Groundwater Resources Planning and Development in Eastern Economic Corridor (EEC) with an Integrated Spatial Plan and Public Participation

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Introduction

- The Thai government places importance on Eastern Economic Corridor (EEC) Project in Chachoengsao, Chonburi, and Rayong provinces, where manufacturing industry has been rapidly expanding, resulting in the shortage of surface water and sometimes the water quality is non-consumable.

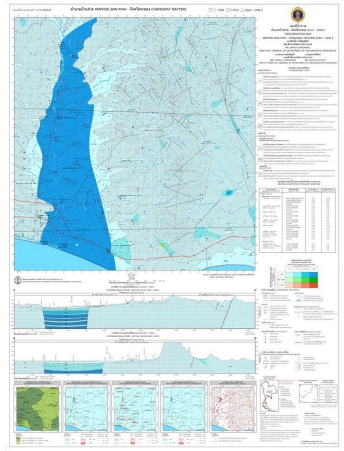
- Therefore, new water resource is needed to serve the development of EEC area. In this regard, groundwater is an important reserved source which could be developed for EEC development use.

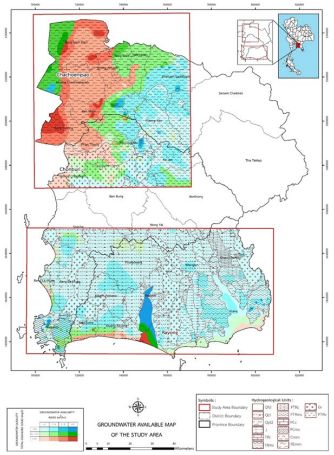
- For more accurate, reliable, detailed, and updated information and economical and efficient groundwater allocation, it is essential to have a study on groundwater resource evaluation in terms of quantity and quality and an integrated plan of groundwater management and development which includes public participation to reduce water conflicts and create a fair and effective allocation.

Introduction

- The Department of Groundwater Resources, in cooperation with Kasetsart University, has launched the Study on Exploration and Economic Evaluation of Large-scale Groundwater Development in Eastern Economic Corridor (EEC).

  - To be a guideline for an effective water management in EEC to prevent water scarcity, increasing input security which directly affect investor confidence, economic climate, and quality of life of people.





Objectives of the Study

1. To explore groundwater resources and get information on groundwater potential in EEC, in both quantity and quality.

2. To conduct an economic viability and analyze the real cost analysis of groundwater utilization in EEC for effective water allocation.

3. To construct an area integrated groundwater resources planning and development in EEC which includes public participation.

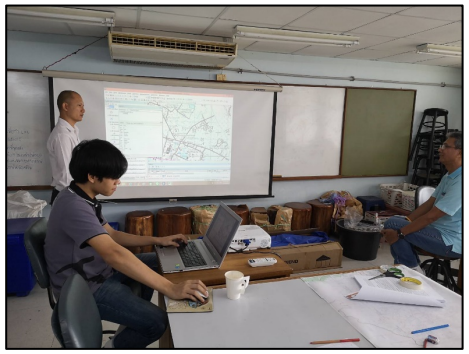
Research Methodology

1) Groundwater Exploration and Evaluation

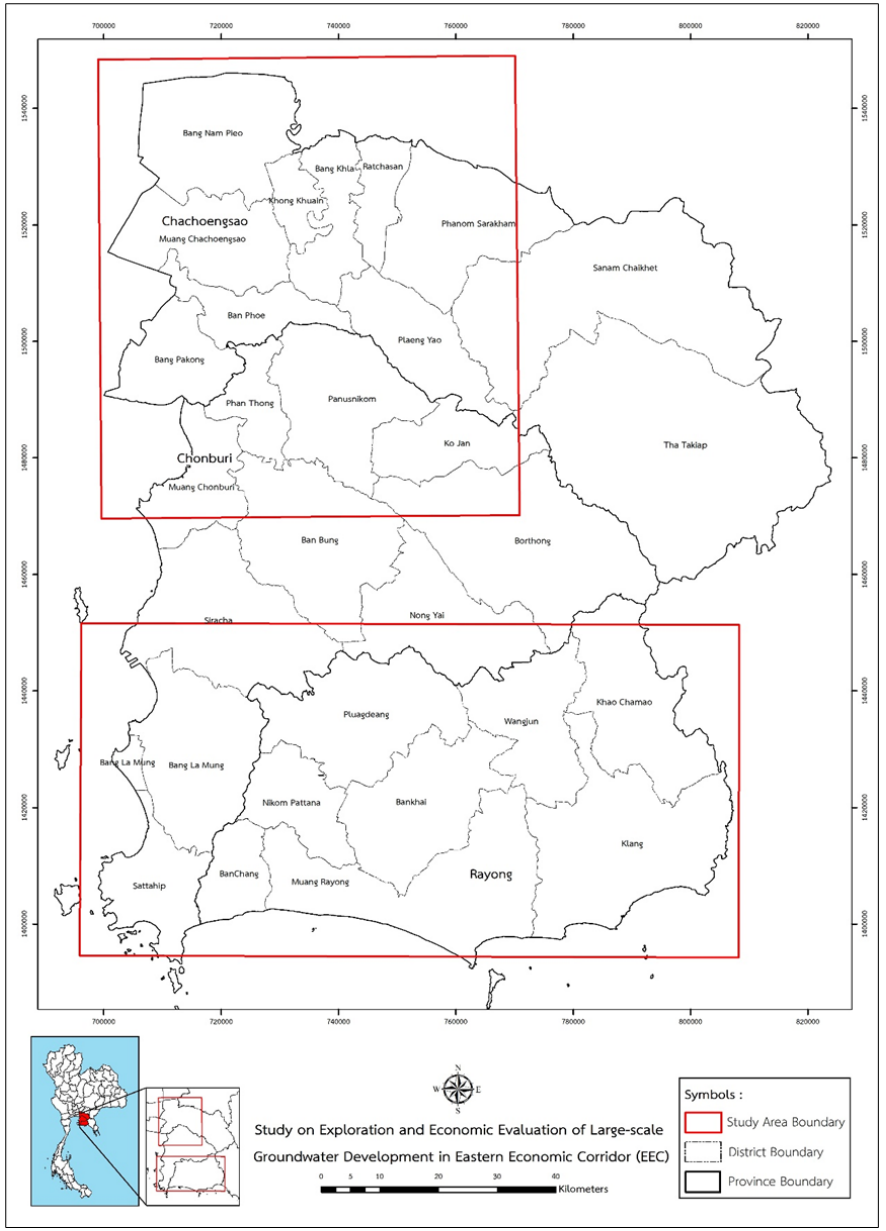
- The methodology consists of:
  - Surface-geophysical survey in 4,517 points where soil and rock data are not available using resistivity survey method, Vertical Electrical Sounding (VES).
  - Selection of at least 150 existing groundwater wells for jetting, following by constant-rate pumping test of 250 groundwater wells to determine groundwater yield and hydraulic properties of aquifers.
  - The data gathered from the tests were analyzed, interpreted, and processed in order to update the hydrologic map at 1:50,000 scale and generate maps of suitable areas for groundwater development of each purpose (consumption, agriculture, industry, and tourism).

Research Methodology

The study area is Eastern Economic Corridor (EEC) located in Rayong, Chonburi, and Chachoengsao Provinces.



Study on Exploration and Economic Evaluation of Large-scale Groundwater Development in Eastern Economic Corridor (EEC)



Research Methodology

2) Economic Evaluation and Analysis

- The research team analyzed water uses and water demands in the EEC, and evaluated water scarcity (current and estimated) of 3 EEC provinces during 2019-2039.
- Willingness to pay for groundwater were collected from 382 sampling persons. In addition, discussion meetings with 35 relevant organizations, public hearings with 1,217 participants, and 3 focus group meetings.
- The project launch seminar and the findings dissemination seminar were organized to collect comments and suggestions from all stakeholders.

Seminar and Focus Group Meetings

Bangkok

Chonburi

Rayong

Chachoengsao

Discussion Meetings with 35 Relevant Organizations

Central Organization

- Office of National Water Resources
- East Water Group
- Industrial Estate Authority of Thailand

etc.

Rayong

- Department of Public Works and Town & Country Planning, Rayong
- Provincial Office of Natural Resources and Environment, Rayong
- Rayong Provincial Administrative Organization
- Provincial Waterworks Authority, Rayong
- Provincial Agricultural Extension Office, Rayong

etc.

Discussion Meetings with 35 Relevant Organizations

Chonburi

- Provincial Office of Natural Resources and Environment, Chonburi
- Chonburi Provincial Administrative Organization
- Provincial Waterworks Authority, Chonburi
- Chonburi Provincial Industry Office
- Tourism and Sports Office, Chonburi

etc.

Chachoengsao

- Chachoengsao Provincial Livestock Office
- Chachoengsao Provincial Administrative Organization
- Provincial Waterworks Authority, Chachoengsao
- Chachoengsao Provincial Industry Office
- Office for Prevention and Mitigation, Chachoengsao

etc.

Public Hearing with 1,217 Participants

Rayong (419 Participants)






Chonburi (402 Participants)






Public Hearing with 1,217 Participants

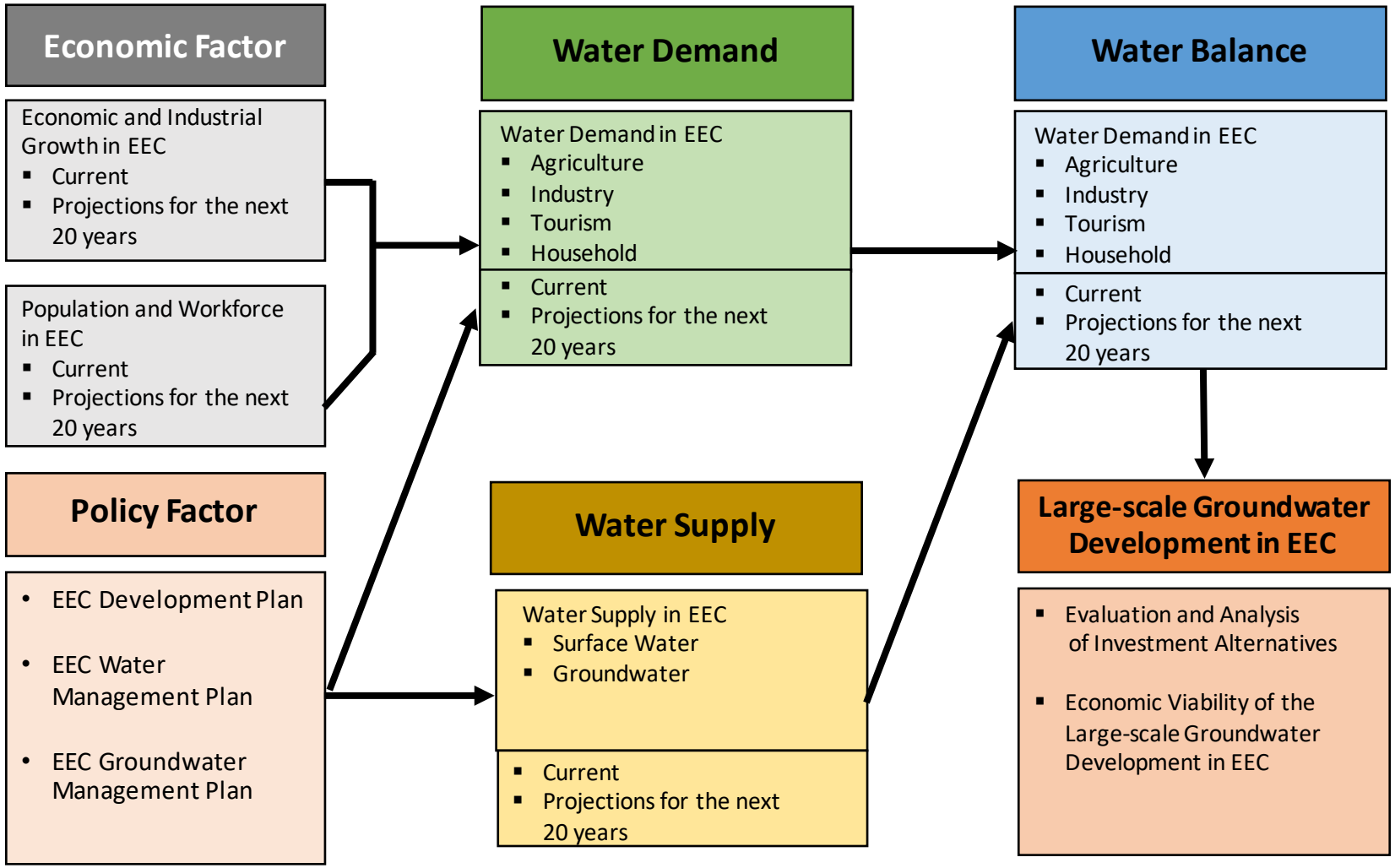
Chachoengsao
(396 Participants)






Research Methodology

2) Economic Evaluation and Analysis

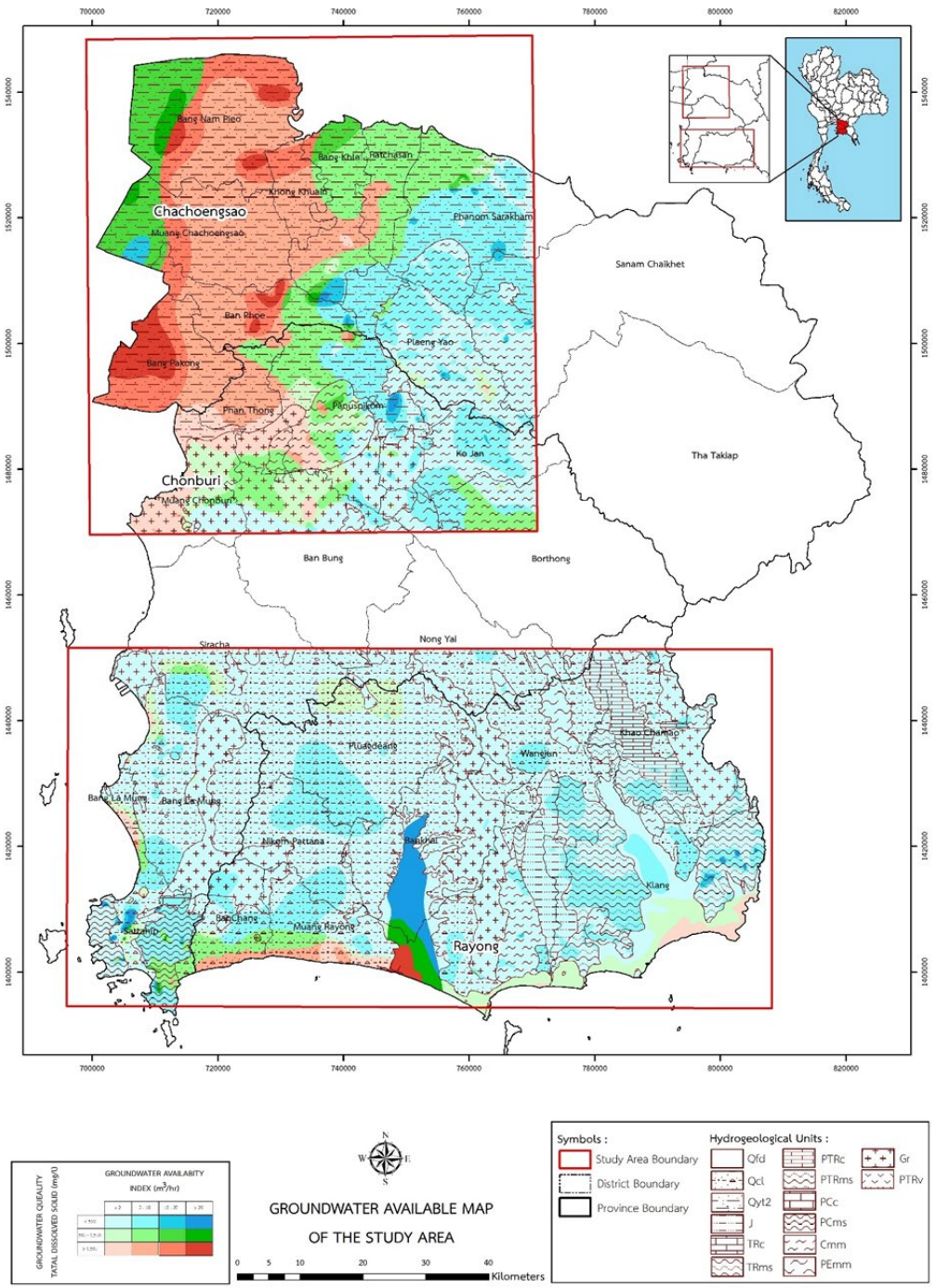


- Analyzing and conducting economic viability of groundwater utilization, using information gathered from field survey and focus group, along with secondary data.
- Also conducting the economic viability of the large-scale groundwater development and analysing the real cost of groundwater utilization in EEC.

Research Results

Groundwater Availability Map (GWAV)

- GWAV of the upper study area found that most of the west of Chachoengsao Province had Max Yield 2-10 / TDS > 1,500; the Central of Chachoengsao Province had Max Yield 2-10 / TDS 500 - 1,500.
- Some parts of the west of Chachoengsao Province had Max Yield < 2 / TDS < 500. For Chonburi Province, most areas had Max Yield < 2 / TDS < 500 and the Max Yield might be slightly different depends on the areas.
- The lower study area generally had Max Yield < 2 / TDS < 500 which could be different in each District. The groundwater potential area in Rayong basin, identified from cross-section data and groundwater usage data, had Max Yield > 20 / TDS < 500.

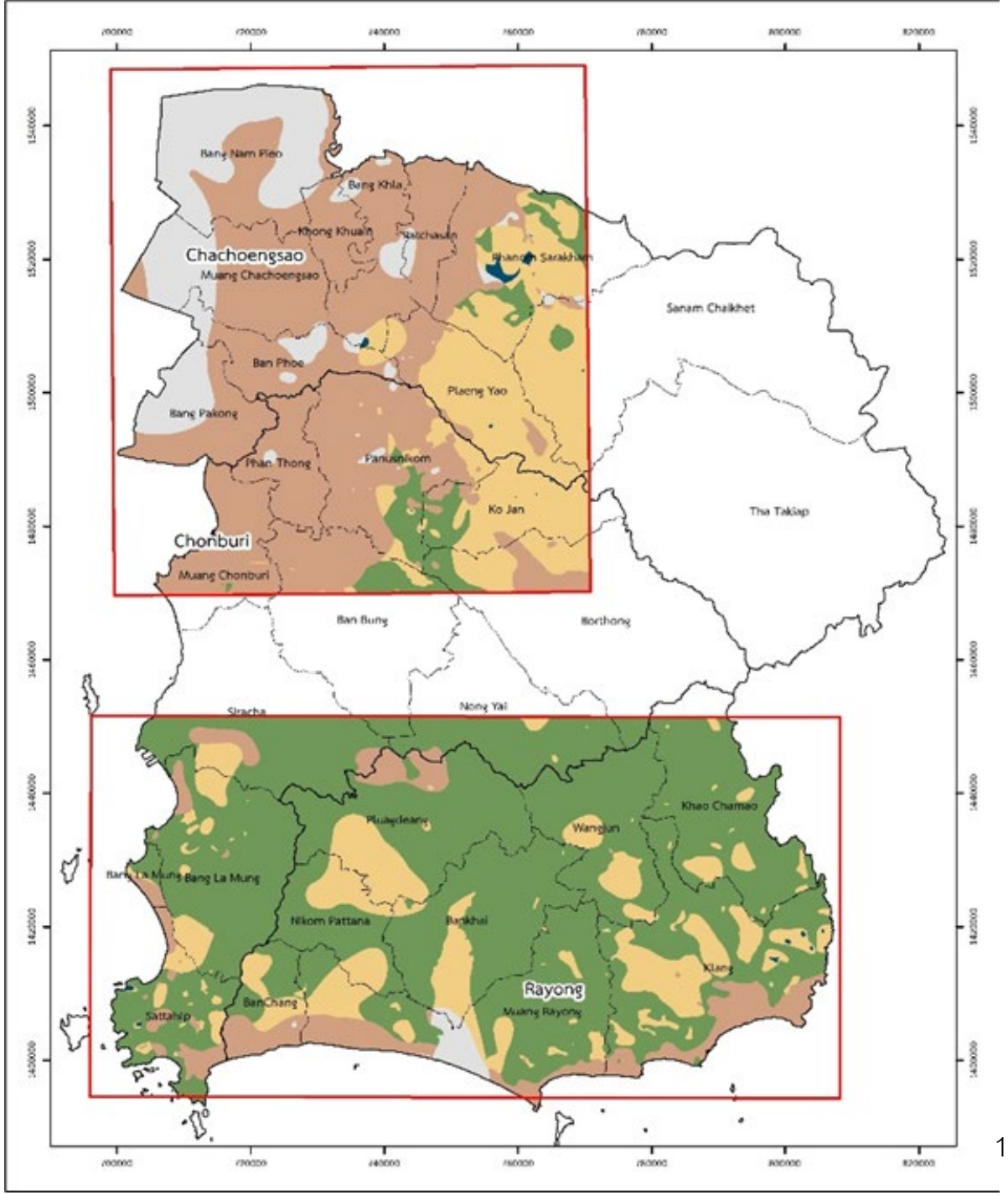


Research Results

Quantitative and Qualitative Application of Potential Groundwater Sources

- The research team used the groundwater potential zone map to categorize areas that are suitable to develop groundwater based on their hydrogeological potential.

- After mapping the groundwater potential zones, the research team used the land use scope of the year 2037 (Department of Public Works and Town and Country Planning, 2019) to be overlayed to create the land use map.



Research Results

Water Balance Analysis (as of 2019)

Unit: million cubic metres/year

Province	Agricultural Water Balance for Non-irrigated Area			Water Balance for Consumption, Tourism, and Industries					Water Storages, Department of Water Resource	Water Scarcity	Groundwater Potential
	Total Water Demand for Agriculture	Water Budget from Groundwater Wells	Agricultural Water Balance	Consumption & Tourism	Industries	Water Budget		Water Balance			
						Waterworks Authorities	Groundwater Wells				
Chachoengsao	257.62	2.36	-255.26	18.68	87.86	57.99	6.39	-42.16	21.85	-275.56	206.82
Chonburi	823.46	2.12	-821.34	93.07	191.85	209.52	17.05	-64.77	19.66	-866.44	17.97
Rayong	407.07	3.74	-403.33	31.41	136.34	51.35	20.29	-95.95	6.80	-492.48	134.78

Source: Author's calculation

- The research team compared water demand and water supply in 2019 in the study areas: Chachoengsao, Chonburi, and Rayong Provinces

Research Results

Water Balance Analysis (2039 Estimated)

Unit: million cubic metres/year

Province	Agricultural Water Balance for Non-irrigated Area			Water Balance for Consumption, Tourism, and Industries					Water Storages, Department of Water Resource	Water Scarcity	Groundwater Potential
	Total Water Demand for Agriculture	Water Budget from Groundwater Wells	Agricultural Water Balance	Consumption & Tourism	Industries	Water Budget		Water Balance			
						Waterworks Authorities	Groundwater Wells				
Chachoengsao	257.62	2.36	-255.26	58.30	128.01	165.22	6.39	-14.70	21.85	-248.10	206.82
Chonburi	823.46	2.12	-821.34	464.51	284.74	319.40	17.05	-412.80	19.66	-1,214.47	17.97
Rayong	407.07	3.74	-403.33	282.64	226.48	122.44	20.29	-366.39	6.80	-762.95	233.27

Source: Author's calculation

- To estimate future water balance, the research team estimated water demand in the next 20 years of each activity and balance it with future water supply planned by relevant authorities.

Research Results

Economic Viability of Groundwater Development in EEC

District	Water Scarcity (million cubic metres/year)		Groundwater Potential		Economic Viability			
	Current (2020)	Estimated (2039)	Amount of Developable Groundwater (million cubic metres/year)	Total Dissolved Solids (mg/l)	NPV (million baht/well)	IRR	B/C Ratio	Payback Period
Ban Khai	38.98	46.33	51.53	TDS <1,000	10.44	26.69%	1.61	3 years 4 months
Sattahip	15.44	68.95	3.38	Sattahip and Na Chom Thian Sub-district; TDS >1,000	21.42	40.59%	2.20	2 years 5 months
Bang Nam Priao	20.93	30.18	51.80	TDS >1,000	15.14	32.68%	1.86	2 years 10 months
Phanom Sarakham	52.75	51.90	26.41	TDS <1,000	9.31	25.23%	1.55	3 years 6 months

Source: Author's calculation

Research Results

Economic Viability of Groundwater Development in EEC

- Economic viability of the large-scale groundwater development in EEC Provinces (Rayong, Chonburi, and Chachoengsao) used Cost-Benefit Analysis method to analyze cost and benefit of important stakeholders, based on water demand, water supply, and water balance in present day and in the next 20 years.

- Furthermore, groundwater potential data are obtained from field survey, mapping of groundwater sources at 1:50,000 scale, and mapping suitable areas for groundwater development.

- The research team found that there are 4 potential areas that could be a pilot project for the large-scale groundwater development to strengthen input security in EEC, namely:
  - Ban Khai District, Rayong Province
  - Sattahip District, Chonburi Province
  - Bang Nam Priao District, Chachoengsao Province
  - Phanom Sarakham District, Chachoengsao Province

Research Results

Groundwater Resources Planning and Development

- The groundwater resources planning and development in the EEC should achieve the Sustainable Development Goals (SDGs) by creating water resource security and effectively utilizing groundwater with maximum benefits, under control of economic measures.

- Groundwater resources planning and development in EEC in short term (5-year), medium term (10-year), and long term (20-year) consist of:
  - **The short term (5-year)**
    - 1) ***Amendment of related laws and regulations*** by indicating the EEC area in 3 Provinces as groundwater critical area and imposition of groundwater use fees and groundwater conservation fees for effective groundwater utilization.
    - 2) ***Large-scale groundwater development*** in the EEC area in:
      - Ban Khai District, Rayong Province
      - Sattahip District, Chonburi Province
      - Bang Nam Priao District, Chachoengsao Province
      - Phanom Sarakham District, Chachoengsao Province
    - 3) ***Supporting public participation*** of citizen and relevant sectors and organizations, and public relation through various types of media.

Research Results

Groundwater Resources Planning and Development

- **The medium term (10-year) and long term (20-year)**
  - ***1) Effective and sustainable allocation and utilization*** (for agriculture, consumption, tourism, and industries) of large-scale groundwater development in 3 EEC Provinces (from year 6 onwards).

  - ***2) Groundwater conservation for sustainable and effective groundwater utilization***, which includes increasing effectiveness of management, conserving upstream areas or groundwater recharge areas, controlling amount of groundwater usage, and identifying EEC area in 3 Provinces as groundwater critical area and imposition of groundwater use fees and groundwater conservation fees (operate throughout 20 years).

  - ***3) Monitoring quantity and quality of groundwater***, consisting of level and quantity of groundwater data, and dispersion and concentration of contaminants in groundwater data (operate throughout 20 years).

Conclusions

- Groundwater resources planning and development in the EEC should consist of:
  - Public participation of citizen and relevant sectors and organizations
  - Large-scale groundwater development, and effective and sustainable allocation and utilization of large-scale groundwater development
  - Groundwater conservation for sustainable and effective groundwater utilization
  - Legislative amendments related to collection of groundwater use fees and groundwater conservation fees
  - Groundwater monitoring (in both quantity and quality)

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