summarized from the form of IO table to 107 industrial types and transformed into the format of international standard industrial classification of all economic activities (ISIC code).

2.1 Input-output (I/O) table model

Input-output (I/O) table was developed from detailed census and survey data to show the value of sales of product, classified by the industry which produces it. This I/O table focuses on the interrelationships between industries in an economy with respect to the production and uses of their products and the products imported from aboard. The links between the industries and the impact of changes in one sector on others are illustrated from transactions among industries as shown in table 1.

In this research, the simple RAS and modified RAS techniques (United Nations, 1999) were used to update entire input-output tables and simulate the effects of economics structure change from the declared industrial cluster strategy by Thai government agencies and FTAs.

2.2 Analysis of changing industrial market share from Free Trade Agreements (FTAs)

Nowadays, the international economic changes rapidly and is more complicate than the past. Free trade agreements or FTAs are one of interesting agreements which resulted to reduce the tax or trade obstructs among the partners in bilateralism, multilateralism and regionalism scale. However, the policy makers have to concern about both positive and negative effects with Thai economic structure.

Table 1 input-output sector classification

<table>
<tr><td>I/O code</td><td>i, AGRI (001-029)</td><td>IND (030-134)</td><td>SER (135-180)</td><td>TOTAL (190)</td><td>(301-309)</td><td>(310)</td><td>(401-409)</td><td>(501-509)</td><td>(600)</td><td>(700)</td></tr>
<tr><td>j, AGRI (001-029)</td><td colspan="3" rowspan="3">Intermediate demand

This matrix tell the amount of sector i’s output used in the production of sector j.</td><td rowspan="3"></td><td>Total final demand (309)</td><td>Total demand</td><td>Total imports (409)</td><td>Total margin and transport-ation (509)</td><td>Control total</td><td>Total supply</td></tr>
<tr><td>IND (030-134)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>SER (135-180)</td><td></td><td></td><td>= sum (301-306)</td><td>(190+309)</td><td>= sum (401-404)</td><td>= sum (501-503)</td><td>(190+309 -409-509)</td><td>(600+409 +509)</td></tr>
<tr><td>TOTAL (190)</td><td colspan="3">Total intermediate transaction = Sum (001-180)</td><td></td><td colspan="5"></td></tr>
<tr><td>(201-209)</td><td colspan="3">Total value added = sum (201-204)</td><td></td><td colspan="5"></td></tr>
<tr><td>(210)</td><td colspan="3">Control total = 190+209</td><td></td><td colspan="5"></td></tr>
</table>

Source: NESDB

From analysis of Thai economic structure, Export and foreign direct investment (FDI) have been key factors for developing Thai economic activities. Nowadays, the United States of America (US), Japan and China are the main export destination of Thailand about 41 percent of all trade, thus, FTAs with these countries will effect to the high changing industrial market share in Thailand. (OIE, 2006)

Base on the FTAs, Thailand will get benefits and complement with the developed countries such as the US, Japan, Australia and Singapore but tends to compete with China and the developing countries with low labor cost such as India, Indonesia, South Korea, Mexico, Vietnam and Philippines.

Table 2 shows impacts of FTAs on changing Thailand industrial structure. Industrial types which have many benefits from FTAs are food and fashion sector. For metal and motor vehicles sector, the output value will decrease affected from these agreements.

3. RESULTS

Table 3 shows water demand in each cases classified by ISIC code in 2025. The table shows how water demand change after applying FTAs with the global in case 3 and the group of the US, Japan and China in case 4.

As can be seen after applying FTAs in case 3 and 4, water user can be divided into 3 main groups as following. The first one is the group which needs more water such as food and fashion cluster. For the second group, water demand is less than the case without applying FTAs such as chemical, rubber, plastic and metal sectors. The last one is the group of constant water demand in case of with and without applying these agreements such as wood, paper, publishing, petroleum, office product, electronic product and service sector.

Table2 impacts of Free Trade Agreements on Industrial sectors (percent changes of output value, %)

code	ISIC	Scenario	
		Case3*	Case4*
15	Food products	12.28	22.77
	Vegetable oils and fat	-10.58	1.69
	Dairy products	-11.81	1.53
	Processed rice	13.56	11.43
	Sugar	6.57	16.28
	Beverage products	-3.64	2.70
16	Tobacco products	-3.64	2.70
17	Textiles	1.70	5.11
18	Wearing apparel	9.10	12.52
19	Leather products	8.40	14.70
20	Wood products	-8.33	-4.72
21	Paper products	-2.40	0.81
22	Publishing	-2.40	0.81
23	Petroleum, coal products	1.62	0.85
24	Chemicals products	-4.74	-1.84
25	Rubber and plastic products	-4.74	-1.84
26	Non-metallic products	-1.92	0.09
27	Basic metals	-0.0	-4.65
	Metal product	-7.09	-5.96
28	Fabricated metal products	-8.45	-6.60
29	Machinery	4.26	0.08
30	Office machinery	-1.92	0.09
31	Electrical machinery	3.44	-0.07
32	Communication equipment	3.44	0.07
33	Medical instruments	-1.92	0.09
34	Motor vehicles	-20.44	-16.16
35	Other transport equipment	50.98	-1.92
36	Furniture	-1.92	0.09
37	Recycling	na	na

Source: edited from Office of Industrial Economics

Note: Case3*:normal growth with industrial cluster strategy and FTAs with the global and Case4*: normal growth with industrial cluster strategy and FTAs with the US, Japan and China

Table 3 water demand in each cases classified by ISIC code, 2025

ISIC code			Water demand in each cases, MCM/year			
Code		Description	Case1# normal growth	Case2# normal growth and industrial strategy	Case3 Case 2 and FTAs with global	Case4 Case 2 and FTAs with US, JP, CN*
A	01	Agriculture and service activities	9	9	10	10
C	14	Other mining and quarrying	4	4	4	4
D	15	Food products and beverages	111	130	142	155
	16	Tobacco products	4	4	4	4
	17	Textiles	265	310	316	326
	18	Wearing apparel	31	37	40	41
	19	Tanning and dressing of leather	25	25	28	29
	20	Wood and of products of wood	9	9	8	8
	21	Paper and paper products	28	28	28	28
	22	Publishing, printing	10	10	10	10
	23	Coke, refined petroleum products	3	3	3	3
	24	Chemicals and chemical products	157	157	149	154
	25	Rubber and plastic products	50	50	47	49
	26	Other non-metallic mineral products	12	12	12	12
	27	Basic metals	20	20	20	19
	28	Fabricated metal products	47	47	43	44
	29	Machinery	78	78	82	78
	30	Office, computing machinery	9	11	11	11
	31	Electrical machinery	8	9	10	9
	32	TV, and communication equipment	23	23	24	23
	33	Medical and optical instruments	10	10	10	10
	34	Motor vehicles	7	8	6	7
	35	Other transport equipment	3	3	5	3
	36	Furniture	33	33	32	33
	37	Recycling	0	0	0	0
E	40	Electricity, gas, steam supply	0	0	0	0
	41	Collection and distribution of water	0	0	0	0
G	50	Sale and repair of motor vehicles	11	11	11	11
	52	Retail trade	4	4	4	4
I	63	Supporting transport activities	11	11	11	11
K	74	Other business activities	8	8	8	8
O	90	Sewage, sanitation activities	0	0	0	0
	93	Other service activities	125	125	129	129
		Study area	1,115	1,188	1,205	1,234

Note: * US: the United States of America, JP: Japan, CN: China

\# the result from P. SUTTINON, 2006

Remark: This calculated output and water demand classified by ISIC code were transformed from 107 industrial types of Department of Industrial Works.

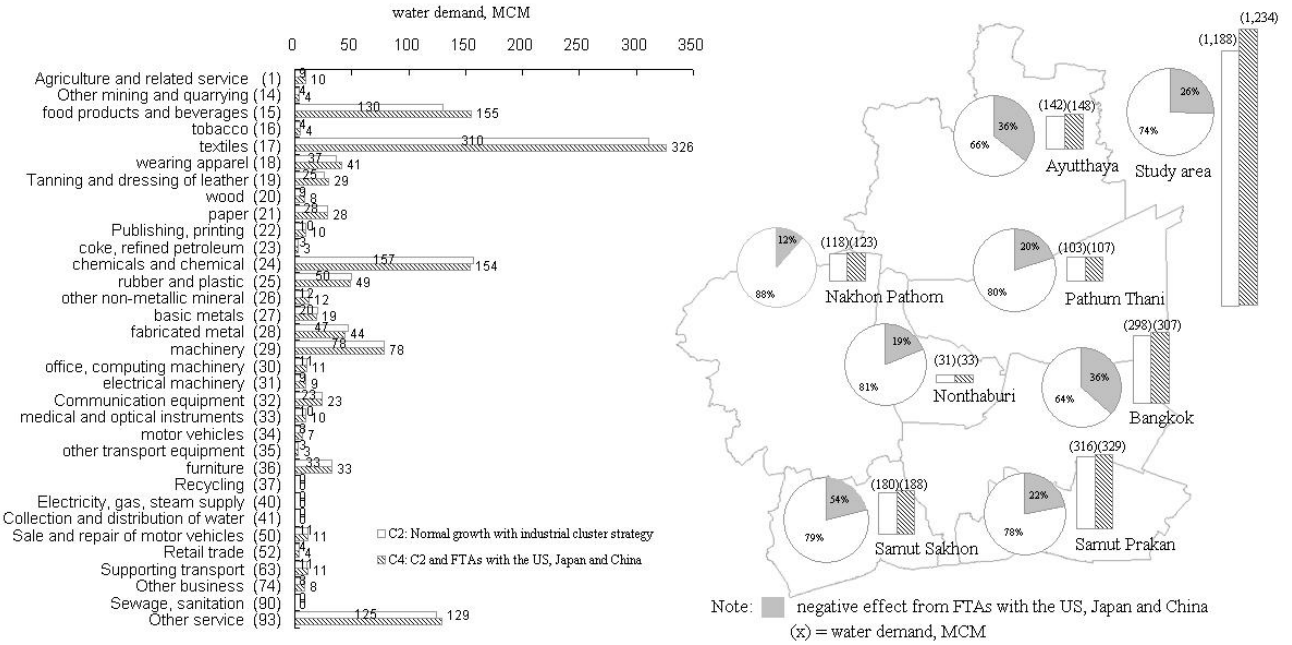


Figure 3 comparison of industrial water demand with and without the effects of FTAs classified by ISIC code, 2025

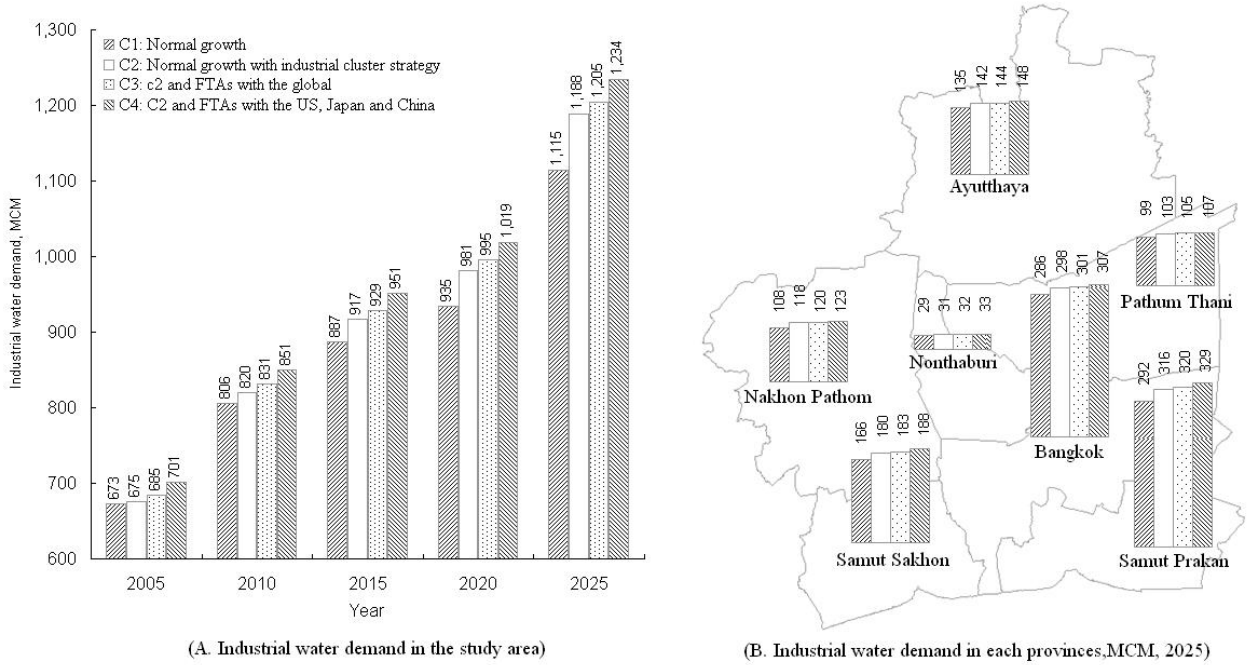
According to the results, industrial sectors need more water after applying FTAs in global scale as showed case 3 and bilateralism agreement with the US, Japan and China in case4.

Base on the results of case 4 which is recommended by Office of Industrial Economics (OIE), the higher production was supported by FTAs mainly in food and fashion sectors which have the main production base in the study area. From this reason, water demand in case 4 is more than case 2 about 46 MCM in 2005. This higher demand is quite serious in this area because the limited of water supply from the groundwater pumpage closing to protect the land subsidence and the high quality for production process in food and fashion sectors. In some factories, production line cannot use the pipe water because of the changed quality of goods by chlorine.

Industrial water demand classified by ISIC code and water demand in each province compared between case 2 and 4 in 2025 was shown in figure 3. Textile, food and chemical products are the top three main water users in this area about 51 % of total water use. After applying FTAs, textile and food sector need more water but the water use in chemical sector decrease. The main reason is the higher production needed from partners in FTAs.

Samut Prakan, Bangkok and Samut Sakhon are the top three main water users in study area about 67 % of total because of the high density of factories. After applying FTAs, these three provinces need more water about 30 MCM, however, most of fashion factories located in this area needs the high quality water such as groundwater may have problem form this policy.

Figure 4 shows trend of industrial water demand in each cases from 2005 to 2025.



(A. Industrial water demand in the study area)

(B. Industrial water demand in each provinces,MCM, 2025)

Figure 4 industrial water demand in each cases from 2005 to 2025

The industrial water demand increase rapidly in this period since industry is the main part concentrated by Thai government declared in the 9th and 10th national economic and social development plan, Thai industrial master plan and international trade by FTAs. However, Thai government has to concern about the higher water demand affected from declared policy and provide water supply or water demand measure to decrease the water use in this area.

4. CONCLUSION

The proposed industrial water demand model with the scenario of growth with Thai industrial cluster strategy and free trade agreements can illustrate the needed water of industrial activities by using Input-Output (IO) table model, water use unit analysis and simulation of industrial market change in study area.

This area is the central of Thai economic development; however, the higher water demand resulted from high growth of industrial activities in this area may face the problem of water shortage in the future because of the critical groundwater zone and risk of low water supply. Thai policy makers should have water management plan to supply more water or decrease water use to keep the satisfied level of all users. However, the suitable choice for Thailand should be the integrated water management mainly concentrated in water demand that use fewer budgets.

5. RECOMMENDATION

After the calculation of water demand in the possible scenarios related with Thai government's policy and international free trade agreements or FTAs, this study area which is the main area of economic development of Thailand need more water to implement that policies. With the risk of water supply and limitation of budget for more water infrastructure, the next interesting topic is how to decrease industrial water demand. Water pricing policy is one of interesting countermeasures,

however, this policy have to keep the target of high growth of economic activities by policy makers. The past experiences of Japan and analysis of industrial questionnaire survey in this area by Kochi University of Technology (KUT) is one of the interesting method to study how the industrial water demand change under the pricing policy.

Finally, the demand side management should be considered with the supply side management to generate the situation of water in the future by using the future plan of water infrastructure, risk analysis, climate model, and the other measures.

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