SEA OF THE RAYONG PROVINCIAL DEVELOPMENT PLAN - SUSTAINABILITY ANALYSIS REPORT

ADB TA-9204 THA: Strategic Environmental Assessment of the Rayong Provincial Development Plan and Revision of the Draft Thai SEA Guidelines

December 2019

SEA of the Rayong Provincial Development Plan Sustainability Analysis Report

This is one of four linked reports in the SEA of the Rayong Province Development Plan set:

1. Methodology and scoping report
2. Baseline assessment report
3. **Sustainability analysis (impact assessment) report**
4. Sustainable development pathways report

DISCLAIMER

This document was prepared for Thailand's National Economic and Social Development Council (NESDC), the Rayong Provincial Governor's Office and the Asian Development Bank (ADB) by an ICEM team engaged to undertake the technical assistance project TA 9204-THA Phase 2: Strategic Environmental Assessment (SEA) of Rayong Provincial Development Plan and Revision of the Draft SEA Guidelines. The views, conclusions and recommendations in the document are not to be taken to represent the views of NESDC and ADB.

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ABBREVIATIONS

ADB	Asian Development Bank
BAU	Business as usual
CSD	National Committee on Sustainable Development
CSR	Corporate social responsibility
DIW	Department of Industrial Works
DNP	Department of National Parks Wildlife and Plant Conservation
DWR	Department of Water Resources
EECO	Eastern Economic Corridor Office
EFC	Eastern Forest Complex
ESB	Eastern Seaboard
ESDP	Eastern Seaboard Development Plan
ESTSP	Environmentally Sustainable Transport System Plan
FES	Fixed or Point Source Emissions Standards
FMP	Marine Fisheries Management Plan
GAP	Good Agriculture Practice
GHGs	Greenhouse gases
GSTC	Global Sustainable Tourism Council
IEAT	Industrial Estate Authority of Thailand
IEs	Industrial Estates
IFLA APR CLC	International Federation of Landscape Architects, Asia Pacific Region, Cultural Landscape Committee
IUU	International Obligations on Unreported and Unregulated
KARNWS	Khao Ang Rue Nai Wildlife Sanctuary
KCKWNP	Khao Chamao-Khao Wong National Park
LNG	Liquefied natural gas
MAF	Mean annual flow
MCA	Multi-criteria analysis
MCM	Millions of cubic metres
MONRE	Ministry of Natural Resources and Environment
MPA	Marine protected area
MRO	Maintenance, Repair and Overhaul Centre
MSW	Municipal solid saste
MWW	Municipal waste water
NESDC	National Economic and Social Development Council
NESDP	National Economic and Social Development Plan

NPOA-IUU	National Plan of Action to Prevent, Deter and Eliminate IUU Fishing
NTFPs	Non-timber forest products
ONEP	Office of Natural Resources and Environmental Policy and Planning
ONWR	Office of National Water Resources
PEA	Provincial Electricity Authority
PCD	Pollution Control Department
PWA	Provincial Water Authority
RBCs	River Basin Committees
RID	Royal Irrigation Department
RPDP	Rayong Province Development Plan
SDGs	Sustainable Development Goals
SEA	Strategic Environmental Assessment
SEP	Sufficiency Economy Philosophy
SPP	Small power producer
TAT	Tourist Authority of Thailand
TPHs	Total Petroleum Hydrocarbons
VOCs	Volatile Organic Compounds

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PART I: SUSTAINABILITY ASSESSMENT OF DEVELOPMENT THEMES

This Strategic Environmental Assessment (SEA) volume describing the results of the sustainability analysis or, using the more familiar term for most stakeholders - impact assessment – is divided into two parts. During the scoping phase of the SEA, twelve strategic themes of importance to development in Rayong Province were identified as the focus of the assessment. Eight of those themes relate to development sectors or resource consumers such as industry, transport and energy. Part I of this volume records the effects of those development themes against the SEA sustainability objectives under various scenarios. A further four themes have been grouped in Part II – they relate to social and environmental well-being. For this group the assessment deals with the impacts of the development sectors and scenarios on the quality of life within the province.

1 INTRODUCTION

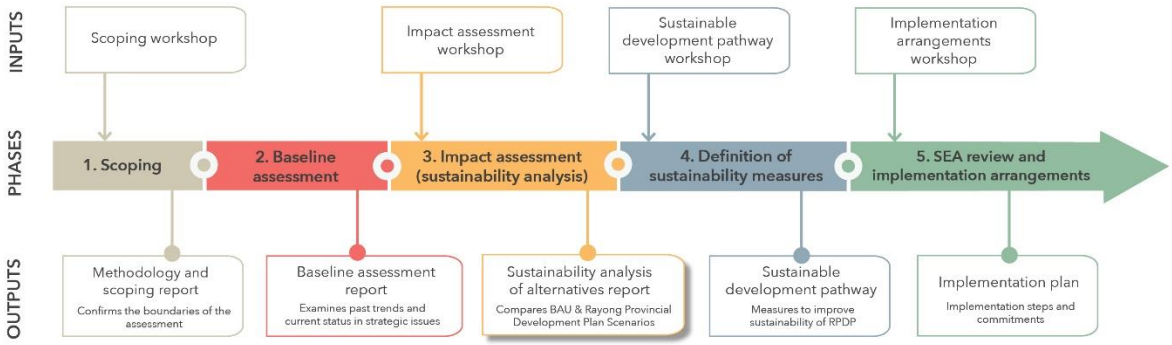
1.1 Background

This Sustainability Assessment is Volume 3 of the pilot Strategic Environmental Assessment (SEA) of the Rayong Provincial Development Plan (RPDP). The pilot SEA was initiated by the National Economic and Social Development Council (NESDC) in collaboration with the Rayong Provincial Governor's Office, the Office of Natural Resources and Environmental Pollicy and Planning (ONEP) and the Department of Water Resources (DWR) with support from the Asian Development Bank (ADB).

NESDC provides the technical secretariat for the Sub-Committee on the National SEA Guidelines set up under the National Committee on Sustainable Development (CSD). In 2018, the Sub-committee completed a draft of the Guidelines. In February 2019, ICEM – International Centre for Environmental Management, was contracted by ADB to assist NESDC in reviewing and completing the Guidelines while testing them through a pilot SEA. The SEA had two main objectives: (i) to test the guidelines and demonstrate international best practice and (ii) to support Rayong Province in defining sustainability measures for inclusion in the next iteration of the Rayong Provincial Development Plan. The pilot SEA was conducted over six months with an extension of time to allow for completion of the National SEA Guidelines and the SEA reports as a case study and reference, and the preparation of linked training materials.

The SEA process followed the steps set out in the National SEA Guidelines of scoping, baseline assessment, impact assessment and development of sustainability recommendations for Rayong Province (Figure 1.1). Through a program of round table meetings with stakeholders and four consultation workshops, the issues of strategic concern to development in Rayong Province were identified across 13 thematic areas. The stakeholder consultation workshops allowed the SEA team to access local knowledge, data and understandings about past trends, current status, likely future trends and the drivers of change for each of the strategic themes and issues.

Figure 1.1: SEA process diagram



The details of the scoping and baseline assessment phases of the SEA are included in the scoping Volume 1 and baseline assessment Volume 2 of the SEA report set.

1.2 Scoping phase

In summary, the scoping phase, which included a stakeholder scoping workshop in Rayong Province, defined the geographic, temporal and substantive boundaries of the SEA, as well as detailing the thematic areas of focus and their strategic issues. Each theme includes two to four strategic issues. While the most substantial decisions on SEA coverage were made during the scoping phase, the process of focusing the assessment on the most significant concerns continued throughout the assessment as more information and views are gathered and analysis is conducted.

Other key outputs of the scoping phase included definition of sustainable development objectives for each strategic theme. Those SEA objectives provide the framework for assessing the sustainability performance of the existing Rayong Provincial Development Plan and alternative development scenarios – the subject of this report. Linked indicators were developed to assist in the impact assessment and for later monitoring of the recommended sustainability measures to be included in the next Rayong Plan.

Finally, early in the phase, a stakeholder consultation and communications plan was prepared to guide and optimize stakeholder engagement in the SEA.

1.3 Baseline Assessment

In the baseline assessment, each strategic theme for the SEA identified through the scoping process was separately researched and developed, with support and input from NESDC, ONEP, the Rayong Provincial authorities and other stakeholders including those representing vulnerable groups and representatives from development sectors. That detailed investigation and consultation helped refine the strategic issues of greatest concern for Rayong's sustainability. Also, it led to the definition of past trends and current status in those themes and issues. Further modelling and analysis enabled for the first time the preparation of a climate change profile of Rayong Province to 2050. Equally important, as part of that trend analysis, the key drivers of change could be described for each of the strategic themes. They are the forces shaping and influencing development in the province. The baseline assessment provides the evidence base or foundation for the entire SEA – it establishes the facts and, through original research and analysis, provides insights into the risks and opportunities for sustainability performance. The baseline assessment is documented in Volume 2 of the SEA report set.

Background: Since the late 1980s, industrial and energy development in Rayong have been the main driving force in shaping environmental and social conditions and resource use. The provincial economy shifted away from agriculture towards capital intensive heavy industry and natural gas processing and distribution. Most of the provincial area remains under agricultural tenure but the balance in land uses is shifting. GPP per capita has become the highest in the country, attracting large numbers of migrants which have swell urban areas, stressed public services and brought a range of environmental problems and conflict. It has also attracted younger people away from their family farms to look for employment opportunities in commerce and industry. The shift to industry has had implications for land and water resources. Now industry is the main consumer of water in the province leading to conflicts with other sectors, especially agriculture.

The quality of water, air and land has become a significant concern of all sectors and community members. The industry sector is faced with serious waste and effluent management challenges, especially the growing accumulation of hazardous wastes. The transport, tourism, agriculture and domestic sectors are also contributing to the total pollution loadings, varying in terms of geographic areas affected and the types of pollutants.

Rayong's three municipal wastewater treatment facilities are operating about 5% of their combined design capacity. Rayong City's municipal and domestic wastewater is being discharged directly to surface waterways. Rayong does not have sufficient capacity to manage the existing 1,000 tons a day of solid waste that is currently generated, let alone the increases driven by increasing consumption and projected population growth.

Climate change is linked closely to sustainability in the province. For example, industry, transport and energy sectors are major emitters of greenhouse gases (GHGs), and emissions trends are rising. On the impact side, changing rainfall and temperature patterns are resulting in more frequent and intense flooding, and longer and hotter drought periods.

Those and other issues and trends provide the baseline foundation for assessing the sustainability of various development scenarios. The questions asked include: "if Rayong develops in this way, how will it affect performance against the SEA's sustainable development objectives?" "How will it affect the

use of resources, environmental quality, ecological integrity, social equity and community well-being?" This report sets out the results of that assessment.

1.4 Introduction to the impact assessment

This sustainability analysis volume follows the baseline assessment by evaluating the impact of a Business as Usual (BAU) scenario and a full implementation of the existing Rayong Provincial Development Plan scenario on the issues within the 13 SEA thematic areas. Some impacts are positive, others are negative. The BAU case sees some improvement in environmental management practices within the industrial sector and tightening of development controls within urban areas. Overall, it is anticipated that environmental and social conditions will become worse before improving in some fields. Water would remain as the critical natural resource constraint and lead to increasing tension between industry and agriculture sectors. Examples of positive impacts of the RPDP is the promotion of agro-ecotourism and the rehabilitation of natural habitats within the coastal zone. The green and equitable vision within a sufficiency economy spelt out in the RPDP is inspirational, but not backed up with a broad range of projects, with needed adjustments to policies and spatial planning, and practical strategies for improving environmental quality and ecological sustainability.

This report first assesses the Rayong Provincial Development Plan and all its projects through a multi-criteria analysis (MCA) against the framework of SEA sustainable development objectives. The report is then divided into two parts – the first addresses each of the development themes or sectors in turn such as water, transport, energy, tourism and agriculture. The baseline trends in each sector are assessed for a BAU scenario and full RPDP implementation scenario. The relationship and interactions between trends under those scenarios are analysed and then all trends scored against the sustainable development objectives. The question addressed – "is this trend under this scenario moving to implement the SD objective or running counter to it?" or in other words "is it a positive or negative influence in achieving the SD objective?"

The second part of the report describes the impacts of the BAU and full RPDP implementation scenario on what are termed the "Quality of Life" themes – meaning, environment quality, social equity, biodiversity and climate change.

2 ASSESSMENT OF RPDP AGAINST SEA SUSTAINABLE DEVELOPMENT OBJECTIVES

2.1 Introduction

As part of the SEA sustainability assessment, and to illustrate the use of a variety of sustainability analysis tools in conducting an SEA, a multi-criteria scoring of the projects in the RPDP was conducted. Projects were evaluated with respect to their size and the sustainability objectives identified in the SEA baseline to arrive at an assessment of relative contribution to sustainability. The scoring methodology and the results of the process are reported in this section.

2.2 RPDP overview

There are 175 investment projects identified in the Rayong Province Development Plan (RPDP) which together constitute a total budget of THB 18.2 billion. For the purposes of the SEA, the projects in the plan have been divided according to the different strategic themes identified for the SEA. It should be noted that there were no energy sector projects included in the plan, and the overarching themes of environmental quality and macroeconomics also had no specific investment projects identified. Transportation and water sector projects represent both the largest number of projects in the plan as well as the largest share of investment by a significant margin (Table 2.1).

Table 2.1: Overview of RMP projects by theme/sector

Theme/sector	No. of projects	Investment (million THB)
Agriculture	8	142
Biodiversity	7	162
Climate Change	1	7
Industry	23	737
Coastal and Marine Environment	7	137
Social	4	113
Tourism	14	716
Transport	33	12,247
Urban	23	1,675
Water	55	2,189
Total	175	18,126

2.3 Methodology

To arrive at an evaluation of project impact each project was scored with respect to the 31 sustainability objectives identified for the 13 SEA themes. The SD objectives are set out in Table 2.2.

Table 2.2: Sustainability objectives by SEA theme

SEA theme	Sustainable development objective
Macro-economics	▪ Ensuring the sustainable development of the economy
	▪ Ensuring equitable distribution of economic benefits including long term support to vulnerable affected groups and areas
Social equity	▪ Strengthen community resilience and inclusive development based on the sufficiency economy philosophy and environmental sustainability
Energy	▪ Promotion of renewables and energy efficient generation technologies
	▪ Affordability of energy supply to residents and businesses in the province
	▪ Reduce pollution emissions from energy supply to meet ambient and point source air quality standards and GHG emissions reductions targets

SEA theme	Sustainable development objective
Industry	▪ Environmentally sustainable growth through the promotion of green industries using cleaner and low emissions production technologies and resource efficient production
	▪ Use of best international practice in environmental technologies and management to prevent and moderate the discharge of industrial pollutants to water, air and land
	▪ Structural transformation increasing the capacity of local industry for value-addition, diversification, job creation and production in high-tech sectors
Transport	▪ Promote an equitable and safe transportation system, offering a choice of transport modes, and a geographical balance of development.
	▪ Reduce transportation related emissions and resource use
Urban development	▪ Urban areas are planned for energy and water conservation, transit oriented design and equity, emphasizing green infrastructure and nature based approaches.
	▪ Pollution and waste streams in urban areas are effectively managed, creating a pollution free environment.
Water	▪ Rehabilitate and manage river basins and water resources for ecological sustainability and environmental quality
	▪ Provide a secure supply of clean water that meets demand in each sector, within ecological limits, without causing conflict between different user groups or with neighbouring provinces.
	▪ Use water efficiently and equitably to eliminate wastage and reduce demand
Agriculture	▪ Modernize the sector to international standards through sustainable production models for small-holders and commercial agriculture.
	▪ Farmers reduce environmental pollution, adopt sustainable land management practices and enhance biodiversity
	▪ Farmers build resilience to climate change through diversity in production and nature based solutions such as through use of agricultural residue for energy production.
Tourism	▪ Promote ecological, community and agricultural tourism
	▪ Ensure that tourism related solid waste and waste-water is treated properly
Coastal and Marine Environment	▪ Sustainably use marine and coastal resources
	▪ Restoration, enhancement and protection of marine and coastal ecosystems and resources, including through natural barriers to prevent coastal erosion.
Terrestrial Biodiversity	▪ Conserve, restore and enhance biodiversity in Rayong
	▪ Increased forest cover throughout the province with a target to contribute to the national goal of 40% forest cover
Environmental quality	▪ Establish effective measures for the prevention, control and abatement of water pollution
	▪ Hazardous wastes from industry, domestic and agricultural sources are identified, minimized and disposed without negative environmental impacts
	▪ Replace open dumping sites by sanitary landfills, green space, incineration and waste to energy and recycling schemes.
	▪ Establish and enforce point source air pollution standards, especially relating to the industry, energy and transport sectors.
Climate change	▪ Enhance capacities to adapt to climate change
	▪ Rayong Province, the EEC and sector agencies operating in Rayong prepare climate change adaptation plans and allocate budget for their implementation

In the first step of the evaluation, projects were scored on a five-point scale running from +2 to -2 depending on the likely project effects with regards to the sustainability objectives detailed in Table

2.2. Where a project was not relevant to the sustainability objective being scored, the score was left blank, and the cell colored grey. The detailed scoring criteria for the projects are given in Table 2.3. This initial phase of scoring does not consider the likely magnitude of the project effect. Rather, the scoring method simply seeks to identify projects that are likely to have direct or indirect implications for achieving the sustainability objective. Impact magnitude is considered separately, after the initial scoring has been evaluated.

Table 2.3: Project impact scoring criteria

Assessment criteria	Score
Direct positive contribution to achieving the sustainability objective	2
Indirect positive contribution to achieving the sustainability objective	1
Neutral contribution to achieving the sustainability objective	0
Indirect negative impact on achieving the sustainability objective	-1
Direct negative impact on achieving the sustainability objective	-2
No contribution to meeting the sustainability objective or otherwise not relevant to the objective	

To indicate the likely relative magnitude of project impacts, projects were weighted by investment size (Table 2.4). Projects were divided into 4 groups based upon investment size. This means that large projects were assumed to have greater affects than smaller investment projects. This implies that investment costs are likely to be generally **indicative of the relative magnitude of impacts**.

Table 2.4: Project impact weighting criteria

Investment budget (THB)	Relative weighting of impact
<8.0 million	1
8.0 – <30 million	2
30 million - <80 million	3
>=80 million	4

A matrix was created showing all projects down the side and sustainability objectives across the top. Each project was assigned a weight (1-4) with respect to investment budget, and a score (+2 to -2) with respect to the effect on each of the relevant sustainability objectives. Each project's effect score was multiplied by its weighting to generate a project impact score. Summary and average impact scores were obtained for each sustainability objective, for investment projects grouped by theme, as well as for sustainability objectives grouped by theme. Color coding was adopted from red (negative) to green (positive), indicating the relative performance of different sectors in the plan. The results and analysis of this exercise is reported in the following section.

2.4 Project sustainability scoring results

Table 2.5 and Table 2.6 provide a summary of the scoring results. In Table 2.5 each cell represents the combined score for each set of investment projects grouped by theme for each set of sustainability objectives (also grouped by theme). For example, transport projects perform poorly on environmental quality (minus126), mainly due to the concentration on road projects and likelihood that greater traffic volumes will imply greater air pollution and broader considerations of the environmental impact of more extensive transport infrastructure.

Similarly, the indirect benefits projects are likely to have in the sector for development are reflected in relatively high scores for the sustainability objectives for the economy (plus 192). In both cases, the high score reflects the relative size and number of projects. The evaluation of the total score for the transportation projects (bottom row), being the sum of all sustainability objective scores for projects in that sector, reflects the positive economic and negative environmental implications of the projects. Relative to other groups of projects in the Plan, transport performs relatively poorly (scoring 83 overall).

Table 2.5: Summary Table of project scoring exercise for RPDP: total project scores

Sustainability objective grouped by theme	Projects grouped by theme										RMP total for Sos
	Agriculture	Biodiversity	Climate change	Coastal and marine environment	Industry	Social issues and demography	Tourism	Transport	Urban development	Water	
Environemntal quality	3	12		2	122		4	-126	57	8	82
Social Issues and Demographics	4				10	13	4	51	10		92
Urban development		4			19	4	6	36	147	23	239
Industry					95		4				99
Energy					1						1
Water	1	6			16				30	246	299
Agriculture	30	8			3		12			191	244
Biodiversity		38			3		2		8	-18	33
Tourism	13	8					48		16		85
Coastal and Marine Environment		22		30	3		22		12		89
Transport								-70			-70
Economy	24	1		14	36		44	192	34	15	360
Climate change		19	3							24	46
Sector project total	75	118	3	46	308	17	146	83	314	489	

The final column of Table 2.5 represents an impact summary for the RPDP, or cumulative assessment of the planned investments with respect to the sustainability objectives for each theme. The poor performance of the plan with respect to the sustainability objectives defined for the transport theme again reflects air pollution impacts of sector development, whereas the overall poor performance for energy, biodiversity and climate change, reflect a low level of investment in projects addressing these sustainability objectives.

Consideration of average scores (final column, Table 2.6) emphasises the relative quality of the whole portfolio of projects in the RPDP with respect to each of the sustainability objectives. In this regard the RPDP scores well in terms of meeting the objectives of tourism, coastal and marine environment, urban development and agricultural sustainability objectives. Whereas, the RPDP performs relatively poorly with respect to sustainability objectives defined for energy, water and transportation.

Table 2.6: Summary Table of project scoring exercise for RPDP: average project scores

Sustainability objective grouped by theme	Projects grouped by theme										RMP project average by SO
	Agriculture	Biodiversity	Climate change	Coastal and marine environment	Industry	Social issues and demography	Tourism	Transport	Urban development	Water	
Environemntal quality	1.5	3.3		2.0	3.1		4.0	-4.1	3.2	4.0	2.1
Social Issues and Demographics	2.0				5.0	3.3	2.0	3.2	2.5		3.0
Urban development		4.0			3.2	4.0	3.0	1.4	5.9	4.6	3.7
Industry					3.4		2.0				2.7
Energy					0.5						0.5
Water	1.0	2.0			2.7				0.9	1.6	1.6
Agriculture	2.5	1.8			3.0		6.0			3.2	3.3
Biodiversity		3.5			3.0		1.0		8.0	-1.6	2.8
Tourism	1.9	2.7					4.1		8.0		4.2
Coastal and Marine Environment		3.5		4.2	3.0		3.1		6.0		4.0
Transport	1.9	1.0		1.2	3.6		3.1	-1.1	3.4	3.0	2.0
Economy	1.7	1.0		1.6	3.6		3.2	3.3	3.4	3.0	2.6
Climate change		3.8	1.5							3.4	2.9
Sector project average	1.8	2.7	1.5	2.2	3.1	3.6	3.2	0.5	4.6	2.6	

It is should be noted that the average project score indicates the average score for each project within that sector. Whereas the cumulative score is the sum of scores for all projects in that sector. So the average score is a relative measure of project quality (in respect of the sustainability objectives), and the cumulative score is a relative measure of likely cumulative impact of the projects for that theme. For example, if there are very few projects identified for a theme or the projects have a relatively low investment value, the cumulative score could be low, but if they are high quality projects the average may be high. Similarly, if a project in a particular theme scores on a large number of the sustainability objectives then the cumulative score may be high relative to a good quality project that only addresses one sustainability objective.

The final row of Table 2.5 gives the cumulative impact of investments in that sector/theme under the RPDP. The final row in Table 2.6 shows the average sustainability score for projects in that sector. For cumulative impacts, social issues and demography, and climate change score poorly reflecting a lack of investment in these sectors relative to other sectors, as well as a lack of cross-cutting/inter-sectoral impacts from projects in these sectors. Despite this, when considered from the perspective of average project scores (final row Table 2.6), social issues and demography does well, despite low investment, as well as a lack of expected impacts on other sustainability objectives for other themes.

The Tables also serve to indicate potential trade-offs. For example, water sector investments have moderate scores apart from when it comes to the objectives defined for agriculture. In that case the expansion and improvement of water supply to agriculture means the plan performs relatively well for this sector. Finally, the industrial sector performs fairly well for objectives defined for environmental quality and industry, reflecting the number of projects and scale of investment in pollution management and control. However, this project specific performance does not indicate whether or not that level of investment is adequate in addressing overall pollution levels linked to the industrial sector.

Table 2.7 further elaborates the performance of projects by sector by average and cumulative scores and generates a ranking of RPDP performance by sector. For example, because of the low investment and a limited number of projects, the social and demographic sector/theme scores poorly in any cumulative assessment - but relatively well when the average score is considered. Water's high cumulative score is also related to a large number of projects, rather than to good individual project performance. Similar considerations can be made for transport sector projects. In comparison, urban development projects score well both in terms of project quality and in terms of overall sustainability impacts.

Table 2.7: Impact summary - RPDP performance by investment project grouping

Projects ranked by average score

Rank	Projects grouped by theme	Average score
1	Urban development	4.6
2	Social issues and demography	3.6
3	Tourism	3.2
4	Industry	3.1
5	Biodiversity	2.7
6	Water	2.6
7	Coastal and marine environment	2.2
8	Agriculture	1.8
9	Climate change	1.5
10	Transport	0.5

Projects ranked by total score

Rank	Projects grouped by theme	Total score
1	Water	489
2	Urban development	314
3	Industry	308
4	Tourism	146
5	Biodiversity	118
6	Transport	83
7	Agriculture	75
8	Coastal and marine environment	46
9	Social issues and demography	17
10	Climate change	3

Source: ICEM, 2019 (based on data from RPDP, 2018)

Table 2.8 shows the poor performance of the plan with respect to transport and the transport sustainability objectives. Similarly, energy, water, and environmental quality rated poorly against their respective sustainability objectives.

"Macro-economics" performs very well if we consider the cumulative score, as many of the projects have implications for economic development. However, if we consider the average score for the theme we can see that projects with implications for the sustainability objectives defined for macro-economics have a relatively low average score, mainly due to the impact being indirect. So overall for the sustainability objectives defined for macro-economics, projects in the RMP only have a moderate average score. Conversely, just considering cumulative impacts for climate change projects gives a poor result, because of the low level of climate change focused investment included in the plan.

Table 2.8: Impact summary - RPDP sector performance

Rank by average	SO grouped by sector	Average score	Rank by total	SO grouped by sector	Total score
1	Tourism	4.2	1	Economy	360
2	Coastal and Marine Environment	4.0	2	Water	299
3	Urban development	3.7	3	Agriculture	244
4	Agriculture	3.3	4	Urban development	239
5	Social Issues and Demographics	3.0	5	Industry	99
6	Climate change	2.9	6	Social Issues and Demographics	92
7	Biodiversity	2.8	7	Coastal and Marine Environment	89
8	Industry	2.7	8	Tourism	85
9	Economy	2.6	9	Environemntal quality	82
10	Environemntal quality	2.1	10	Climate change	46
11	Transport	2.0	11	Biodiversity	33
12	Water	1.6	12	Energy	1
13	Energy	0.5	13	Transport	-70

Source: ICEM, 2019 (based on data from RPDP, 2018)

2.5 Conclusion

This chapter elaborated a sustainability analysis methodology based on an MCA of the RPDP investment plan. The MCA method illustrates the importance of defining themes and their sustainability objectives. The exercise highlights potential areas of weakness and strength in the plan in terms of sustainability.

In particular, the MCA highlights the weakness of the plan with respect to transportation and water management, which are also the main focus for investment in the province, highlighting relatively poor investment project performance, rather than a lack of investment. Weakness in other sectors is more closely related to a lack of investment projects (biodiversity, climate change, social and demographic issues), rather than project quality.

Finally, this analysis says nothing about the overall effectiveness of the plan in achieving sustainability. For example, the planned projects to improve the environmental performance of the industrial sector perform relatively well in the MCA. But considered against the magnitude of the serious environmental issues posed by the industrial sector in the province, the plan investments are likely to have a marginal impact at best.

3 INDUSTRY

Strategic theme	*Strategic issues of critical concern for sustainable development in Rayong*
Industrial development	▪ Rapid industrial growth ▪ Increased generation of Industrial pollution ▪ Resource use in industry
The sustainable development objectives for the industrial theme are[1]: ▪ Environmentally sustainable growth through the promotion of green industries using cleaner production technologies and resource efficient production; ▪ Use of best international practice in environmental technologies and management to prevent and moderate the discharge of industrial pollutants to water, air and land; and, ▪ Structural transformation increasing the capacity of local industry for value-addition, diversification, job creation and production in high-tech sectors.	

3.1 Introduction

The industry baseline assessment outlined the rapid growth of industry in Rayong Province since the mid-1990s. Rapid industrial growth has led to significant declines in environmental quality, with air and water quality of particular concern. Growing levels of industrial solid waste and hazardous waste are also a major concern.

In order to examine the effect of the RPDP on sustainability in Rayong, the main drivers of industry related trends, and the cumulative effects of these drivers on the trends, are examined first without, and then with, full implementation of the RPDP. This is done by extending the work done in the baseline chapter, and cross-referencing this with stakeholder workshops, where local officials, private sector and civil society representatives used their expert knowledge and understanding to conduct an impact assessment of the BAU and RPDP scenarios.

3.2 Summary of Industry Related Aspects of the RPDP

Industrial development is a core aspect of the RPDP vision. The Plan includes the following elements that relate to industry:

- Industrial development should be balanced with development in other sectors, including agriculture, tourism, and the commercial sector;
- Development will take a "middle of the road" path, as espoused in Thailand's sufficiency economy principles;
- Rayong will pursue knowledge and innovation intensive industrial development; and,
- Environmental and social goals and needs will continue to be met.

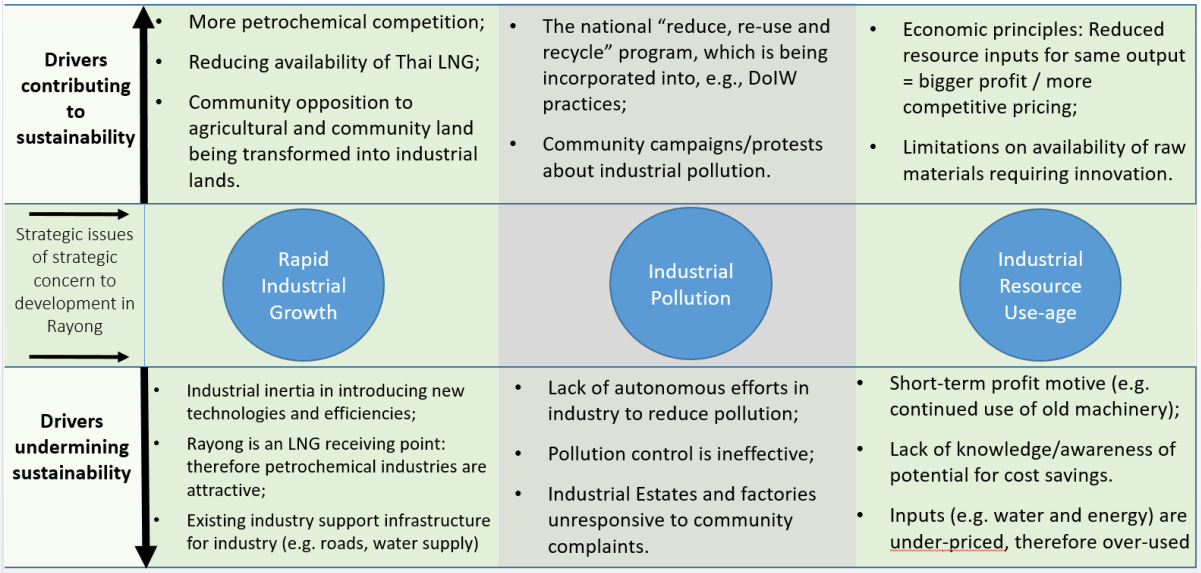
The RPDP includes a variety of aspirations. For example, it includes commitments to participatory development, balanced economic, social and environmental aspects (adhering to Thailand's sufficiency economy philosophy[2]), with specific reference to balancing industrial development with quality of life and environmental quality.

As part of the process of assessing how well the RPDP realizes these aspirations, the baseline identified three industrial issues of strategic concern for sustainable development in Rayong. Industrial development has large effects on quality of life and on the environment in Rayong, which are driven by trends in the three strategic issues. The strategic issues and the main factors driving trends in these

[1] Based upon Thailand 4.0 and UNIDO principles, see https://thaiembdc.org/thailand-4-0-2/
[2] http://www.tica.thaigov.net/main/en/information

issues are shown diagrammatically in Figure 3.1. These issues are discussed in more detail in later sections of this chapter.

Figure 3.1: Summary of business as usual thematic drivers: Industry

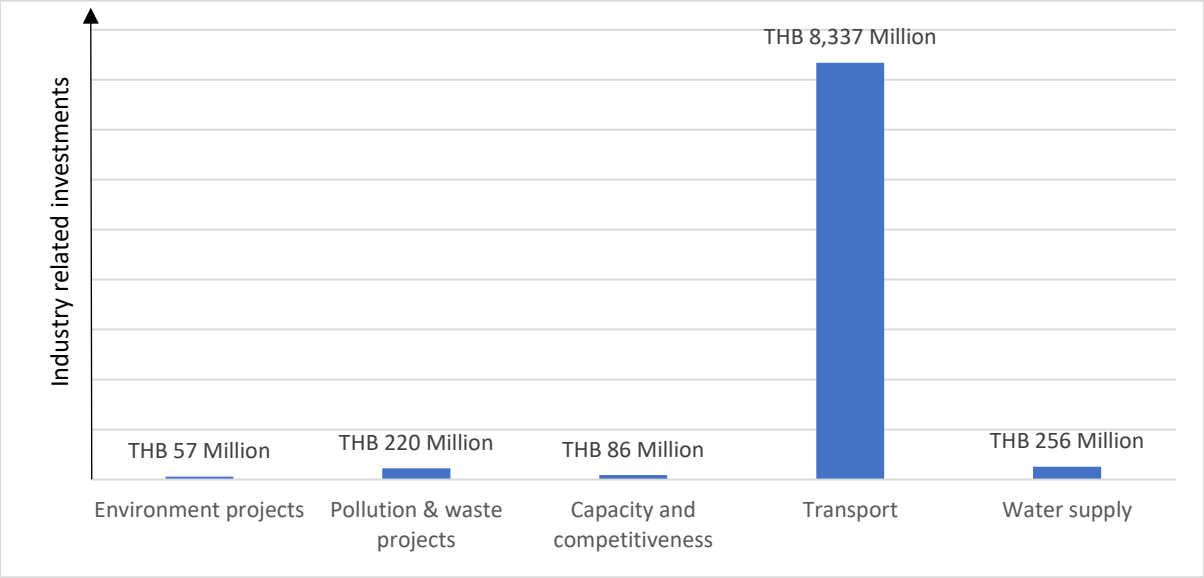


Source: ICEM, 2019

Despite the strong links that industry has with sustainability and quality of life issues, the RPDP includes limited direct expenditure in the industrial sector. With the exception of certain nationally strategic elements, such as oil refining, industrial development is primarily driven by private sector investment, and as such investment in industry is outside the provincial remit. While private sector investment in industry is already very important for the sector in Rayong, the emerging focus on "second S-curve" industries that are intended to help Thailand move out of the "middle income trap"[3] means that private sector investment in industry is likely to become even more important. This aside, of the 18.2 Billion Thai Baht that would be spent to fully implement the RPDP, almost 9 Billion Thai Baht is destined to facilitate industrial development (as well as other sectors) in the province, largely through the provision of supporting water supply and transportation infrastructure (Figure 3.2).

[3] A discussion on the middle income trap can be found at: http://www.levyinstitute.org/pubs/wp_715.pdf

Figure 3.2: RPDP - Industry related investments



Source: ICEM, 2019 (based on data from RPDP, 2018)

All except 27 Million Thai Baht of the transport-related infrastructure investment (Figure 3.2), is specifically targeted at supporting EEC development in the province. All of the industry-related water supply projects shown in Figure 3.2 are also destined to directly support the EEC development program. The other investments shown in the graph do not specify an EEC linkage, and for the purposes of this chapter, it is assumed that any support to the EEC program is peripheral to their main intended function.

3.3 Business as usual scenario for industry in Rayong

The analysis in this section draws from the Rayong Industry baseline report, and also uses the work done during the second workshop (impact assessment workshop), as inputs. It reports on a business as usual (BAU) scenario, where the influence of the RPDP is not included, and provides analysis to 2040, in line with current long-term (20 year) planning precepts in Thailand. The BAU scenario also sets the EEC plan aside and just projects forward the conditions, trends and management approaches drawn from the recent past in Rayong without assuming the EEC developments will proceed.

3.3.1 Industrial growth

Industry in Rayong has grown rapidly over the last two decades, however in the absence of external stimulus in the form of government incentives, strategies and support this growth rate is likely to slow in the future. There has already been a recent slow-down in industrial growth in Rayong, as identified in the industry baseline assessment. This slowdown in growth can be seen in Figure 3.3, which shows the cumulative capital investment between 2009 and 2019. The data in Figure 3.3 is supported by a flattening in growth in land use for industry over the same period. These trends in industry also align broadly with a decline in industrial growth rates nationally.[4]

[4] World Bank, 2019, World Development Indicators Database, broadly, since the Global Financial Crisis the industrial sector in Thailand has been on a lower growth trajectory than prior to the crisis. This has perhaps been compounded by other factors such as domestic political instability, sluggish demand in high income countries and competition from development of the industrial sector in regional competitors (such as Vietnam and China).

The cause of the slowdown in Rayong's industrial growth is related to a flattening of investments in the investment in the petrochemicals subsector. Likely causes of declining investment in Rayong's petrochemical sector are

(i) Natural s-curve attenuation of these older industries, and national focus on launching newer and high-tech industries are seen as a way for Thailand to avoid the so called "middle income trap",
(ii) Declining availability of domestic natural gas from the Gulf of Thailand, which is contributing to the decline in competitive advantage for Rayong's petrochemical industries (although the availability of 84% of Thailand's gas separation capacity highlights that Rayong's competitive advantage has not been eliminated), and
(iii) Other countries in the region increasing their domestic oil refining industries and growing their own petrochemical industries.

It is also reasonably likely that the decline in investments in petrochemicals has had both direct and in-direct flow-on effects on other industrial subsectors. For example, Figure 3.3 shows that, apart from a single large period of investment in the electricity, gas, steam and air-conditioning subsector around 2016 and 2017[5], the majority of growth in capital investment in the last 5 years has been in what is classified in this SEA as "other industry". The reason for separating the investment in small power producer (SPP) power plants is that as an energy hub for Thailand, the economic influences on Rayong's power/energy sector are distinct from those in other sectors.

The slowing growth rate does suggest a stagnation in industrial investment. This stagnation means that without policy and government intervention, industry will tend to remain in its current configuration with a strong emphasis on heavy low value-added industries like oil refining and petro-chemical industries with all its environmental challenges. With no structural change in industry projected under the BAU scenario, combined with a declining competitive advantage in these heavy industries like petrochemicals, the slowdown in industrial growth observed over the last 5 years is likely to continue (i.e. the industrial sector will continue to grow in Rayong, but at slower rates. Because of decreasing investments, more new industry will be small scale, and likely to be located outside industrial estates (IEs). Those BAU trends will have significant sustainability implications because smaller scale projects attract less environmental scrutiny and IEs have tighter environmental controls and enforcement mechanisms than those applied outside IEs.

[5] This was a series of SPP power plants that form a part of the power/energy investments in the province

Figure 3.3: Cumulative investment capital by major subsector by value (1989 - 2019)

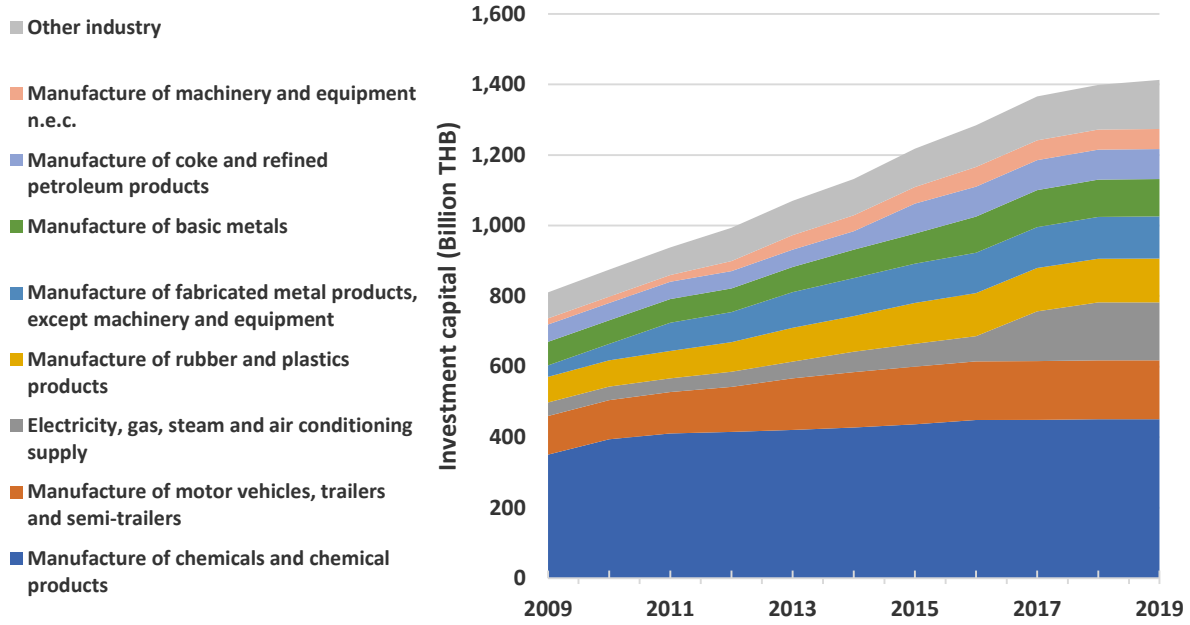


Figure: ICEM and data source: Rayong Provincial Industry Office (2019)

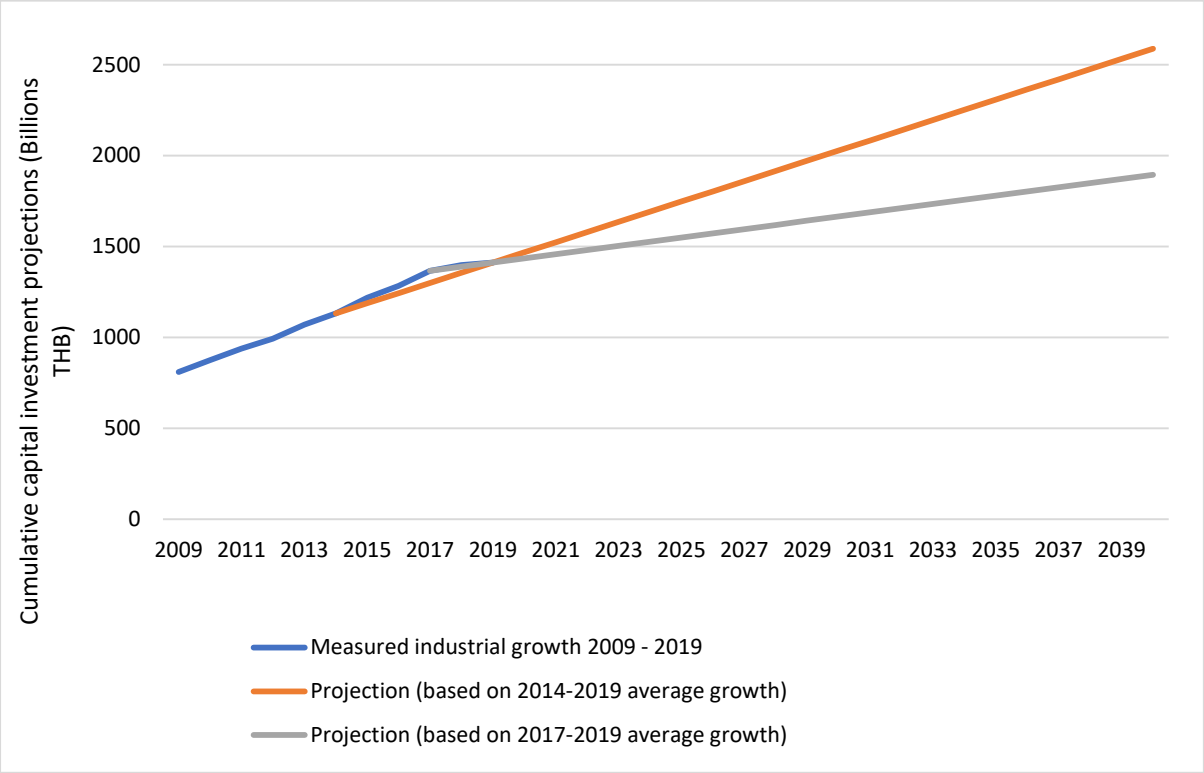
Figure 3.4 shows that the main areas of industrial growth in Rayong over the last decade have been:

(i) Other industry;[6]
(ii) Manufacture of machinery and equipment;
(iii) Manufacture of coke and other refined petroleum products;
(iv) Manufacture of basic metals;
(v) Manufacture of fabricated metal products;
(vi) Electricity, gas, steam and air conditioning supply.

Forward projections of the BAU over the next 20 years are somewhat complicated by the inflection point around 2016/17 that can be seen in both Figure 3.3 and Figure 3.4. While it is indicative of a general slowdown in industrial development, it may include some elements related to data. For this reason we take the average growth over the last five years for the whole sector and project this forward for the BAU scenario. From 2014 to 2019 cumulative capital investment grew from 1,130 Billion THB to 1,410 Billion THB. The average annual capital investment over this 5 year period is ~56 Billion THB. In comparison, if we only look at the inflection point forwards, we see an annual average capital investment of just 20 Billion THB. These projections are shown in Figure 3.4:

[6] "Other industry" refers to industry relating to textiles, clothing, wood, leather, pulp and paper, food and beverage production as well as machinery installation and repair, pharmaceuticals and warehousing.

Figure 3.4: BAU scenario projections for industrial growth up to 2040



The two projections for industrial growth shown in Figure 3.4 are the projected upper and lower bounds for industrial growth in the BAU scenario.

3.3.2 Increased industrial pollution

There are a number of factors under the BAU scenario that will influence the levels of industrial pollution over time. The detail is provided in the industry baseline chapter, however, the main factors are:

(i) Continued expansion of the industrial sector (although at a slower pace);
(ii) Lack of adequate standards and control mechanisms to address water, air and terrestrial pollution;
(iii) Illegal emissions of wastewater as well as illegal dumping of solid and hazardous waste;
(iv) Overlapping reporting lines and inadequate capacities for environmental management agencies;
(v) Inadequate autonomous action by industry to address pollution issues;
(vi) National government programs to encourage and promote re-use and recycling of waste.

Past and current efforts to address waste generation per unit of industrial activity are minimal, especially when the magnitude and severity of the situation is considered. For example, the re-use and recycling programs are mainly targeted at domestic and municipal waste rather than industrial waste. Thus, under the BAU scenario industrial pollution emissions (to air, water and land) are projected to continue on trend with growth in the industrial sector. The environmental impacts of industrial pollution are not addressed here, but are considered in the environmental quality impact assessment.

3.3.3 Industrial resource use

Energy efficiency in Rayong can be estimated by comparing industrial growth rates with growth rates in energy use and water consumption. Table 3.1 shows the growth in consumption of these resources during the ten years from 2009. For industrial water consumption, water supplied by East Water is

used as a proxy as direct figures for industrial water consumption were not available. That will lead to an underestimate of consumption for the period because some enterprises also use ground water.

Table 3.1: Growth in industrial consumption of energy and water resources in Rayong

	Energy Use*	East Water supplied water (millions of cubic metres)**
2009	7.5 TWh	230
2016		300
2017	10.75 TWh	
Annual percentage increase	**5.4%**	**4.3%**

** Energy Use and Land Area Used data come from the industrial baseline chapter of this SEA*

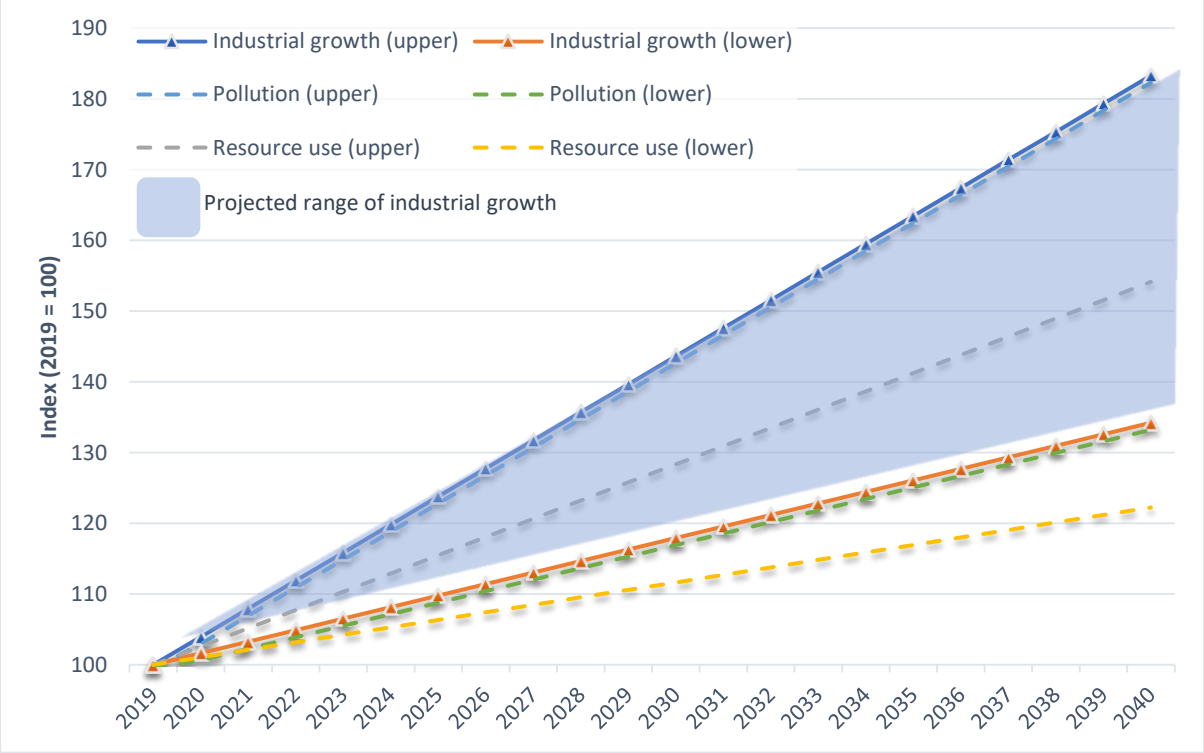
*** Data for East Water supplied water comes from the water resources baseline chapter of this SEA*

Averaging the annual growth rates from Table 3.1 shows that resource use in Rayong has grown at around 4.9% per year for industry. In comparison, cumulative capital investment grew from 810 Billion THB to 1,410 Billion THB. This equates to an annual growth rate of around 7.5% per year in capital investments in Rayong. Those comparative figures indicate that resource use in Rayong is becoming more efficient i.e. that increases in capital investment are not directly proportional to increases in resource use. In quantitative terms, resource use is growing at about 65% of the rate at which capital investment is growing.

3.3.4 Summary of BAU scenario

Industrial growth projections were calculated using a two year and a five year average, resulting in upper and lower projections for industrial growth. The BAU scenario does not include measures that will decouple industrial pollution from industrial growth, and thus pollution will track industrial growth over the next 20 years. Industrial resource use is not growing at the same rate as industrial investment, and thus resource use is projected to grow at 65% of the rate at which industrial investment (and industrial pollution) grow. Figure 3.5 graphs growth in industry against usage under the BAU scenario.

Figure 3.5: BAU projections for industrial growth, industrial resource use, and industrial pollution



Source: ICEM calculations

3.4 The impact of the RPDP

This section of the chapter examines the effects of full implementation of the RPDP on the three strategic issues of critical concern for sustainable development in Rayong.

3.4.1 Rapid Industrial Growth

The RPDP does not directly focus on the industry sector, despite a majority of funding being targeted to support the EEC development plan. The impacts of the RPDP on industrial growth in the Province are likely to be marginal because the infrastructure projects included in the RPDP are supportive of the EEC development plan but not driving or shaping EEC developments. For example, the RPDP includes over 8 Billion THB targeted towards road expansions, upgrades and repairs in support of EEC. However, in the case where the RPDP is fully implemented, but the EEC development plan is not, the RPDP infrastructure expansion would not be sufficient, in and of itself, to have a significant impact on levels of investment in the industrial sector in Rayong. Under this scenario, industrial growth will closely track that projected for the BAU scenario, because the RPDP only supports industry in a limited and indirect way.

3.4.2 Industrial pollution

The RPDP recognizes that industrial pollution in Rayong is a problem, particularly in areas where industrial development is dense, and adjacent to residential areas, such as is the case in Map Ta Phut. For example, the RPDP mentions both air quality near Map Ta Phut, as well as water quality issues in nearby areas, including issues relating to heavy metals and volatile organic compounds.

Despite the recognition of pollution as a problem, only 6 projects focusing on cleaner production processes address the industrial pollution problems. The total planned investment for these projects is 239 Million THB.

Consequently, projections conclude that the investments in the RPDP will have no significant impact on trends for industrial pollution to air, water and land.

3.4.3 Resource use in industry

Because the RPDP does not focus specifically on industry, full implementation will have relatively little impact on industry-related resource use. The area where there may be some impacts are in industry-related transport, however this is dealt with in the transport impact assessment chapter. The projects referred to in the section on industrial pollution are aimed at reducing industrial waste and pollution through enhancing efficiencies in resource use. Yet, implementation of these projects would have only a small impact on the amount of resources being used in industry.

Therefore, full implementation of the RPDP is projected to have no significant effect on industrial resource use trends.

3.4.4 Summarizing RPDP influences

Based on the analyses presented above, the SEA team conclude that full implementation of the RPDP will not have a significant impact on any of the three strategic issues of critical concern for sustainable industrial development in Rayong. Thus, the trend lines for these industrial issues will remain the same as those shown in Figure 3.5.

3.5 Other factors that influence sustainability in Rayong

The government in Rayong does not have control over or an influence on all development activity in the province. National line agencies have decentralized units within the Province which tend to function independently of the local authorities. For example, Map Ta Phut port is an industrial harbour owned and managed by the Industrial Estate Authority of Thailand (IEAT). It has direct authority over substantial areas of provincial coastal waters. Similarly the Provincial Electricity Authority (PEA) is a

central agency that has implementation (i.e. not decision-making) offices in Rayong City. Between 2015 and 2018 the total budget allocation to Rayong province doubled, but the budget for provincial and provincial cluster authorities only grew by 20%, with the remainder going to central agencies like IEAT and PEA.

The broader issues that affect industry-related sustainability in Rayong include:

1. Establishment of pollution control zones;
2. Energy efficiency and emissions reductions commitments (e.g. NDCs);
3. EEC and s-curve industries;
4. Continuing changes in the competitive environment for some types of heavy industry e.g. petrochemicals and possibly oil refining

3.6 Conclusions

Under the BAU, continued efficiency changes in industry are anticipated. Resource use will grow at a rate of about 0.65 times that of investment capital in industry. However, because of very limited initiatives to limit and reduce industrial pollution, pollution rates are expected to increase in line with industrial growth. On average, 10% growth in industry will be accompanied by a similar increase in levels of industrial pollution. The proportion of hazardous wastes within the overall industrial pollution loadings is expected to increase.

The RPDP includes very limited direct investment in the industrial sector, and is not expected to have any appreciable positive or negative affect on any of the three strategic issues of concern for industry.

The RPDP uses a project based approach to address provincial development. That means the Plan does not have significant scope to affect sustainability related change in industry. For the RPDP to achieve changes in this area its needs to address rules and regulations for industry operating in Rayong and their effective implementation and management. Currently those issues and responsibilities are largely mandated at the national level.

4 WATER

Strategic theme	*Strategic issues of critical concern for sustainable development in Rayong*
Water resources	• Water demand and supply • Water quality (surface and ground water)
The sustainable development objectives for water resources are: • Rehabilitate and manage river basins and water resources for ecological sustainability and environmental quality • Provide a secure supply of clean water that meets demand in each sector, within ecological limits, without causing conflict between different user groups or with neighbouring provinces. • Use water efficiently and equitably to eliminate wastage and reduce demand	

4.1 Introduction

Over the last 30 years, industrial growth has driven increasing water demand in Rayong and will continue to do so in the decades to come, particularly due to Rayong's central role in EEC development. Industrial expansion brings with it population growth – registered and unregistered – and continuing increases in household water demand, which is accentuated by increasing per capita consumption. Despite declining agricultural lands in Rayong, agricultural water usage is also increasing as a result of changing cropping patterns. Tourism too is growing, with rapidly increasing numbers and facilities all adding to increasing water consumption. Water supply and demand is becoming an increasingly complex issue in Rayong, with water authorities already initiating plans to pipe water from neighbouring provinces and even neighbouring countries, so that demand will be satisfied. Much less attention is being given to reducing demand, and to water conservation, recycling and efficient use.

At the same time, water quality in Rayong has been declining because of a variety of factors, including: (i) population growth and concentration increasing and intensifying the pollution loadings, (ii) poor domestic, commercial and municipal wastewater treatment, (iii) runoff of pesticides and fertilisers from agricultural lands, (iv) increasing industrial effluents and hazardous wastes, and (v) leaching of chemicals from illegally dumped hazardous waste, and from improperly decommissioned factories. Water quality trends are being exacerbated through unclear and unenforced land-zoning, by many factories located outside industrial estates, and with more factories being established in upper catchment areas near Rayong's northern border.

4.2 Summary of water-related aspects of the RPDP

While water is not identified as a key development issue in the RPDP, there are success indicators related to reducing wastewater consumption and efficient agricultural water management in irrigated areas. Additionally 76 out of 176 RPDP projects (40% of projects) are water focused, with a total cost of about THB 2.7 billion (around 15% of the RPDP budget). RPDP activities are split across the six RPDP development sectors and themes, as shown in Table 4.1: Water related projects in the RPDPTable 4.1.

Table 4.1: Water related projects in the RPDP

Development issue	Number of water-related projects	Cost (millions THB)
1. Agriculture	23	1,667
2. Tourism	0	0
3. Industry	3	160
4. Natural Resources	36	327
5. Quality of life	7	99
6. Competitiveness of commerce & services	8	486
Total	**76**	**2,739**

Source: ICEM, 2019 (based on data from the RPDP, 2018)

The three largest budget areas for water are (i) water supply, (ii) water diversion (both intra-basin and inter-basin transfers), and (iii) water transmission, which account for almost half (~THB 1.3 billion) of the proposed water focused expenditure in the budget (Figure 4.2). The next largest planed expenditure is for dredging. The RPDP includes 29 dredging projects across 4 different development objectives, with the projects generally referred to as *"water course restoration and rehabilitation"* which is a not an accurate descriptor for what is intended.

Table 4.2: Main water related activities in the RPDP

Main activities in the proposed projects	Cost (millions THB)
Village and municipal water supply	483.5
Water diversions	438
Water transmission systems	398
Dredging	309
Drainage improvements	260
Pumping stations	230
Floodgates and weirs	223
Water Management Koh Samet Island	130
Pumped storage in Prasae reservoir	100
Water treatment	50
Bank erosion prevention with concrete	45
Awareness raising, networking, youth training, participatory pollution monitoring	30
Wetland ecotourism development	23
Wastewater management in tourism areas	10
Monkey Cheeks	5.5
Ground water development	4
TOTAL	**2,739**

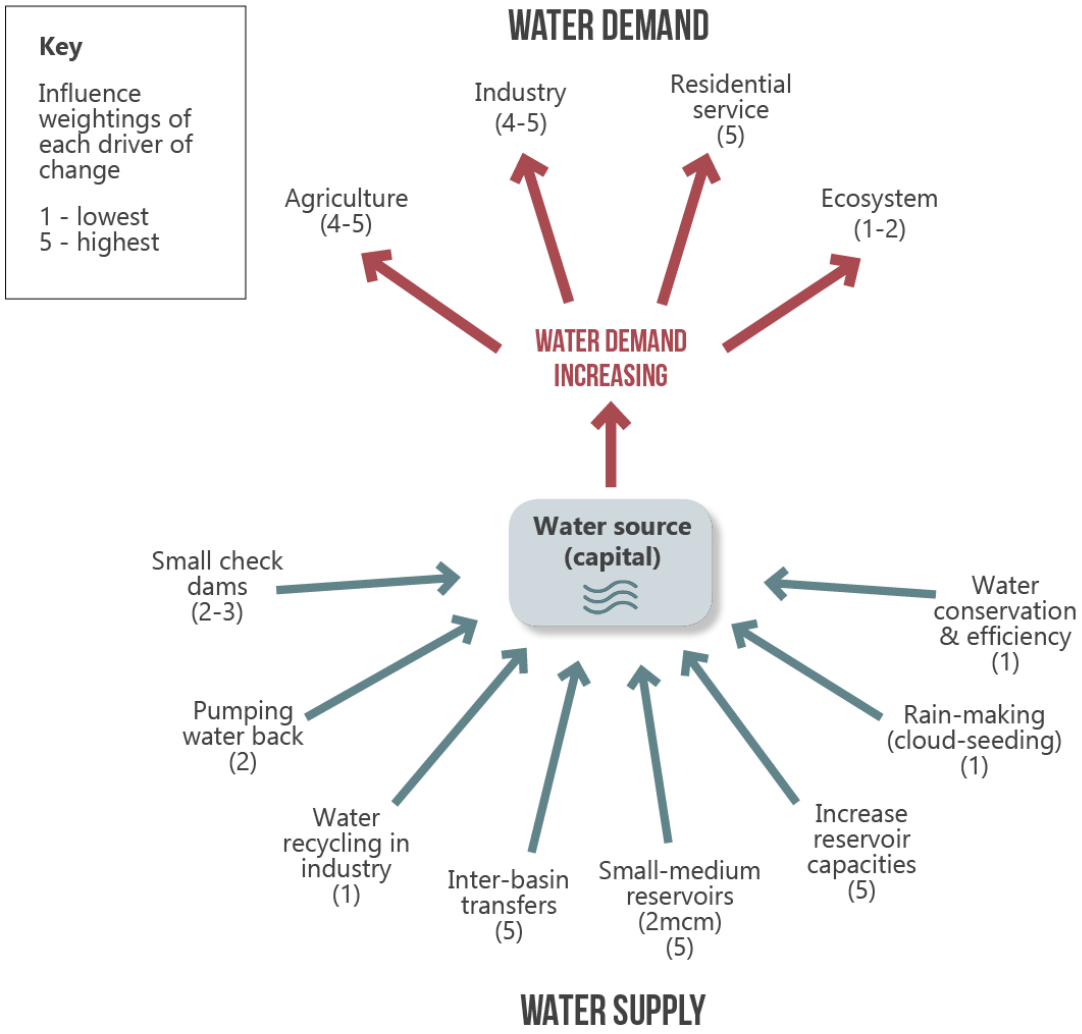
4.3 Water resources and sustainability under the BAU scenario

The BAU scenario excludes any influences of the RPDP as well as of other policies and strategies that are yet to be implemented. The following sections consider the positive and negative influences of the BAU scenario on the key water resource related issues of strategic concern for sustainable development in Rayong. The BAU scenario is assessed against the sustainable development objectives defined for the SEA during the scoping phase.

4.3.1 Strategic Issue 1: Water Demand and Supply

Under the BAU scenario, there are a number of issues related to water demand and supply, which will have ongoing impacts on Rayong's future. Figure 4.1 scores the relative influence of drivers of change on demand and supply in the water sector, as identified by local stakeholders. The scoring reflects stakeholder opinion that industry, domestic and agriculture are the main consumers, while ecosystems has a low demand rating, which reflects the current lack of priority given to environmental flows and limited awareness of their importance. On the supply side, stakeholders identified increasing of reservoir capacity, the addition of a network of small to medium reservoirs and inter-basin transfers as the main sources. The ecological and social effects of inter-basin transfers have not been adequately assessed or considered by the Royal Irrigation Department (RID) or East Water.

Figure 4.1: Water demand and supply in the BAU scenario (as identified by local stakeholders)



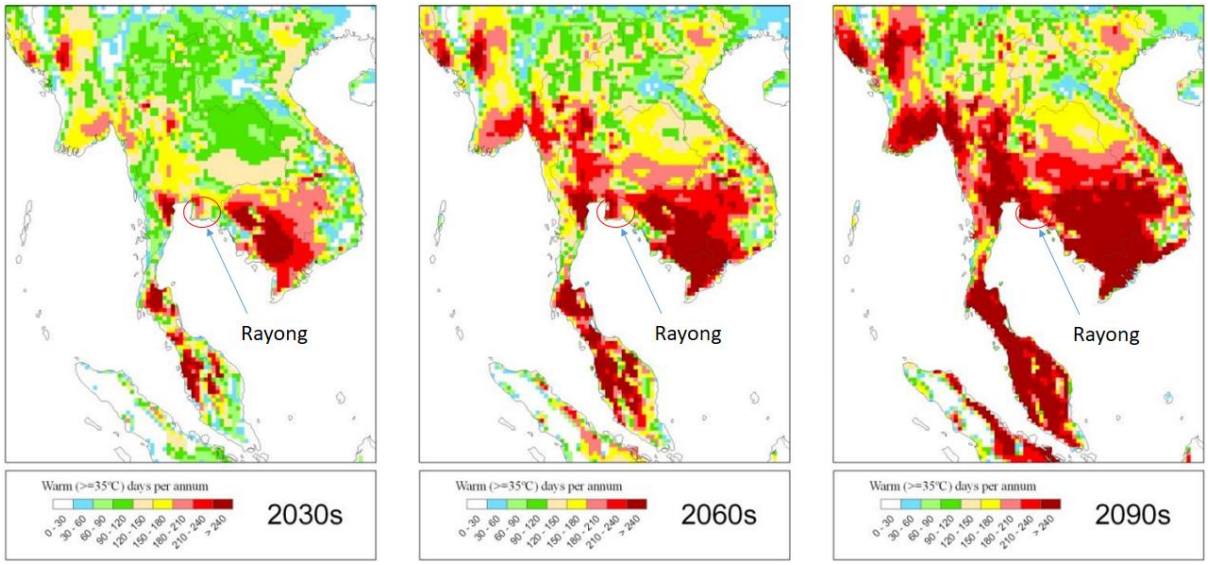
Industrial growth under the BAU scenario will be accompanied by high growth rates in industrial water demand, as well as growing residential and municipal demand. In the agricultural irrigated zone (~13% of Rayong's farmland), there will be increasing numbers of water intense plantations of crops like durian driven by domestic and international demand. There is also significant unmet demand, with farmers outside the irrigation zone suffering water shortages each dry season.

Environmental flows have not been seriously considered in Rayong. Environmental flows enable ecological functionality to be retained along the full length of the river system. For example, environmental flows help dilute pollution in lower stretches rivers, counteract dry season salt-water intrusion, and support aquatic biodiversity. Generally, in Thailand, environmental flows are calculated based on the minimum dry season flows. However, as outlined in the Water Resources baseline chapter, a more robust scientific approach to managing environmental flows is needed in Rayong. Currently, RID states that 7% of water releases from Rayong's reservoirs are allocated to environmental flows, although evidence would suggest that target is not achieved for most of the year. The figure seems to be calculated based on what water is available after industrial, domestic and agricultural demands have been satisfied. In contrast, a scientifically robust approach, based on

natural flow rate observations, would allocate around 20% of mean annual flow (MAF) for dry season flows.[7]

Linked to issues of environmental flows and the need to satisfy growing demand for water, climate change projections show overall declining rainfall, with longer dryer dry seasons (see the SEA climate change baseline assessment). Projections also highlight rising average and peak temperatures, including increasing numbers of "hot" days each year. For example, Figure 4.2 gives projections for a mid-range global emissions and warming scenario (ECHAM4 A2) showing the increasing numbers of days above 35^{0}C each year for the 2030s through to the 2090s in Thailand and surrounding areas. East Water and ONEP conducted a climate change assessment and found that the risk of drought in the near future is higher than the base year and the risk towards the end of the century is higher than that in the near future.[8]

Figure 4.2: A2 emissions scenario projection of numbers of "hot" days per year.



Source: https://unfccc.int/sites/default/files/sea_start.pdf

Higher temperatures are likely to drive up water demand from all sectors. For example, when it is hot crops need more water, and people drink more and bathe more. At the same time declining rainfall will decrease water availability. Increased demand, coupled with supply-related challenges will increase the likelihood of conflict between different water user groups (e.g. industry, urban dwellers and agriculture). Climate change will also exacerbate salt water intrusion into coastal agricultural areas, and may impact households and businesses that rely one shallow wells for their water. Some local stakeholders suggest that, with water scarcity, there will need to be investments in cloud seeding and artificial rain-making under the BAU scenario, and that this may somewhat counteract changing rainfall patterns.

To satisfy increasing demand, and to counteract changing rainfall patterns, RID and East Water are incorporating three main water supply extension strategies: (i) Increasing the capacity of existing reservoirs; (ii) Constructing new small and medium sized reservoirs; and (iii) inter-basin transfers.

[7] Mean annual flows and their relationship with conservation and preservation of ecological functionality and aquatic biodiversity are the basis of the Montana Method of calculating minimum flow rates. The Montana Method was developed by Don Tennant in the 1970s. More depth on this method is available in *Tennant, D.L., 1976. Instream flow regimens for fish, wildlife, recreation and related environmental resources. Fisheries, 1 (4), 6–10* The article can be found at: https://archive.org/details/instreamflowregi1975tenn/page/n1

[8] http://www.onep.go.th/climatechange/ index.php/about-east-5

Emphasis has been on continuing to satisfy demand rather than seeking to reduce demand and to promote recycling and self-sufficiency. Encouraging, promoting and incentivizing demand side water management has not been the priority.

Over the last two years water storage in Rayong has been increased across 4 reservoirs by 100 million cubic metres (100 mcm). As part of satisfying future demand, between 2019 and 2021, RID and East Water plan the following increases totaling 107 mcm:

- Pumped storage at the Prasae reservoir of 50 mcm
- Pumped storage at Nong Pla Lai reservoir of 5 mcm
- Increased capacity of Khlong Luang reservoir of 27 mcm
- Increased capacity at Khlong Pan Thong reservoir of 20 mcm
- Increased storage at other small reservoirs 5 mcm

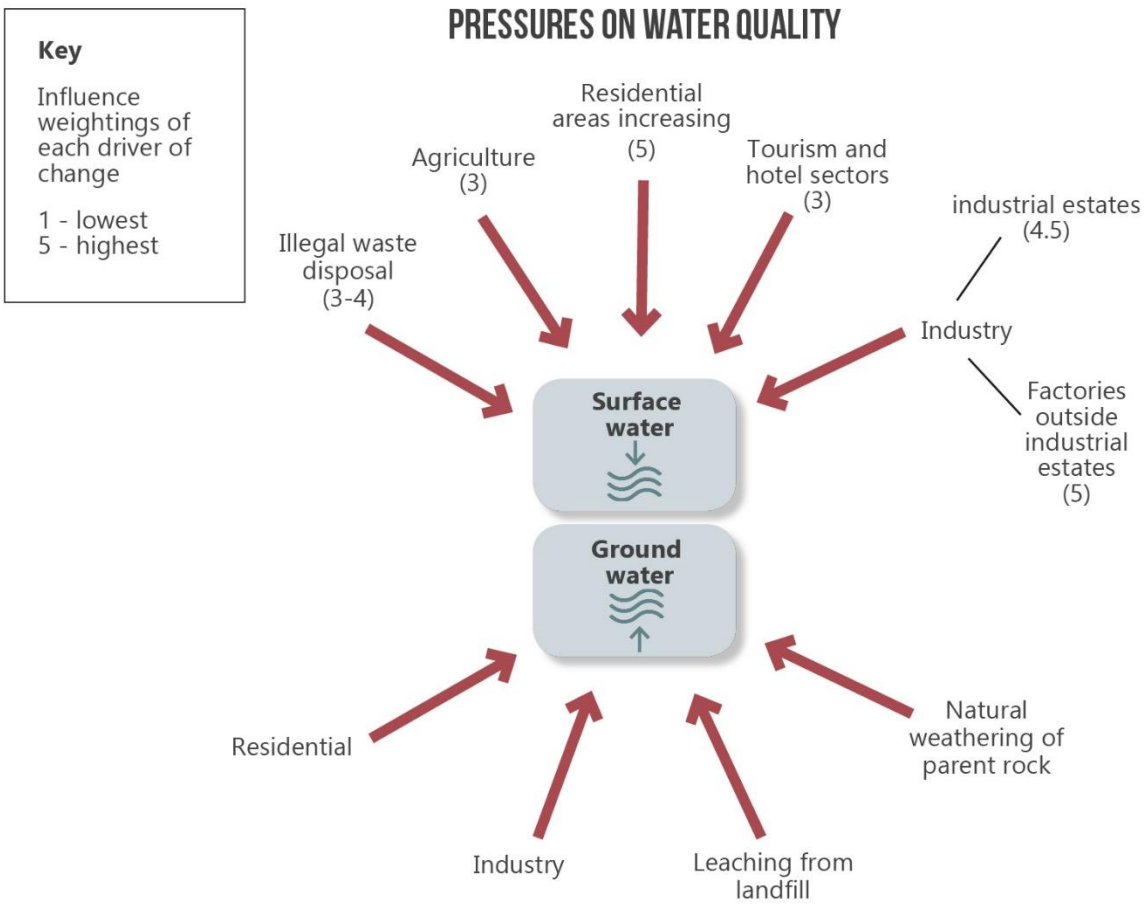
In addition, local stakeholders anticipate creation of small check dams in watershed areas, as well as construction of pumped water storage systems.[9] Only small increases in the use of groundwater are anticipated under Rayong's BAU scenario.

4.3.2 Strategic Issue 2: Water Quality

Stakeholders identified industry outside industrial estates and domestic sources as the main contributors to reducing water quality under the BAU scenario (Figure 4.3). Leaching from landfill and industry were identified as the most significant sources of ground water contamination.

[9] Pumped water storage is typically a small scale water storage solution, where water is pumped out of a waterway and stored in a tank, pond or dam. From the storage point, the water may either be pumped or gravity fed for irrigation or other purposes.

Figure 4.3: Water quality in the BAU scenario



Generally, under the BAU scenario, strategies for addressing pollution to water are not countering negative trends. Factories located outside industrial estates tend to have higher pollutant emissions than those inside industrial estates where there are tighter environmental controls Industrial growth outside estates in Rayong's upper catchment areas are of particular concern. Domestic and municipal wastewater is also a major contaminant of surface water. Municipal wastewater treatment systems are operating at around 5% of their capacity, and domestic septic systems are often non-functional or only partially functioning. Under the BAU scenario, surface and ground water pollution will continue to increase.

Illegal waste disposal in water courses is a growing source of water contamination, and agriculture is an important non-point pollution source due soil erosion and run off of agricultural chemicals. Agricultural encroachment within reservoir buffer zones and along river courses is contributing to algal blooms and reduced water quality.

Ground water sources are being polluted by discharges from domestic and industrial sectors, as well as by leaching from landfill. Natural weathering of rock may also be a source of heavy metal contamination of ground water in Rayong (Figure 4.3).

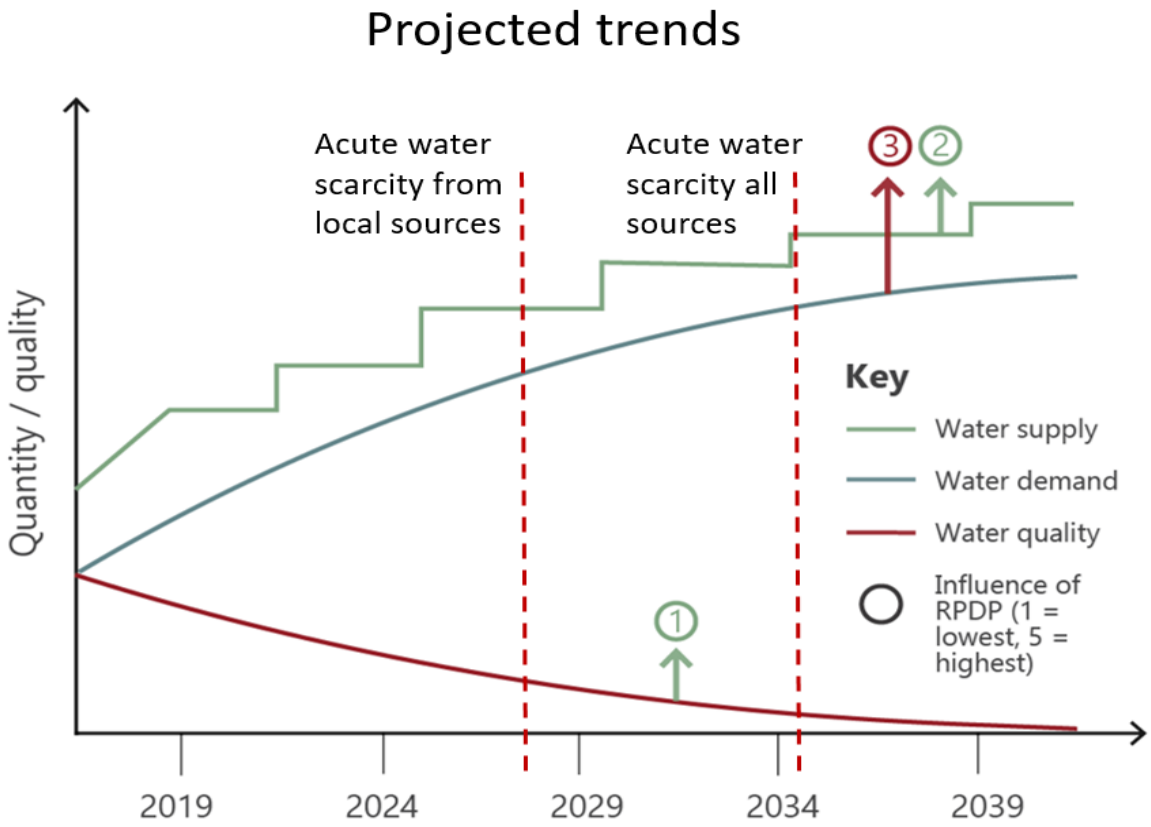
4.3.3 Summary of overall impact of the BAU scenario on sustainability in the water sector

Figure 4.4 shows stakeholder views on likely water scarcity points in the late 2020's and early 2030's due first to a failure of local water sources to meet demand and then a failure of local and external

sources to meet demand (see also Table 4.5 and Table 4.6 which reinforce the likelihood of water scarcity). Projections by RID suggest that demand will continue to be met to 2026 through the Department's plans to expand sources of supply (Table 4.3 and Table 4.4). Figure 4.4 also shows that while demand increases (also reflected in Table 4.3), water quality diminishes. The stakeholder scoring on the influence of the RPDP on demand and supply and water quality as shown in the Figure is considered in section 4.4.

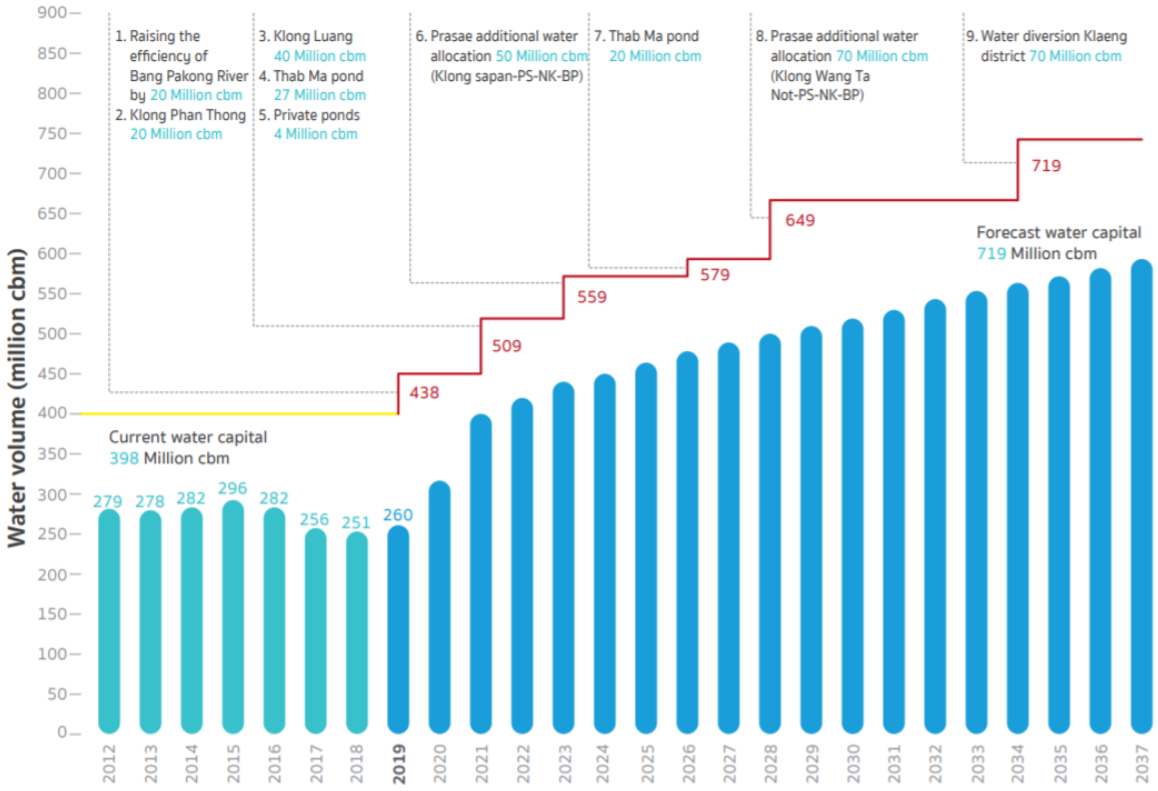
East Water also anticipates demand more than doubling to 2037 in the EEC region but projects that the measures identified in section 4.3.1 will keep pace over the next 20 years (Figure 4.5).

Figure 4.4: Overall BAU trends in water, as identified by local stakeholders



The BAU scenario does not include demand side management measures that might moderate water usage in Rayong. Further, the BAU does not promote recycling of waste water and self-sufficiency, complementary use of ground water, or establishment of desalination plants to bolster supply. Thus, projections including existing plans and strategies for water supply are likely to result in the province being faced with water shortages within the next ten years. Farmers outside the irrigation zone will continue to be concerned about their access to dry season water, and this could result in continuing conflict and dissatisfaction, exacerbated because of existing perceptions that RID prioritises water supply to East Water and industry and urban communities over the needs of agricultural water users.

Figure 4.5: East Water 20 year demand and supply forecast



Source: East Water, 2018, We see the future – smart water for all – Sustainability Report10

Finally, despite Thailand's national plans to address climate change[11] that include adaptation priorities relating to water provisioning for agriculture, regional and provincial level plans have not effectively taken climate change into account.

Table 4.3: Projected Water demand in Rayong for the BAU scenario (units = million cubic metres)

Sector/Year	2017	2021	2026
Residential	40.4	45.4	50.6
Agricultural	226	226	226
Industrial	305	335	369
Environmental	54	54	54
Total	**625.4**	**660.4**	**727.6**

Sources: RPDP 2018-2022, Provincial office of Agriculture and Cooperatives, RID, Provincial Water Authority and East Water

Table 4.4: Projected Water supply in Rayong for the BAU scenario

Sector/Year	2017	2019	2021	2026
Storage volume (mcm)	620	710	817	817

Source: RID planned water infrastructure development projects

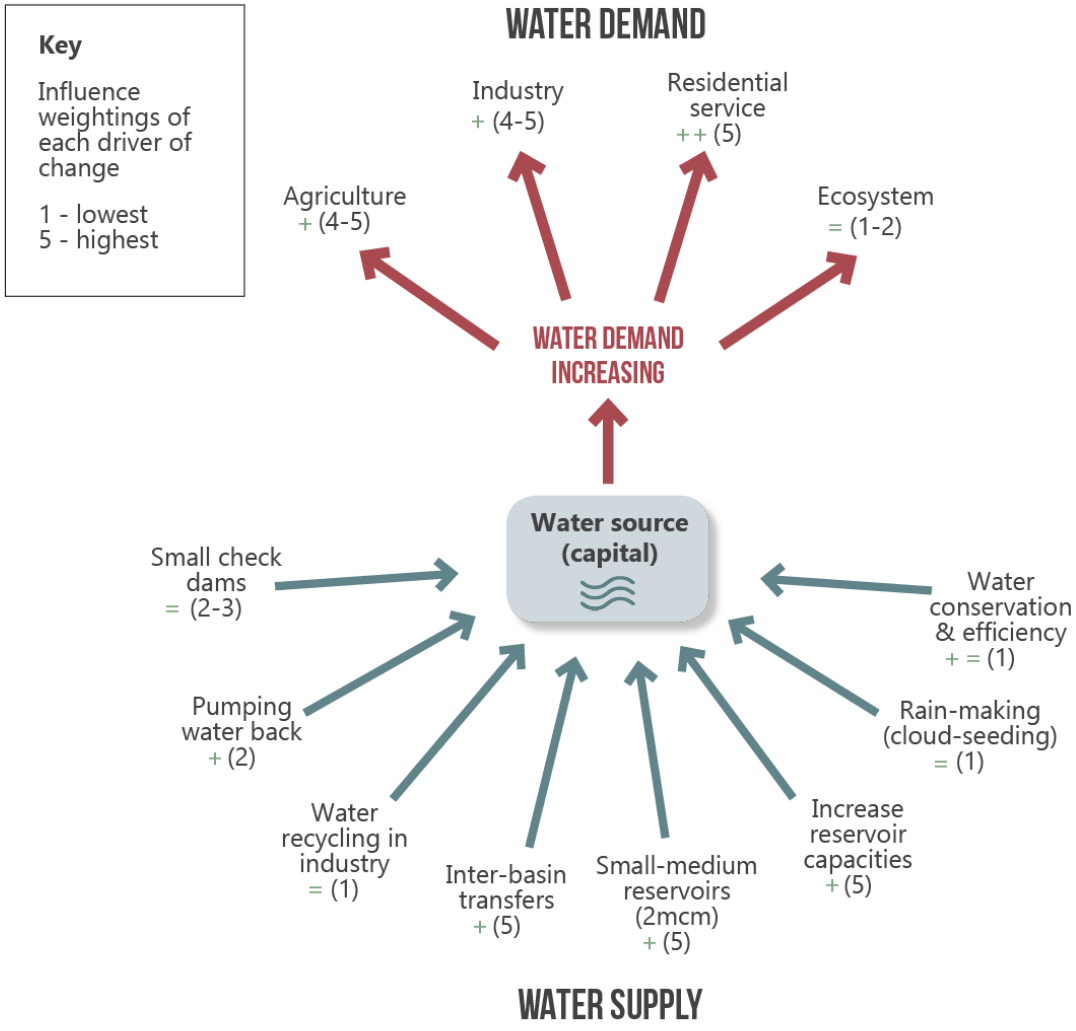
Water pollution will continue to increase driving down water quality. The lack of resourcing and capacity for monitoring and enforcement related to pollution will increase the challenges of addressing industrial, domestic, municipal and agricultural pollutants entering Rayong's waterways.

[10] Available for download from http://eastw.listedcompany.com/misc/sdr/20190401-eastw-sdr-2018-en-03.pdf
[11] E.g. Thailand's Climate Change Master Plan (2014-2050)

4.4 Impact of the RPDP on sustainability in the water sector

Under the full RPDP implementation scenario, SEA stakeholders consider that residential water demand will increase most significantly over the next decade as provincial population expands. Industry and agriculture water demand will also increase (Figure 4.6). On the supply side stakeholders consider that inter-basin transfers will need to be the most important addition source of water if current projected demand is to be met, because of a short fall in local supply.

Figure 4.6: Water demand and supply issues identified by local stakeholders under the RPDP scenario



4.4.1 Key Issue 1: Water Demand and Water Supply

If the RPDP were fully implemented, there would likely be increases above the BAU scenario for both water demand and available water supply. The main areas of the demand growth will continue to be residential, industrial and agricultural sectors (Figure 4.6).

For agriculture, the promotion of higher quality produce, including efforts to achieve certification for Good Agriculture Practice (GAP), is likely to intensify water demand. Thai GAP standards have been in place since 2005 to help Thai farmers become more competitive in global markets. This is particularly important because of stricter food safety requirements of major export markets such as the EU, as well as growing competition in other markets. GAP will specifically add to demand for contaminant free water that is becoming increasingly difficult to source in Rayong. Promotion and marketing

support in the RPDP for water intensive fruit crops such as durian is adding to agricultural water demand.

The RPDP includes some limited demand side management investment. For example, there are projects to promote new technologies and ideas such as the use of drip irrigation, which would lead to more efficient agricultural water use.

The main thrust of the RPDP is to support further industrial development in Rayong, with a focus on encouraging "greener" and more water efficient industries. However, the RPDP project content does not significantly influence industrial growth rates. Under the RPDP scenario, industrial growth will continue at the BAU rate, and will be accompanied by continued in-migration of workers to Rayong.

RPDP support for the tourism sector and for enhanced transport linking Rayong to Chonburi and Bangkok means accelerated tourism sector growth, which will drive up tourism-related water demand, as well as pollution related to tourism generated wastewater and solid waste that finds its way into waterways.

As a result, there will be an increased ecological demand for environmental flows under the RPDP scenario but without measures to accommodate it.

Full implementation of the RPDP leads to increased demand for water, with the gap between supply and demand narrowing (Table 4.5 and Table 4.6). If plans for inter-basin transfers from Chantaburi Province are disrupted by local community objections and opposition from the River Basin Organisation responsible for the basin where the Khlong Wang Tanote reservoir is planned, water shortages in Rayong would become critical by the mid to late 2020s.

Table 4.5: Projected Water demand for the RPDP implementation scenario (units = million cubic metres)

Sector/Year	2017	2021	2026	2031	2036
Residential	61	76	91	106	108
Agricultural	226	260	301	330	350
Industrial	305	395	476	524	561
Environmental	54	55	56	57	58
Total	**646**	**773**	**914**	**1,014**	**1,067**

Sources: Compilation and adaptation of figures from Provincial office of Agriculture and Cooperatives, RID, Provincial Water Authority and East Water. Water demand increase for environmental flows has been estimated by ICEM.

Table 4.6: Projected Water supply in Rayong for the RPDP implementation scenario

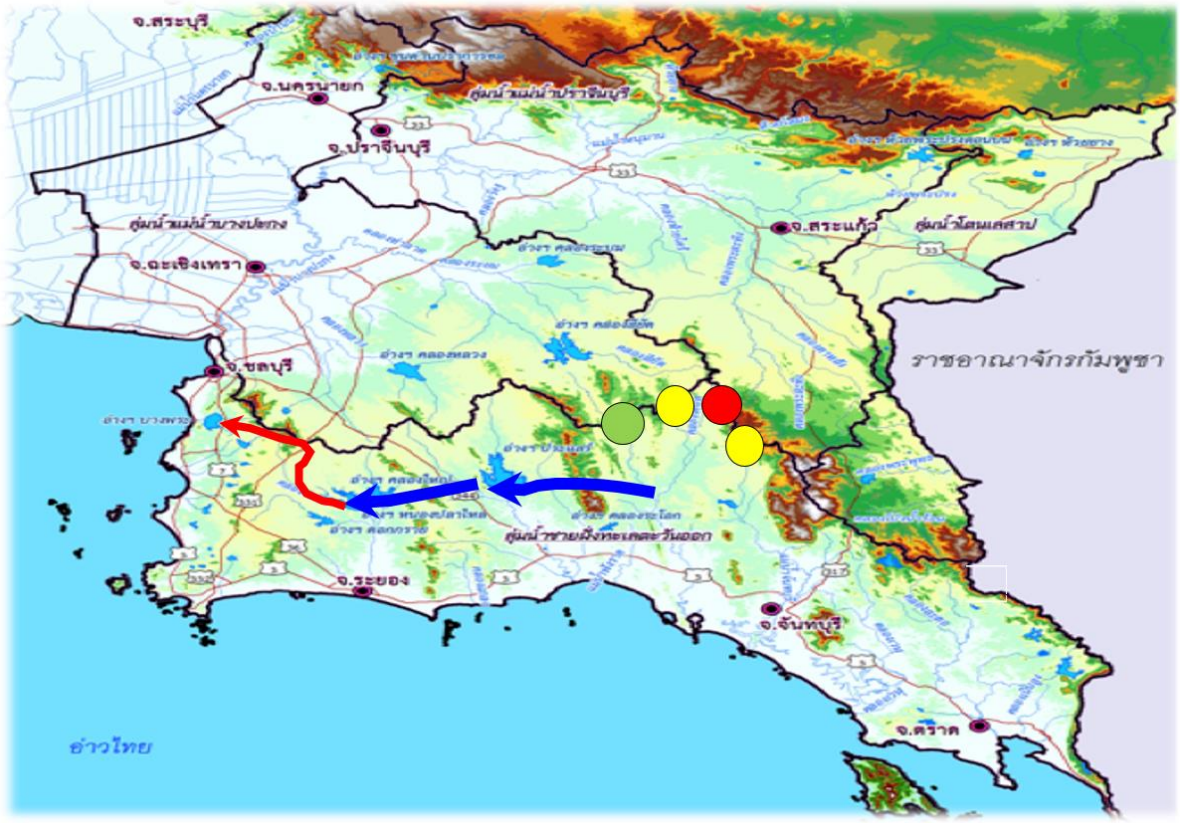
Year	2017	2021	2026	2031	2036
Water supply (mcm)	**644**	**817**	**994**	**1,006**	**1,006**

Source: RID Planned water infrastructure development projects and East Water planned projects

Establishing an inter-basin transfer from Khlong Wang Tanote reservoir faces significant political and environmental challenges, but if it were to proceed, the project would add around 100mcm/year to Rayong's water supply. The plan for this transfer scheme involves construction of four reservoirs in Chantaburi Province, which are being opposed by local residents, and for which there is still an incomplete EIA. If these major obstacles are successfully navigated, the water will need to be piped from Khlong Wang Tanote reservoir in Chantaburi, to Prasae reservoir in Rayong, and then piped from Prasae to Nong Pla Lai Reservoir, from where it would be distributed to various industrial and domestic clients and users through East Water. This planned inter-basin transfer will offset some of the water that is already being piped by East Water to Chonburi.

The reservoir locations and the necessary pipelines are shown in Figure 4.7. The blue lines represent the Khlong Wang Tanote to Prasae reservoir, and Prasae to Nong Pla Lai reservoir pipelines. The RPDP includes funding for the Prasae to Nong Pla Lai pipeline, with RID committed to funding the Khlong Wang Tanote to Prasae pipeline.

Figure 4.7: Four new reservoirs in Chantaburi Province, and Water Transfer to Rayong and Chonburi



Pipeline	Key
RID pipeline	
East Water Pipeline	

Reservoir¤	Storage·Capacity¶ (mcm)¤	Expected·completion¤
Praked¤	60.2¤	Completed¤
Pawa·Yai·¤	68.1¤	2021·¤
Hang·Maew¤	80.7¤	2021¤
Wang·Tanod¤	99.5¤	Awaiting·EIA¤

4.4.2 Key Issue 2: Water Pollution/Water Quality

With the increase in growth of residential areas and increasing tourism projected under full implementation of the RPDP, water quality will continue to decline. However the RPDP includes some projects on wastewater treatment, and "restoration" of waterways. These will not be sufficient to reverse the decline in water quality, but should slow the rate of water quality deterioration. Although if "restoration" refers to dredging water quality could be reduced during the operation. Figure 4.4 provides local stakeholder identified changes to the water supply and demand drivers under the RPDP scenario as compared to the BAU scenario.

4.4.3 Summary of RPDP impact on sustainability on the Water Sector

The RPDP vision and broad goals emphasise the importance of developing along a sustainable pathway. Yet, that vision is not reflected in the plan's actionable projects. For example, while water free of pollutants is one of the highest priorities for SEA stakeholders, only about 0.5% of the RPDP budget (THB 100 million) is directed towards water pollution issues, and climate change focused actions in the plan account for less than 0.05% (THB 7 million) of the proposed budget. In contrast, two thirds of the budget is allocated to transport related projects, largely highway upgrades (e.g. a Map Ta Phut bypass and road widening projects) driven by the EEC plans to support industrial development in Rayong.

4.5 Other factors likely to affect sustainability in the water sector in Rayong

Plans included under the EEC development banner will have a significant impact on sustainability issues for water. For example, under the EEC, demand for water will increase, not just to meet Rayong's growing needs, but also because EEC planning covers rapidly growing demand in two neighbouring provinces. East Water will source extra water from Rayong to pipe to clients in neighboring Chonburi Province, where demand will increase as a result of the EEC driven investments.

East Water expects that new customers (i.e. from new factories, commercial enterprises and urban areas) will require 60mcm/year by 2021, and 108mcm by 2026, on top of increases in water demand from existing clients. The other main water supplier in Rayong is the Provincial Water Authority (PWA). PWA projections under EEC development planning include an additional 143 mcm/year of water from Rayong's reservoirs by 2022, so they can support five water supply projects in Chonburi. The extra industrial demand in Rayong, plus the water expected to be provided to Chonburi, means that by 2022 water supply in Rayong will not be sufficient to meet demand.

For this reason, current planning involves looking beyond the EEC provinces of Chachoengsao, Chonburi and Rayong. This planning means diverting "excess" water from other water basins to meet the EEC's growing water demand, for both industrial and residential use. The Eastern Economic Corridor Office (EECO) is working with related agencies, primarily RID, to find more water sources in nearby provinces: Chanthaburi, Trat, Prachin Buri and Sa Kaew. In response:

- RID has committed 11.2 billion THB to build 16 new water supply projects in the three EEC provinces to boost the volume of available water by an additional 260.67 mcm, specifically to feed the industrial sector.
- Separately, RID is developing 10 new reservoirs in Sa Kaew, Chanthaburi and Trat, which are planned to have a capacity of 570 mcm.

Also, the Office of National Water Resources (ONWR) is coordinating with Groundwater Resources Department to tap more groundwater to meet the EEC's demands. Initial estimates indicate that the three EEC provinces have potential to access an additional 1.187 billion cubic metres of groundwater per year above current extraction of 1.31 billion cubic metres per year.

In parallel, under EEC auspices, there is a feasibility study being carried out assessing possibilities for water transfers from the Streung Manom River in Cambodia, with a capacity of 1,200 million cubic metres which would be piped to reservoirs in Trat province, and from there through another pipeline to Rayong's Prasae Reservoir.

4.6 Conclusions

4.6.1 Main positive effects of the RPDP

Setting aside social and ecological sustainability concerns, the parts of the RPDP that work well for improving trends in the water sector are the water infrastructure developments that will help maintain an adequate supply to meet growing demand. Yet, water is likely to remain a contentious issue under RPDP implementation, with farmers remaining unhappy with increasing water allocations to industry and urban areas, in their view to the neglect of agriculture.

4.6.2 Main negative effects of the RPDP

Support for industrial development and urban expansion in the plan will have negative impacts on the strategic issues of critical concern for water sector sustainability – water supply and water pollution. The large number of dredging and water diversion projects in the RPDP are likely to have negative impacts on freshwater ecosystems and aquatic species. Those effects have not been adequately assessed. The negative effects of RPDP developments on natural drainage corridors and water quality are not offset by practical commitments to improving environmental management capacities and enforcement. The new transitional spatial plan to be issued late in 2019 as an adjunct to the RPDP will provide more detailed prescriptions on zoning of land use, but the environmental safeguards associated with the new zoning scheme are either inadequate or unenforceable under current local

government capacities. Very little of the EEC Environmental Plan, prepared by the Ministry of Natural Resources and Environment (MONRE) and its Regional Environment Office, appears in the RPDP.

Most serious in the water sector is the very limited commitment to emphasising demand side management to restraint growth in water demand and to adopting more creative approaches to water supply especially by requiring an increasing proportion to come from recycling of waste water.

4.6.3 Gaps in the RPDP

The analysis of the RPDP highlights five main sustainable development related gaps which could be addressed during the mid-term review process for the plan, as well as in future iterations of the plan.

1. Overall the RPDP treats water as a resource. In doing so, it limits the possibilities for ecosystems-based approaches to managing rivers and wetlands, which are vital for sustainable and environmentally friendly water use. For example, the plan does not include any watershed management interventions apart from one very small tree-planting activity in the Prasae watershed. Apart from two projects for ecotourism development in wetlands, the RPDP does not provide any support for protection of natural wetlands or creation of new wetlands or for rehabilitating the Rayong River and other waterways, beginning with adequate provision for environmental flows.
2. Where erosion prevention has been identified as a need in the RPDP, reinforced concrete structures are the only proposed solutions. There has been no consideration of the benefits of nature-based alternatives. For example, the plan does not include any measures to incentivise farmers to respect river buffer and water body zones and to restore their riparian vegetation, which could have numerous co-benefits in addition to bank stabilisation and sedimentation reduction. Benefits could include providing feed for livestock and reducing run-off of agricultural fertilizers and pesticides into waterways.
3. The RPDP does not consider climate-smart development in relation to water resources and the projected reduction in water availability.
4. The RPDP does not include any significant measures to address the generation or treatment of pollution emissions that are currently degrading Rayong's waterways.
5. The RPDP has no substantive plans for demand side water management. For example, there is no support in the RPDP for introduction of more water-efficient forms of irrigation such as drip irrigation or sub-surface irrigation, or measures to promote the development of on-farm water storage.

A particularly serious omission is that development in Rayong is continuing largely in ignorance of the overall condition of surface and ground water systems through inadequate investment in monitoring, research and assessment. Those systems are degrading while decisions are being made with little understanding of the ecological and environmental quality consequences.

5 AGRICULTURE

Strategic theme	*Strategic issues of critical concern for sustainable development in Rayong*
Agriculture	• Transformation of the agriculture sector, including land-use change and shortage of agricultural labour • Securing water supply for crop production
The sustainable development objectives for agriculture are:[12] • Modernize the sector to international standards through sustainable production models for small-holders and commercial agriculture. • Farmers reduce environmental pollution, adopt sustainable land management practices and enhance biodiversity • Farmers build resilience to climate change through diversity in production and nature based solutions.	

5.1 Introduction

While the agricultural sector remains an important part of Rayong's cultural identity, the economic importance of the sector has declined from nearly 8% of GPP in 1995 to around 2% in 2016. Similarly, the proportion of people living in rural areas has declined rapidly. In the last fifteen years, the number of farming households in Rayong have dropped by 20%, and area under cultivation has declined by 13%. Farming income in Rayong has not quite followed those trends. From 2003 to 2011, farming income per household grew by a factor of 2.5, but since then has fallen dramatically. By 2016, average farming household income had dropped back to the same level it was in 2007 (around 400,000 THB per household per year).

Associated with changes in contributions to GPP and declining numbers of farming families and farmed area, traditional farming lifestyles are changing. The average age of farmers is increasing, largely because younger generations from farming families are seeking employment in urban areas. Thus, the agricultural sector in Rayong is increasingly dependent on migrant labour, especially rubber tappers from neighbouring Cambodia. However, following the principles of Thailand's sufficiency economy enunciated in the RPDP, the agriculture sector in Rayong should be fostered despite its declining economic importance. Aside from assuring diversity of income sources, fostering agriculture supports ideals of self-sufficiency as well as offering a safety net for out of work industrial labourers in the case of future global or regional financial crises.[13]

5.2 Summary of Agriculture-related aspects of the RPDP

The aspirational goal of agricultural development in Rayong as reflected in the RPDP is to develop high quality products through innovation and technology, and to value-add to agriculture produce, including through agro-tourism. This includes:

- Building sales networks for agricultural produce
- Seeking to add value to agricultural products through post-harvest processing and packaging
- Strengthening farmers groups and cooperatives
- Improving agriculture-related infrastructure
- Developing synergistic relationships with tourism and industry (agro-tourism, agro-industry)

[13] E.g. As outlined in the Agriculture baseline chapter, during the 1998 Asian financial crisis, the agricultural sector was able to absorb a large portion of those workers who lost their jobs in the industrial sector.

- Enhancing Rayong's natural resource base through rehabilitation (with community participation as a key element)

The RPDP includes around THB 2 million of funding for agriculture-related projects. Many of these are dredging projects that may achieve flood and water access related objectives in the short-term, but which are likely to result in damage to waterways and water quality that will impact negatively on the agricultural sector. The other concern expressed by farmers in Rayong, is that many of the larger water supply projects are intended to supply additional water for industry via East Water, rather than for agriculture.

The plan does include THB 87.5 million for projects including developing farmers' markets, monitoring of water quality, developing a sustainable agriculture database, supporting value-adding for agricultural produce, screening and testing of meat for improved quality, and for projects focused on use of (and training around) organic fertilizers and farming methods.

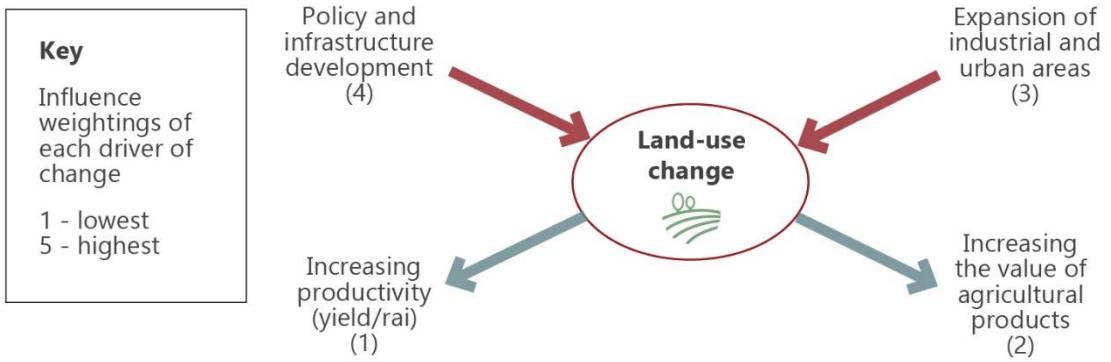
5.3 Agricultural sustainability under the BAU scenario

The key agricultural issues of strategic sustainability concern identified by SEA stakeholders are considered below under the BAU scenario.

5.3.1 Drivers of land-use change

Land-use change drivers, as identified by local stakeholders, are detailed in Figure 5.1. They identified two large forces driving land use change away from agriculture – expanding industry and infrastructure development – as well as two that will tend to retard land-use change trends. The two retarding drivers are increasing productivity (building on work done by the Rayong Agricultural Research Office), and increasing value of agricultural products because of factors such as GAP certification which will allow farmers to sell their produce to more exclusive markets.

Figure 5.1: Land-use change drivers under the BAU scenario, as identified by SEA stakeholders



Source: ICEM (from Impact Assessment Workshop, SEA of Rayong Province, 2019)

The SEA team further elaborated on the issues identified in Figure 5.1, highlighting six main drivers shaping land use in Rayong and their positive or negative influence on sustainability (Table 5.1).

Table 5.1: Drivers of land use change relating to agriculture in Rayong under the BAU scenario

Drivers and assumptions	Direction of influence on sustainability
Rayong is known from its agriculture research stations, which will continue to develop improved crop varieties that produce higher yields (such as cassava varieties that have been very successful in the past). These research centres are continuing to develop	↑ +ve

Drivers and assumptions	Direction of influence on sustainability
improved agricultural technologies to be shared with farmers through extension and trials.	
Demand for fresh and frozen produce from Thailand (e.g. Chinese demand for Thai durians), as well as for processed foods (e.g. canned pineapple) is growing. Despite those trends, occasional downturns should be expected as a result of vagaries in international markets and exchange rates.	 +ve
The training of farmers in Good Agriculture Practice (GAP) to achieve GAP certification has already started in Rayong. This process will continue under the BAU scenario. GAP certification will increase access to markets which demand certifiable quality standards and are prepared to pay for it.	 +ve
Improving transport corridors will make it faster and cheaper for farmers to get their fresh produce to markets and processing plants. This is likely to support farm related incomes, and is likely to be an incentive for farmers near relevant transport corridors not to sell their land	 +ve
Industrial and residential land areas will continue to grow under the BAU scenario, raising land prices and encouraging the conversion of agricultural land.	 -ve
New cities and infrastructure such as roads, railway lines, as well as expansion of airports and seaports will create additional pressure for converting agricultural land. There are approved plans for development of significant transport infrastructure in Rayong (e.g. Map Ta Phut port facility expansion, and work underway to widen Rayong's highways) and the Rayong transitional spatial plan includes transport corridors and expanded areas for development centres and zones.	 -ve

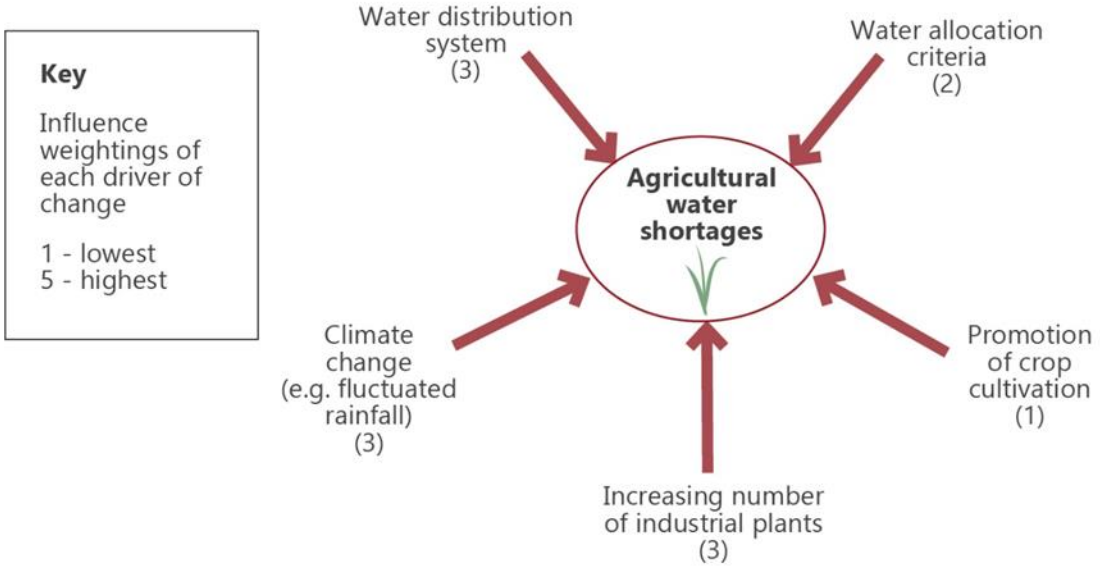
Improving productivity through improved crop varieties and certified produce standards will support increased incomes for farmers. Those factors may encourage farmers to retain their land. However, there are risks associated with those positive drivers which need to be carefully managed. For example, if productivity increases faster than demand, oversupply could mean prices drop. Also, if improved crop varieties require increased inputs such as fertilizer and labour, this could outweigh financial benefits.

It seems inevitable that expanding industry, populations, urban areas and alternative employment opportunities will tend to increase the rate of land use change, as will planned infrastructure developments. Overall, the factors driving land use change will have a stronger influence than the factors retarding land use change. Further declines in farmed area and in numbers of farming households can be expected.

5.3.2 Water shortages for crop production (BAU)

SEA stakeholders identified a number of drivers of agricultural water shortage (Figure 5.2). Water allocation between agriculture and industry is a major concern for farmers in Rayong. Also, there are mounting concerns that climate change impacts will exacerbate water shortages, with promotion of fruit cultivation likely to add to agricultural water demands.

Figure 5.2: Drivers affecting the trend in water shortage for agriculture under the BAU scenario, as identified by SEA stakeholders



Source: ICEM (from Impact Assessment Workshop, SEA of Rayong Province, 2019)

The issues identified by stakeholders in Rayong are detailed in Table 5.2.

Table 5.2: Drivers of agricultural water shortages under the BAU scenario

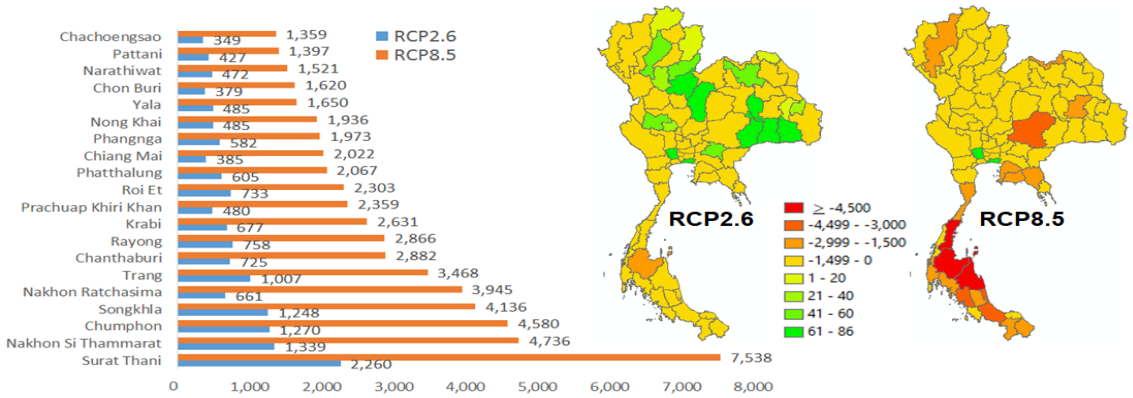
Drivers and assumptions	Direction of influence on sustainability
Limited coverage of irrigation in Rayong. Farmers outside of the irrigation zone are primarily dependent on rainfall for irrigation, although some farms located near waterways are able to pump water. There is limited groundwater use for irrigation although some farmers are dependent on this source.	↓ -ve
Where water for irrigation is distributed through canals, evaporative losses are significant.	↓ -ve
When there are water shortages, allocations of water to industry are prioritized over allocations to agriculture	↓ -ve
GAP certification requires access to unpolluted water – which is becoming increasingly scarce for farmers	↓ -ve
Promotion of water intense crops such as durian is creating additional demand for water in the agricultural sector	↓ -ve
Climate change projections are showing decreasing rainfall, and longer and dryer dry seasons	↓ -ve
Another climate change impact will be sea-level rise. Sea-level rise will only have a minor reducing influence on agricultural access to water over the next 20 years	↓ -ve
Lack of enforcement of regulations designed to ensure that farmers outside the irrigation zone develop their own water storage systems means that these farmers will face increasing water shortages with longer and dryer dry seasons	↓ -ve

Even in the irrigation zone, where water is distributed through canals, evaporative losses are significant. Only 13.5% of Rayong's agricultural area is irrigated. The BAU scenario does not include plans to expand the irrigated area, and this issue will continue to be a bone of contention for affected farmers. Apart from farmers whose lands are adjacent to waterways, all farmers outside the irrigated zone are dependent on rainfall. There is limited use of groundwater for agriculture, and farmers outside the irrigation zone face water shortages during the dry season. This limits the crops they can

grow. For example, high value fruit crops like durian which is actively promoted in the province, require significant dry season watering. Under BAU agricultural demand for water will increase.

Climate change will become a key factor likely to intensify water shortages in Rayong as reflected in the SEA baseline assessment. It will result in increased variability of rainfall, including longer and drier dry seasons and shorter more intense monsoons. The number of very hot days will increase. For example, under high global emissions pathways, the number of days with temperatures over 35°C is likely to increase from the current 50/year to around 120 very hot days per year in the 2050s.[14] Additionally, more intense storms along the gulf of Thailand are likely to have an impact on agricultural especially during the flowering and fruiting periods. Vulnerability of agriculture to climate change varies according to crops, crop varieties, as well as location and soil characteristics. However, forward projections based on current agricultural practices and cropping patterns show that agricultural losses in Rayong over the period 2011 – 2045 due to climate change will be in the $750 million to $2.9 billion range (Figure 5.3).

Figure 5.3: Accumulated provincial level cost of climate impacts on agriculture (2011-2045) (Millions US$)



Source: Attavanich (2018), available at: https://mpra.ub.uni-muenchen.de/90255/1/MPRA_paper_90255.pdf

Limited environmental flows in Rayong's rivers, in combination with climate change induced sea level rise will increase the inland reach of salt water intrusion into water courses and ground water, affecting agriculture in the coastal areas. In the medium term, only small areas of agricultural land would be affected. In the longer term, sea-level rise could lead to substantial impacts, with significant reductions in fresh water availability for agriculture.

Lack of effective regulations and enforcement around water management outside of the irrigation area is hampering responses to current and future water shortages. Farmers are not required to develop their own on-farm water storage ponds, rain-water harvesting systems, or to employ water conservation techniques in their crop growing.

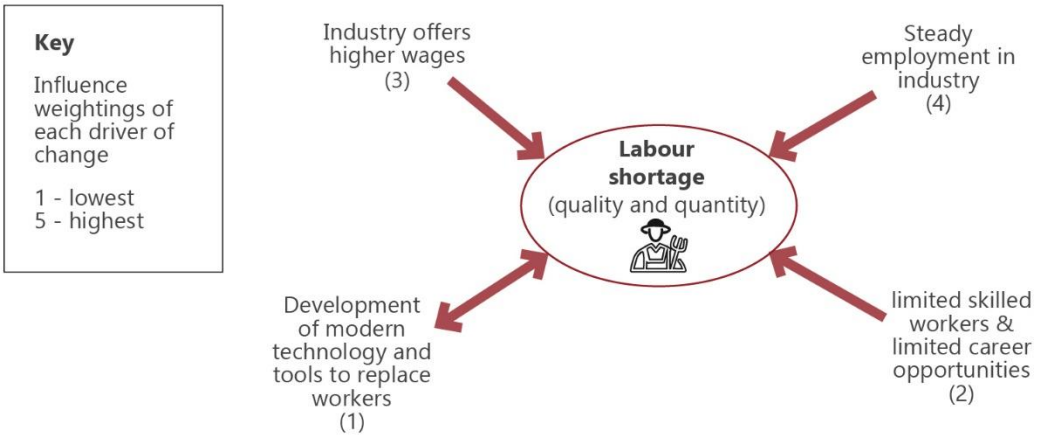
5.3.3 Labour shortage in the agricultural sector under the BAU scenario

SEA stakeholders identified four main drivers of labour shortages in Rayong's agricultural sector (Figure 5.4). They relate mainly to competition between the industrial and agricultural sectors. New technology and mechanization in agriculture has a two-edged influence. While mechanization can replace some works, thereby reducing labour shortages, the expense of investing in technology and

[14] SEA-START (2011) Downscaled Climate Change Projections for Chanthaburi and Trad Provinces. Unpublished report for the EU-IUCN Building Coastal Resilience Project for Thailand, Cambodia and Vietnam. SEA-START Regional Centre, Chulalongkorn University.

mechanical assistance means it is only an option for larger farms that have available capital and appropriate economies of scale.

Figure 5.4: Agricultural labour shortage drivers under the BAU scenario, as identified by SEA stakeholders



5.3.4 Summary of impact of the BAU scenario on sustainability in agriculture

Under the BAU scenario, the trends in the number of farming households, and the area of land farmed, are likely to continue to decline. Assuming commodity prices remain low, income from farming will also continue to decline with patchy success stories based on successful marketing of high priced produce. With falling income and rising land prices, more farmers are likely to sell their land. While much of the land will go to expanding residential and industrial areas, some may be purchased by larger farmers who, because of economies of scale, are able to invest in mechanized technologies, and to take advantage of new trends such as agro-tourism.

Farmers in unirrigated areas are reporting water shortages, especially in the dry season. That situation can only become more severe with climate change. Contamination of sources of agricultural water is also limiting options and opportunities associated with GAP certification, a trend likely to become more serious under the BAU scenario.

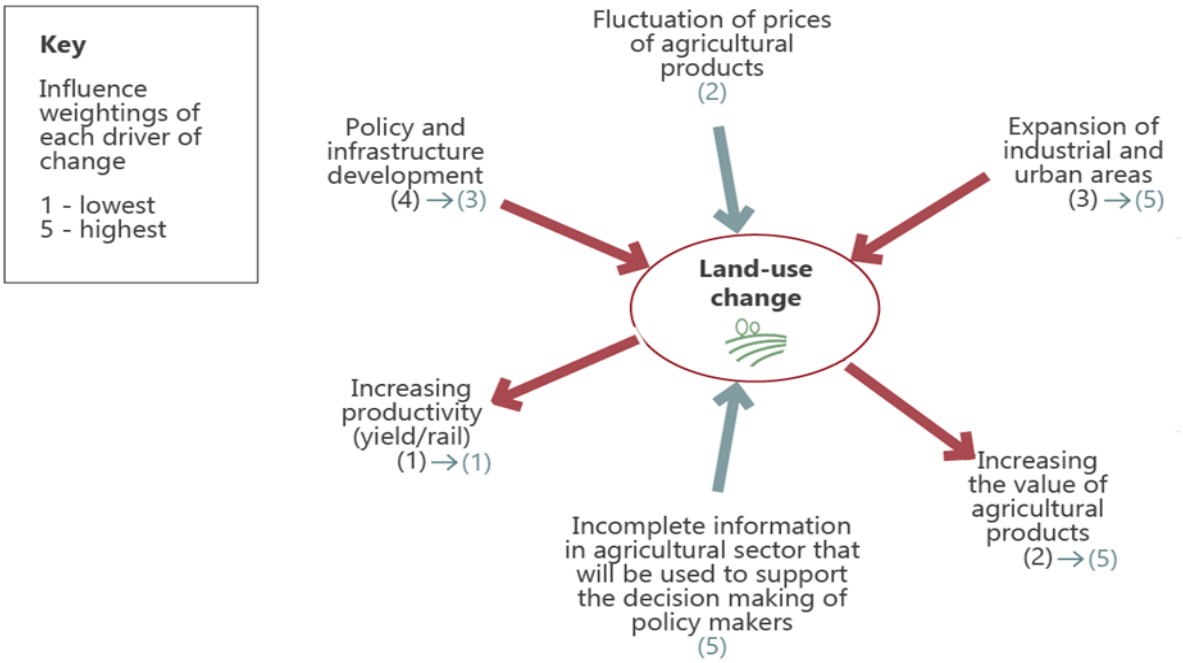
Farmers will continue to plant crops that they believe will offer the greatest returns. Their choices will continue to be influenced by their peers, by advertising and marketing from seed, fertilizer and agri-chemical companies, and by the advice from agriculture extension offices. Currently, those influences and advisory services are creating uncertainty and a relatively haphazard approach to farm management which is likely to continue for the foreseeable future.

5.4 Impact of the RPDP on sustainability in agriculture

5.4.1 Land-use Change

SEA stakeholders identified how full implementation of the RPDP would influence the drivers of land use change defined in the BAU scenario (Figure 5.1). Figure 5.5 shows those additional influences in green scores. Expansion of industrial and urban areas is viewed as a more severe negative influence on agricultural sustainability under the RRPD than for the BAU. On the other hand, the potential increasing value of farm produce is much more significant with the RPDP. SEA stakeholders identified two additional drivers under the RPDP scenario which negative affect the sector. They are the lack of monitoring and evaluation data available to decision-makers when shaping agricultural policy and management strategies, and the fluctuation of prices for agricultural products placing farmers at risk. There are inadequate measures within the RPDP to support and advise farmers in reducing that price volatility risk (Figure 5.5).

Figure 5.5: Changes in land-use change drivers under the RPDP scenario, as identified by SEA stakeholders



Note: *Arrows in green indicated factors that SEA stakeholders considered as additional areas of concern in the scenario with full implementation of the RPDP*

Table 5.3 provides more detail on the drivers of change influencing land use under the RPDP scenario.

Table 5.3: Changes to drivers of land-use change (RPDP)

Full RPDP implementation scenario - changes from BAU	Direction of influence on sustainability
Increasing tourism in Rayong will encourage the expansion of local produce markets and maintenance of this traditional heritage sector. This will benefit farmers, and slightly reduce incentives for them to sell their land.	↑ +ve
Transport infrastructure development will give farmers more ready and cheaper access to markets	↑ +ve
Additional transport infrastructure could increase land value in affected areas, encouraging farmers to sell their land.	↓ -ve
Increasing productivity and increased value of agricultural products because of investments in organic farming methodologies and other value-adding mechanisms will tend to maintain the sector and existing land uses	↑ +ve
Development measures in the RPDP are defined in an information scarce environment. Therefore measures do not effectively meet all stakeholder needs.	↓ -ve

The overall trend for land-use change will not be significantly affected by full implementation of the RPDP, because the drivers retarding land-use change are small compared to the drivers reinforcing change, in particular, industrial and urban expansion. There is likely to be some increased productivity associated with RPDP implementation, and this may lead to increased illegal encroachment onto public lands (e.g. reservoirs edges, riparian buffer zones, and national reserve forests.).

5.4.2 Water shortage for Crop production

For agricultural water shortages, full implementation of the RPDP results in one significant change when compared with the BAU drivers – disruption of natural drainage patterns (Table 5.4 and Figure 5.6).

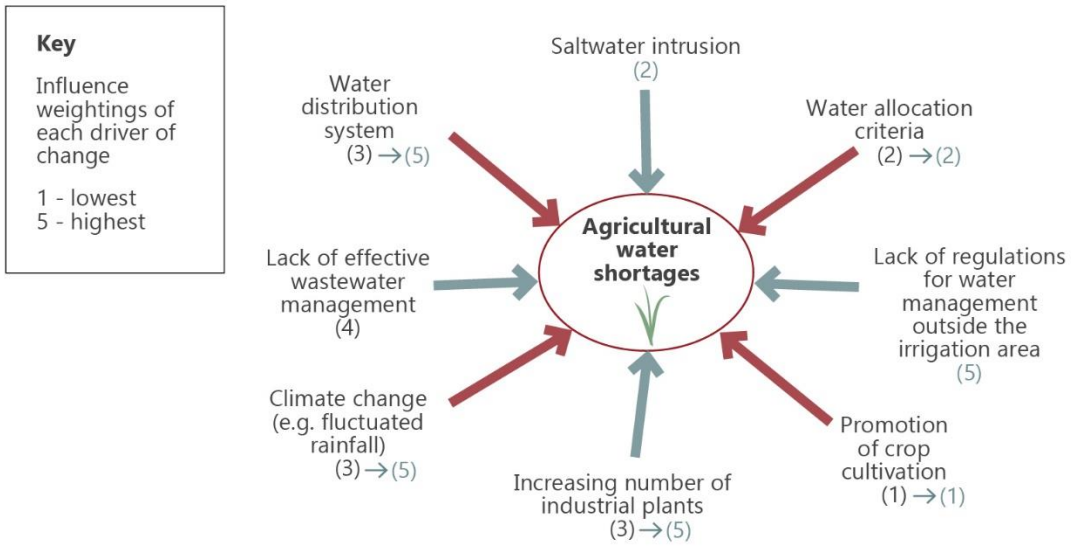
Table 5.4: Changing drivers of water shortage under the RPDP scenario

Full RPDP implementation scenario - changes from BAU	Direction of influence on sustainability
RPDP implementation scenario includes new linear transport infrastructure that will disrupt water flow patterns, and this could exacerbate issues relating to agricultural access to water.	↓ -ve

In addition to transport infrastructure affecting water flows, SEA stakeholders considered other aspects of RPDP implementation including (i) more industrial water usage, (ii) lack of consideration of water allocation priorities, and (iii) lack of wastewater management (Figure 5.6). In relation to industrial water usage, industrial expansion under RPDP is not projected to change significantly from the BAU scenario. For water allocation and wastewater management issues, SEA stakeholders were identifying gaps in the plan rather influences attributed to the plan. These are important issues, however, because perceptions about lack of fair access to water, for example, could lead to open conflict in the future if not addressed and resolved. This is particularly important because the gap between supply and demand of water is projected to narrow over the next 10 – 15 years.

Wastewater management issues have been highlighted in other impact assessment chapters as a major challenge for the province with a variety of public health and development consequences with similar trends under BAU and RPDP. Increasing domestic waste-water discharges will remain largely untreated, and will lead to increasing contamination of agricultural water sources. This is particularly problematic because of the relationships with GAP certification. Guaranteeing use of uncontaminated water for agricultural production has been the weakest element in GAP certification in Rayong to date.

Figure 5.6: Changes in drivers affecting agricultural water shortages under the RPDP scenario, as identified by SEA stakeholders



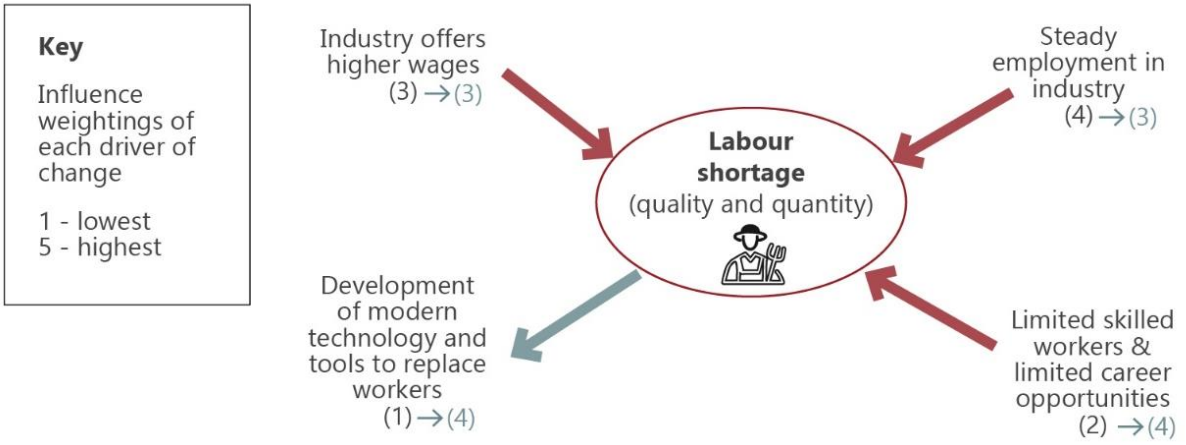
Note: Arrows in green indicated factors that the SEA stakeholders considered as additional areas of concern in the scenario with full implementation of the RPDP

5.4.3 Agricultural labour shortages

SEA stakeholders identified several changes to agricultural labour shortage drivers under the RPDP scenario (Figure 5.7). The changes they identified related primarily to new technologies and support for innovation in agriculture that the RPDP targets. However, there was also concern that insufficient

training mean farmers will not be able to take full advantage of opportunities being supported under the plan, which could exacerbate skilled labour shortage issues.

Figure 5.7: Changing agricultural labour shortage drivers under the RPDP scenario, as identified by SEA stakeholders



Additional insights and explanations of the changes to agricultural labour shortage drivers are provided in Table 5.5.

Table 5.5: Changing agricultural labour shortage drivers under the RPDP scenario

Changes from BAU	Direction of influence on sustainability
The RPDP includes a focus on innovation and use of technology in agriculture, which will reduce requirements for manual labour.	↑ +ve
The RPDP includes 4 projects that have training elements designed to help farmers take advantage of mechanization trends. This will help farmers to use new technologies.	↑ +ve
The allocation to farmer training will be insufficient to address the capacity gap. Thus, there will be a greater need for skilled labour than the BAU scenario.	↓ -ve

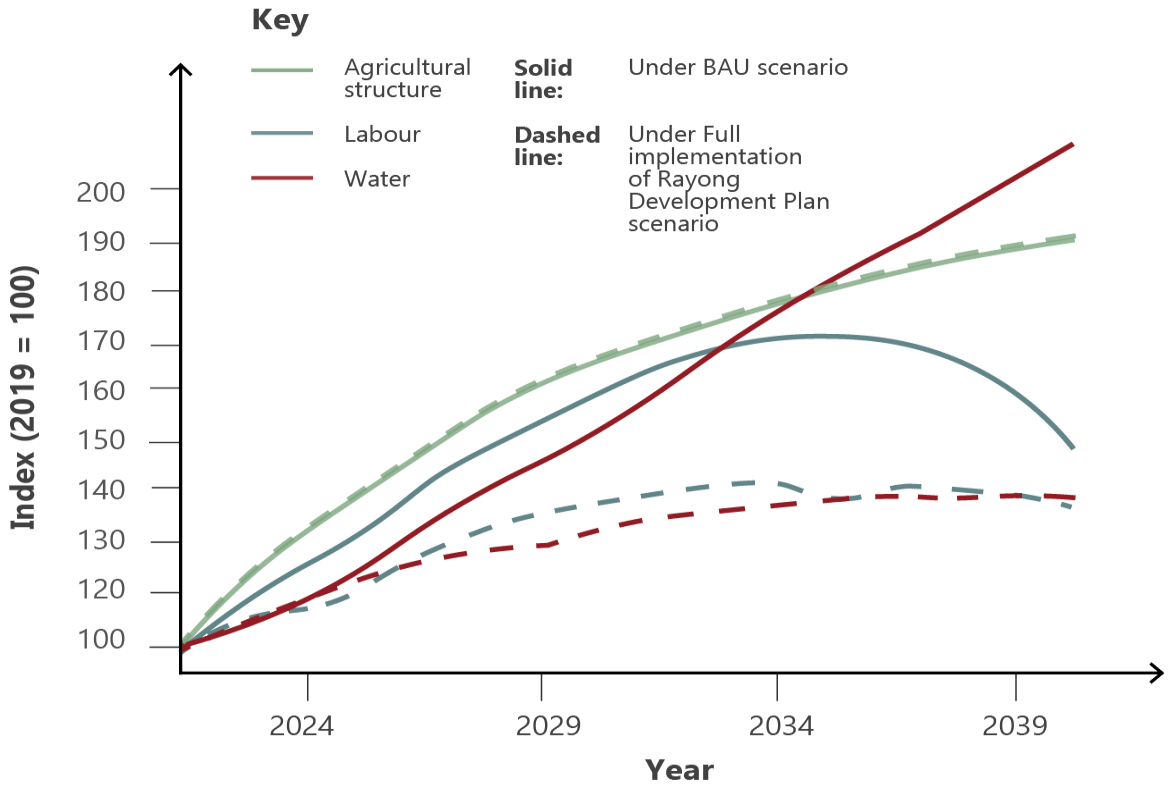
The major influences of the RPDP on labour shortages relate to technology, innovations and mechanization that is supported under the RPDP. While the goals in the RPDP are positive, the bulk of the benefit will tend to accrue to larger-scale farmers who can afford to invest in new technologies. The plan does offer some support for establishing and strengthening farmers' groups and networks. Acting collectively, small-holder farmers may be able to jointly invest in new farming technologies.

5.5 Summary of RPDP impact on sustainability in Agriculture

Only around 1% of the RPDP budget directly targets agriculture, with an additional 1% on agriculture-related projects. Much planned agriculture related expenditure is for water infrastructure and dredging. Many of these are led by RID, and while the text of the plan suggests these projects will be implemented for the benefit of farmers, the investments in additional reservoir storage and water pipelines are much more oriented more towards industrial, commercial and residential water users. For example, pipeline and water storage elements do not respond to the agriculturally important need of increasing the area of Rayong's irrigated zone. Other gaps in the RPDP are a lack of inclusion of crop insurance schemes that could, for example, provide farmers with a buffering mechanism in the face of projected climate change effects, as well as the lack of consideration of wastewater management and water allocation priorities. Minimal attention is paid to the significant projected impacts of climate change. This is concerning because of the direct reliance on natural systems and resources in the sector.

Considering the inter-relationships of the three strategic issues of concern for agriculture, and projecting their trends with and without the influences of the RPDP, the area of most influence of the RPDP will be on improving water quality. That it will have a positive influence on labour shortage concerns, but that it will have little or no effect on the overall structure or place in the broader economy of the agricultural sector (Figure 5.8).

Figure 5.8: Trends in key issues under the BAU and RPDP implementation scenarios, as identified by SEA stakeholders



Overall, under the full RPDP implementation scenario, the following can be expected:

- **Land use change in agricultural sector**: In the next 15 years agricultural land will continue to be transformed to urban and industrial areas as well as being expropriated for transport infrastructure, after which time the transformation will start to slow down as the driving forces stabilise
- **Water shortage in agricultural sector** will be more severe due to climate change, increasing demand from other sectors, and priority given to providing water to industry in times of critical shortage of water supplies
- **Labour shortage in agriculture** will be more severe during the first 15 years, until more advanced technology and machinery is progressively introduced. The modification of crop types and cultivation patterns will also results in using less labour over the longer time frame.

5.6 Other factors likely to affect sustainability of agriculture in Rayong

There are future influences beyond those which make up the BAU and full RPDP implementation scenarios. The RPDP only covers a relatively small part of the likely investments and forces for development within the province. That reflects a weakness in the Thai planning system which greatly constrains the responsibilities, authority and capacities at provincial level. It is a heavily centralised system which creates uncertainty on what should be covered in provincial development plans as the principle integrating and guiding framework for all development actors within provincial boundaries.

At a regional level, developments included under EEC planning will tend to further undermine Rayong's agriculture sector. More transport infrastructure, more industrial development, more higher-paying jobs in factories, and more residential development, will reinforce agricultural land loss and sector disincentives; reduced availability of water for agricultural production, and shortages of agricultural labour. The national transport, energy and industry sectors will increasingly dominate development in Rayong and its shift away from agriculture. The combined influence and actions of RID and East Water will determine the direction of water management and continue the reduced emphasis on agriculture.

Nationally, two policies have the potential to influence agricultural development in Rayong. The first is Thailand's Climate Change Master Plan (2014-2050), which includes a number of priorities for adaptation in the agriculture sector:

- Increase the number of farmers with crop insurance
- Increase the proportion of irrigated areas
- Improve water resource management in non-irrigated areas
- Increase use of soil and water conservation practices in climate change hot-spots
- Reduce open burning of agricultural residue
- Increase proportion of GAP and Organic Farming

The second national policy is the Water Act (2018), which will lead to the strengthening and establishment of River Basin Committees (RBCs), including for the Khlong Yai (Rayong) and Prasae River systems in Rayong. The RBCs will develop Basin Master Plans for the two Rayong river basins, and while it is not yet clear what the Basin Development Plans covering the Khlong Yai and Prasae Rivers will look like, there will very likely be implications for agricultural land-use and water availability in Rayong.

5.7 Conclusions

5.7.1 Main positive effects of the Plan

The main supports in the RPDP for sustainability in agriculture relate to innovation and technological development in farming, as well as the provision of skills training. In addition there are planned projects in the RPDP for new market buildings, for marketing promotion, and for agro-tourism. The water infrastructure developments in the plan could be helpful, but the apparent focus on providing water to industry means that farmers are unlikely to be significant beneficiaries.

The transport links and road upgrades in the plan have some positive implications for agriculture, by improving farmers' access to markets.

5.7.2 Main negative effects of the Plan

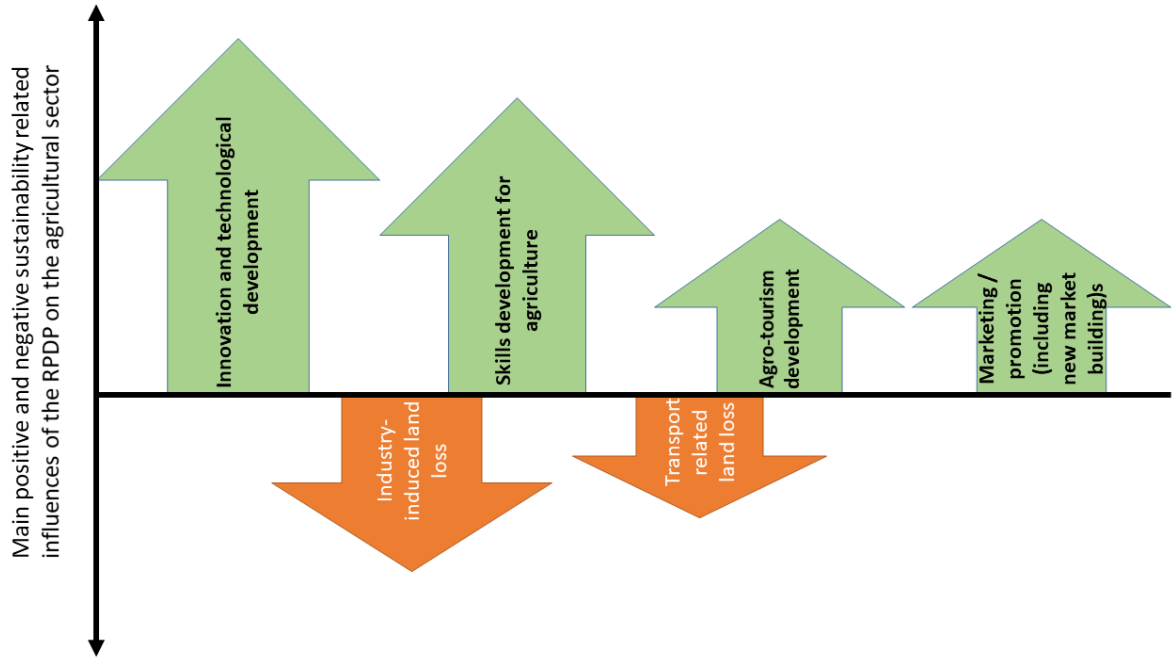
A primary focus of the RPDP is to support industry in Rayong, but forward projections of full RPDP implementation show that it will have little influence on industrial growth. Thus, the trend of declining agricultural land area will be driven largely by plans and budgets of the industry, energy and transport line agencies and by implementation of the EEC development plan.

With transport infrastructure as a major focus of the RPDP budget and projects, RPDP implementation will result in some land acquisition for road building, for example, the Map Ta Phut bypass will require at least 7 hectares of land (assuming an existing two lane road is already there, and that the width of two additional lanes will be another 7m), which will contribute to reducing agricultural land area in the province.

5.7.3 Gaps in the Plan

In summary, the RPDP has positive influences on agriculture sector sustainability but significant gaps in sustainability have not been addressed (Figure 5.9).

Figure 5.9: The RPDP sustainability related influences on agriculture



The RPDP does not adequately address water supply, demand and pollution issues, which are all infringing on agricultural sustainability. In relation to water supply and demand, for example, the RPDP does not address farmer perceptions that in times of water shortages water supply to industry is given priority. Also, the plan does not address root causes of limited municipal wastewater treatment or other effluent emission problems. Declining water quality in Rayong is undermining the agricultural goal of broad GAP certification for farmers in the province.

While the RPDP includes some skills development and training components for the agricultural sector, there is insufficient investment related to high value fruit crops and horticulture production. RPDP measures are not sufficient to provide small holder farmers with adequate training or access to investment capital to take advantage of new technology developments.

The RPDP does not include expansion of the irrigation systems, or support introduction of more water-efficient forms of irrigation such as drip and sub-surface irrigation, which are promoted in Thailand's Climate Change Master Plan (2014 – 2050). Similarly, there is a lack of encouragement for on-farm water storage, efficient use of ground-water, and soil and water conservation techniques.

The RPDP does not include measures to incentivize farmers in riparian zones restore riverbank vegetation, or for farmers in upper watersheds to reduce chemical run-off and sedimentation of reservoirs and waterways.

Perhaps most significant for agriculture in the long term is the failure of the plan to address climate change, and the lack of any support for climate-smart strategies including insurance mechanisms.

6 ENERGY

Strategic theme	*Strategic issues of critical concern for sustainable development in Rayong*
Energy	• Continued growth of decentralised power generation • Rayong as a strategic energy hub for Thailand • Environmental consequences of energy sector development
The sustainable development objectives for energy are: • Promotion of renewables and energy efficient generation technologies • Affordability of energy supply to residents and businesses in the province • Reduce pollution emissions from energy supply to meet ambient and point source air quality standards and GHG emissions reductions targets.	

6.1 Introduction

Rayong has developed into Thailand's main energy hub. Most domestic gas and oil resources are landed in the province through a pipe-line network. The province houses significant oil terminals, and the country's only liquid natural gas (LNG) import facility, as well as 55% of oil refining capacity and around 25% of Thailand's electricity generation capacity. Those facilities are of critical importance for national and regional economic development.

Since the late 1980s, the energy sector has grown rapidly as a result of the development of the domestic off-shore industries and implementation of the Eastern Seaboard Development Plan (ESDP) as one of the largest infrastructure development projects in Thailand at the time. The baseline assessment identified significant environmental and sustainability concerns related to energy development. This section recaps these issues and investigates the likely impacts and influences of the BAU and full RPDP implementation scenarios in the energy sector on trend lines for the three key strategic issues of concern for development in Rayong.

6.2 Energy investments in the RPDP

The inclusion of the energy sector as a separate theme for consideration in the SEA reflects its great importance for the province, and for the environmental consequences of the concentration of energy sector development. The RPDP includes a number broad industrial and environmental objectives that have potential implications for the sector:

- **Industry**: Develop facilities and personnel in preparation for Thailand 4.0 and for the EEC development plan
- **Natural resources and the environment (water)**: Manage water resources to ensure water supply is sufficient and of adequate standard
- **Natural resources and the environment (waste management)**: Manage solid and hazardous waste, including ensuring proper waste treatment/disposal, including through recycling and community garbage collection and disposal.
- **Natural resources and the environment (climate change)**: Reduce greenhouse gas emissions and adapt to impacts of climate change

However, there are no energy projects or energy related projects within the RPDP.

6.3 Drivers of change in the energy sector

For each of the three key strategic issues for Rayong's energy sector, the main drivers were identified in the baseline, and are described briefly in Table 6.1:

Table 6.1: Key issues and drivers for energy sector

Key issue	Drivers
Continued growth of decentralised power generation	▪ Demand for multiple energy services from large scale energy intensive industries in the province - future growth will depend upon demand form industry ▪ National legislative changes made to promote private sector investment in generation – changes in approvals for gas-fired plants may limit future growth ▪ Easy access to gas supply
Rayong as a strategic energy hub for Thailand	▪ Growth in national energy demand (fossil fuels and electricity) ▪ Development of off-shore gas/oil fields and development of Rayong as suitable landing site for pipelines ▪ ECC development including Map Ta Phut port and petrochemicals industry
Environmental consequences of energy sector development	▪ Rapid growth of energy sector in province ▪ Limited efforts to limit energy related resource use ▪ Limited efforts to mitigate or manage energy related pollution/emissions

6.4 BAU scenario and energy

The BAU scenario for the energy sector in Rayong represents a continuation of the current trend in line with Thailand's 2018-2037 PDP. That is, Rayong continues to function as Thailand's main energy hub, due to it being a landing point for both the domestic gas industry and a hub for the import of fossil fuels (in particular coal, and increasingly LNG). Any declines in domestic production of fossil fuels will be more than offset by increasing demand for imports. This will likely mean the continued growth of decentralised energy production, with the caveat that this will depend on increasing demand from industry.

The environmental consequences will continue to increase as energy generation increases, in terms of GHG emissions and other pollutants to the air, discharge of cooling water and other contamination to water bodies and the generation of solid and hazardous waste. Although pollution and waste generation is expected to increase, the new PDP envisages a significant increase in the share of renewables in Thailand's energy generation mix (an additional 21 GW by 2037), with solar PV in particular being targeted. If this proposed expansion of renewables includes a significant proportion of new capacity constructed in Rayong, it would moderate increases in energy related pollution emissions. However, it is likely that most planned renewables capacity will be constructed elsewhere in the country because of greater availability of cheap land. Therefore, gas-fired generation will continue to dominate in Rayong, and emissions due to energy are likely to grow in line with past trends.

6.5 Other influences on BAU trends in the energy sector

As already noted the 2019-2037 PDP plans significant expansion of the national power system. This includes several known large committed developments in the province, including both additional generation capacity and expanded important capacity for LNG:

- A **2.65 GW gas-fired power plant** developed by Gulf PD to be constructed in Pluang Daek with a COD date of 2023 for phase one and 2024 for phase two;[15]
- Additional **1 GW unit at BLCP coal fired power plant**, unclear how far this project has progressed, although the EIA for it is complete; and,

[15] (EPPO, 2015), See also https://gulf.listedcompany.com/misc/presentation/20180820-gulf-presentation-2q2018.pdf (slide 12); also MHPS, 2018, MHPS Receives Order to Construct 5,300MW Power Plant Project in Thailand Incorporating Eight M701JAC Gas Turbines. Website retrieved from https://www.mhps.com/news/20180209.html

- **Map Ta Phut Port Phase 3** - port facilities will be expanded from the current 160 hectares to 320 hectares which will include 56 hectares for gas terminals and gas-related warehousing and businesses including additional LNG terminal, able to support 264,000 DWT vessels.

Again, these are assumed to be reflected in the national PDP and were therefore included in the BAU scenario.

6.6 Influence of RPDP on the energy sector

The RPDP includes no energy projects. Therefore, implications for the energy sector of full RPDP implementation would be marginal. Energy is a very important sector in Rayong, particularly because the province is Thailand's main energy hub. Rayong's competitive advantage in terms of traditional sources of energy such as LNG mean that the province has a head start in transitioning to cleaner electricity generation.

The province should not waste this opportunity, but should invest now in ensuring that opportunities for waste-to-energy, utility, commercial and domestic scale solar, as well as other alternative energy sources are encouraged and developed to supplement and then supersede the existing coal and gas fired systems. The following volume of this SEA, the Sustainable Development Pathways Report, provides details and recommendations on how Rayong can take advantage of its current lead in power generation to maintain it during, and following, national and global transitions to clean energy.

6.7 Conclusions

Energy sector development in Rayong province is largely outside the remit of the RPDP and the Rayong authorities. This is reflected in the absence of any specific energy related investments in the plan. The plan may have some demand-side implications for energy use but these are addressed where relevant in the theme chapters dealing with those sectors (industry, urban, transport). Nevertheless., there are some areas where provincial authorities need to have greater involvement, such as the promotion of small scale micro-grids using renewables, the provision of better air quality monitoring in the province and the promotion of energy efficiency measures and renewable energy at sites owned and operated by provincial and municipal governments (e.g. administrative buildings).

7 TRANSPORT

Strategic theme	*Strategic issues of critical concern for sustainable development in Rayong*
Transport	• Expansion of transport infrastructure • Expansion of resource use • Increasing air pollution
The sustainable development objectives for transport are to:[16] • Promote an equitable and safe transportation system, offering a choice of transport modes, and a geographical balance of development. • Reduce transportation related emissions and resource use	

7.1 Introduction

Growth in Rayong's transport sector has been driven largely by industrial expansion, but is also influenced by a growing urban population and increasing tourism. Industry related transport is not restricted to roads and railways. The Map Ta Phut port has existing capacity to receive around 15,000 tankers and cargo ships annually, and U-Tapao airport is scheduled for significant upgrades which will support development in other economic sectors such as energy, tourism and industry.[17]

Significant environmental impacts accompany the expansion of transport infrastructure in Rayong. For example, exhaust emissions from cars and trucks impact on air quality as well as contributing to climate change. Dust from brake discs and tyre wear also contribute to air pollution and vehicle servicing centres dispose of significant quantities of used oils and other lubricants, which affect water quality and create hazardous land disposal areas.

Expanding transport infrastructure, such as railway lines, roads, airports and ports lead to pollution hot spots, bringing with them uncontrolled commercial and urban development which in turn intensifies pollution problems, and act as a magnet for resource consumption. Without adequate environmental assessment, spatial zoning and safeguards, they can create and exacerbate flooding problems, heat island effects and conditions for cascade infrastructure failure because of increasing interdependencies between assets and areas.

Airports and ports in particular bring multiplier impacts which need to be considered and managed. Shipping and port facilities impact on the environment and sustainability through air pollution including emissions of Sulphur oxide, nitrogen oxide, and particulate matter. Ship tanks and bilges are flushed out, leading to significant effluents entering the marine and coastal environment. Accidental spills from shipping traffic also pose a significant environmental risk. Already, all these issues are present in Rayong as reflected in the transport baseline assessment.

In order to examine the effect of BAU and full RPDP implementation development scenarios on sustainability in Rayong, the main drivers of transport trends, and their cumulative effects are examined without, and then with, the influence of the RPDP. This is done by extending and projecting forward the work done in the baseline assessment. Round table discussions and stakeholder workshops were critical in shaping the impact assessment. "Other factors" affecting sustainable development in Rayong are also considered because of the variety of influences outside the direct control of provincial authorities, which are not covered in the RPDP.

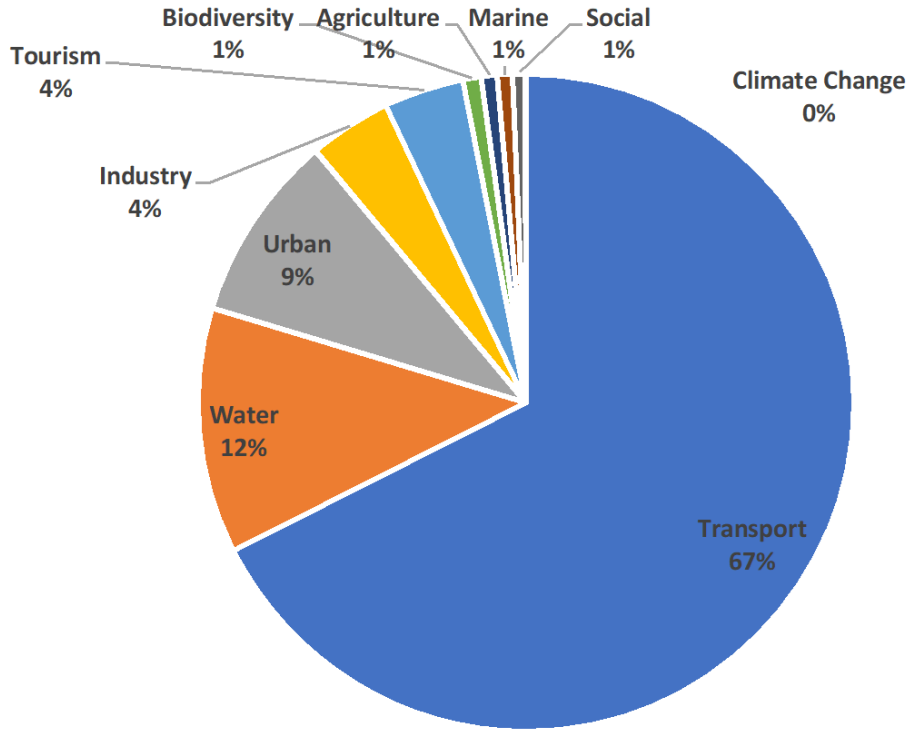
[16] Based upon Thailand 4.0 and UNIDO principles, see https://thaiembdc.org/thailand-4-0-2/

[17] For example, U-tapao airport has announced it will have a second 3.5km long runway operational by 2021. See: https://www.flightglobal.com/news/articles/u-tapao-to-have-second-runway-by-2021-446870/

7.2 Transport in the RPDP

The RPDP does not include significant transport related goals, but investment in transportation infrastructure is included as a sectoral objective. Despite the lack of prominence transport receives in the overall RPDP goals, the sector attracts most investment under the Plan – i.e. 67% of the total (Figure 7.1). Even ignoring the THB 6 billion Map Ta Phut by-pass project which is by far the largest project within the RPDP, the sector still accounts for around half of all planned RPDP investment.[18]

Figure 7.1: Transport infrastructure accounts for two thirds of proposed RPDP investment



Source: RPDP (2018 - 2022)

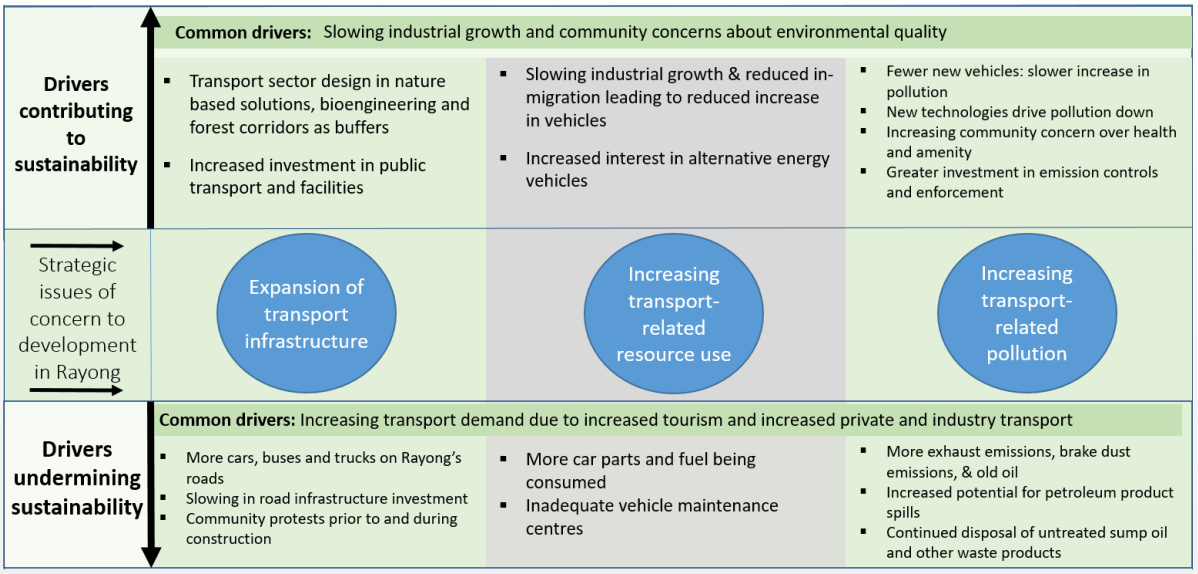
7.3 BAU scenario for transport in Rayong

The BAU scenario for transport is developed through the projection of established transport trends into the future. For the purposes of this assessment, projections are undertaken to 2040 in line with government planning guidelines.

The overall driver of transportation growth is national and provincial government investment in transportation infrastructure. However, there is a complex interplay between supply and demand, with Figure 7.2 highlighting the demand side factors. It is worth noting that the negative drivers shown in Figure 7.2 are only likely to have a marginal or negligible impact on the trends in the strategic issues of concern for transport outlined in the box at the top of the chapter.

[18] This reflects the remit of the provincial authorities as well as the nature of the infrastructure provided – which, in the case of transport, is relatively capital intensive.

Figure 7.2: Summary of BAU thematic Drivers: Transport



7.3.1 Expansion of transport infrastructure and resource uses

Under the BAU scenario, the expansion of transport infrastructure continues to be relatively ad hoc and incremental without adequate spatial planning, detailed modelling of options and associated environmental assessments. Because of this, the level of traffic congestion and traffic-related pollution will intensify under this scenario. Key BAU trends in terms of transport expansion and resource use include, for example:

- More serious road traffic congestion as populations expand, per capital income increases, and the of private and commercial vehicles increase
- Ad hoc expansion of roads, parking areas and vehicle servicing stations with inadequate supporting drainage and waste management
- Mounting economic costs due to constraints on the movement of goods and people
- Reduced attraction of Rayong as a tourist destination

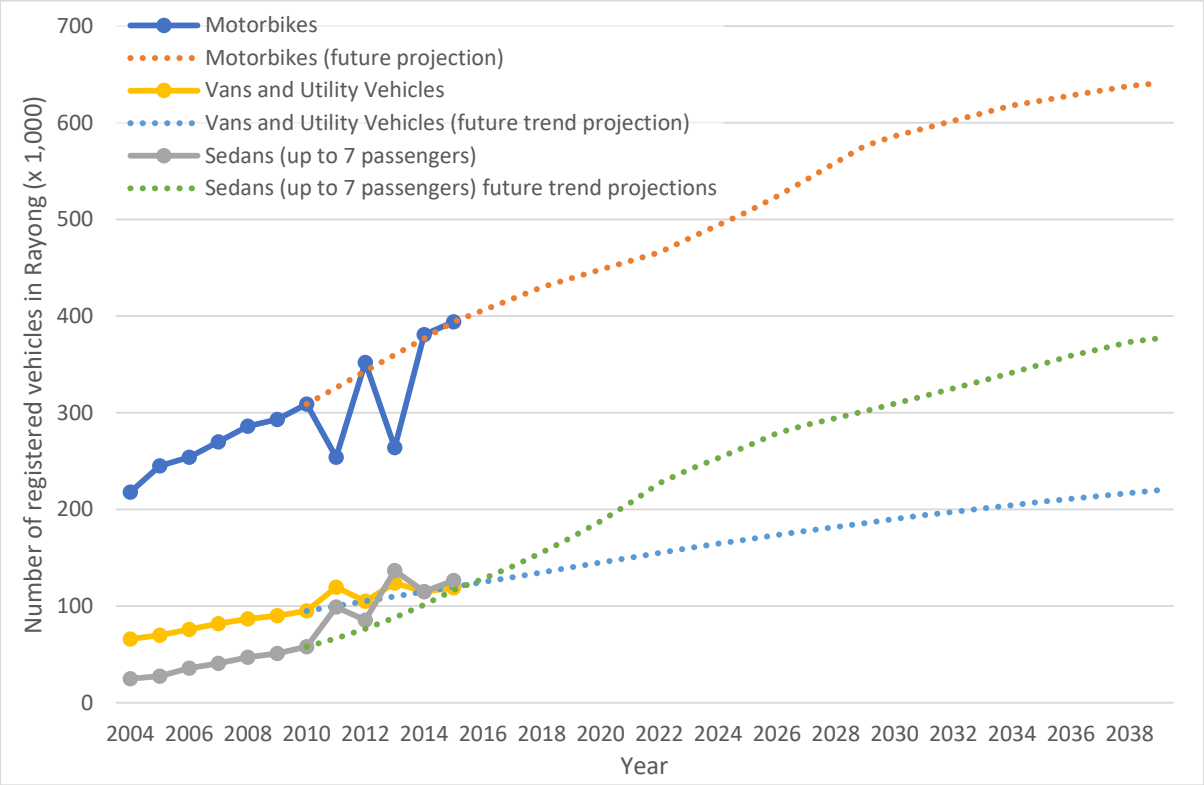
A number of major ongoing transport infrastructure projects are part of the BAU - the 32km long Pattaya to Map Ta Phut motorway that is almost complete[19] and the ongoing upgrade, from 4 to 6 lanes, of Highway 36 from Rayong City to Chonburi.[20] These projects are shown in Figure 7.8. The opening of the Pattaya to Map Ta Phut motorway is likely to increase vehicle numbers on Rayong's roads, primarily because in the short-term, it will reduce congestion of freight traffic related to Map Ta Phut Port and industrial zone (thus making it more attractive for factories to ship their products by road), but also because it will facilitate tourist and business travel between Rayong and Pattaya.

Two driving factors influence transport infrastructure under the BAU scenario. The first is that industrial growth has shown some signs of slowing down. That slowing in growth rate is likely to continue with BAU. Consequently, growth in freight requirements would slow as would employment related immigration. That trend would tend to suppress transport expansion – but also investments in enhanced environmental performance in existing commercial stock and linked facilities.

[19] https://pattayaprestigeproperties.com/whats-coming-to-pattaya-in-2019/ & https://vaaju.com/thailandeng/open-apr-63-highway-7-pattaya-map-ta-phut-last-completed-10-episodes/
[20] http://www.publicconsultation.opm.go.th/phs/new_phs_proj_view.asp?editId=P610116004

The second, and opposing driver is that Thailand's economy as a whole is continuing to grow, and as people become wealthier rates of private motor-vehicle ownership rise. For example, the number of private vehicles in Rayong more than doubled between 2004 and 2015.[21] Thus, despite slower industrial growth and the dampening effect of that on investment in infrastructure and effective environmental management technologies and measures, there will be growth in numbers of vehicles on the roads because of broader economic growth.

Figure 7.3: Projections of vehicle numbers under BAU scenario



Source: Measured data from Rayong Provincial Transport Office, 2019; Projections by ICEM

Projections of growth in vehicle numbers takes into account slowing industrial growth in the BAU scenario (as well as consequent slowing economic growth and population growth). Growth in the number of passenger vehicles is likely to follow established trends until the early 2020s, at which time growth in passenger vehicle registrations is likely to begin slowing down driven by the slowing growth in industry (Figure 7.3). There is a similar trend for vans and utility vehicles, but because the growth curve is flatter it is not as noticeable. Because motorcycles are cheaper, as people register fewer new cars, they are likely to register more motorcycles, as can be seen in the motorcycle registration curve in the early 2020s. This effect can be seen in reverse in 2011 and 2013 with the spikes in car registrations as a result of a first car buyer incentive scheme.[22]

7.3.2 Increasing air pollution due to increased transportation

As highlighted in Figure 7.3, transport demand in Rayong is likely to continue growing through 2040. In addition to demand for private vehicles, the tourism sector will add to growth in Rayong's transport

[21] Data from Rayong Provincial Transport Office (2016)
[22] See: https://www.mdpi.com/2073-4433/8/9/167/pdf

sector, and even though industrial expansion is slowing under the BAU scenario, it will bring increases in transport demand.

Private transport demand (vehicle ownership) is driven two factors. There are (i) population (i.e. more people = more cars), and (ii) personal income growth (because richer people own more cars per capita).[23] Both wealth and population are projected to increase in Rayong under the BAU scenario. The drivers behind tourism growth and industrial expansion are detailed in the tourism and industry impact assessment chapters of this SEA.

Growth in transport for personal use and tourism will all drive transport-related pollution upwards. A factor which may have a downwards impact on transport-related pollution is community concern about environmental quality. These concerns are demonstrated, for example, in initiatives like the free public transport service being provided in Klaeng District in Rayong as a way to reduce vehicle use and fuel consumption.[24] However the effect of downwards drivers like this will be relatively small when compared with the drivers increasing pollution, especially in the short-term. In the longer term, it may lead to more environmentally conscious choices about vehicle purchases, including smaller more fuel efficient and pollution free vehicles. Because of the marginal and speculative nature of these effects, they have not been included in the calculation of the BAU trend lines for transport in Rayong.

Slowing industrial growth is likely to have little impact on shipping transport using Rayong ports. As a national energy hub, regardless of the state of Rayong's provincial economy, there will still be a need for raw energy imports such as oil and LNG, as well as for electricity production for the national grid. Thus, with the recent cabinet approval for phase III of Map Ta Phut Port, continued unabated growth in the number of oil and LNG tankers visiting Rayong's ports is projected. However, container shipping will be affected by slowing industrial growth, but as with other industry affected aspects of transport, the number of container ships offloading and loading cargo in Rayong is still projected to grow (although growth with slow over the next 10 years).

Since the 1980s, Thailand has introduced a variety of initiatives to address vehicle related emissions.[22] Key measures are detailed in Table 7.1:

Table 7.1: Measures introduced in Thailand to limit vehicle related pollution

Year	Instrument	Objective(s)
1983	Fuel and Engine Quality Standard Enforcement	Limit sulfur and aromatic hydrocarbon content in fuel
2009 - 2015	Eco-car (phase 1 & 2)	Encouraged car producers to produce more efficient and smaller engine vehicles that met the Euro 4 emissions standard
2015	Oil Plan (2015)	Promote usage of LPG and natural gas as alternatives to benzene and diesel
2015	Biofuel Development under Alternative Energy Development Plan 2015 (AEDP-2015)	Sets targets for increases in biofuel use in Thailand.
(i) 1995 (ii) 1999 (iii) 2005 (iv) 2012	Compliance with European emissions standards	(i) Euro I (ii) Euro II (iii) Euro III (iv) Euro IV

Source: Cheewaphongphan et al., 2017[22]

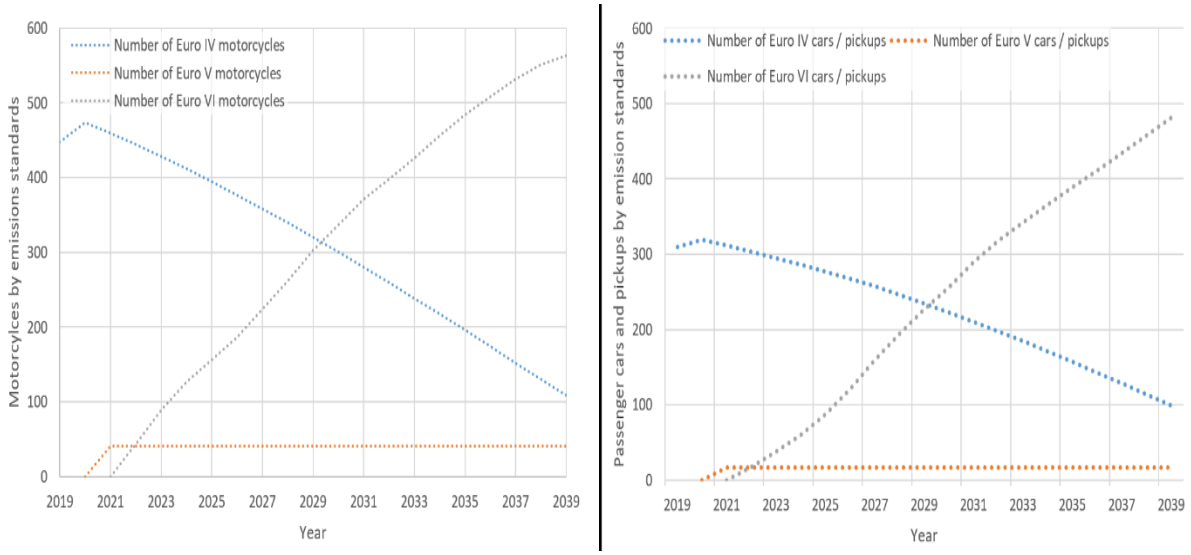
[23] See: https://www.accessmagazine.org/fall-2010/megacities-megatraffic/
[24] http://www.uncrd.or.jp/content/documents/7EST-B1G4-6.pdf (slides 37 - 43)

Also, Thailand has been increasing the planned rate of transition to more stringent emissions standards for vehicles. For example, in 2017 Pollution Control Department (PCD) plans were for all heavy vehicles to meet Euro V emissions standards by 2026. However in 2019, the government announced that all new vehicles sold in Thailand from 2021 will be required to be Euro V compliant, and by 2022 all new vehicles sold will need to be compliant with Euro VI emissions standards.[25] There are other means being used in Thailand to reduce vehicle based pollution. For example, as highlighted in their intended nationally determined contribution to the United Nations Framework Convention on Climate Change in 2015,[26] Thailand's 2013 environmentally sustainable transport master plan (2013) included targets to shift passengers and freight from road-based transport modes to rail-based transport.

Despite these national level goals and targets little action has been taken at the provincial level to enact them. Without efforts to decouple emissions from transport, pollution related to transport will track the number of vehicle kilometers travelled, including air, sea and land vehicles. The vehicles in Rayong will follow national emissions standards, which are becoming more stringent over time. Figure 7.4(left and right) shows projections for numbers of vehicles under particular emissions standards regimes in Thailand. Having established projections in vehicle numbers, the emissions of three of the main air pollutants are calculated based on traffic figures for Rayong (Figure 7.5). The following assumption are used in calculating the total vehicular emissions of PM, CO and NO_x:

- All motor cycles have petrol engines
- 73% of passenger cars and pickups are petrol (based on transport baseline data)
- 27% of passenger cars and pickups are diesel (based on transport baseline data)
- On average, motorcycles travel 1269km/year (based on 2015 data from Rayong Provincial Transport office)
- On average, cars/pickups travel 5095km/year (based on 2015 data from Rayong Provincial Transport office)

Figure 7.4: Indicative projections for motorcycles, cars and utility vehicles by emission standard



Source: Baseline data came from Rayong Provincial Transport Office (See Figure 7-3); Projections by ICEM

[25] https://www.bangkokpost.com/thailand/general/1676592/a-clear-path-to-cleaner-air-%EF%BF%BD%EF%BF%BD
[26] See: https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Thailand/1/Thailand_INDC.pdf

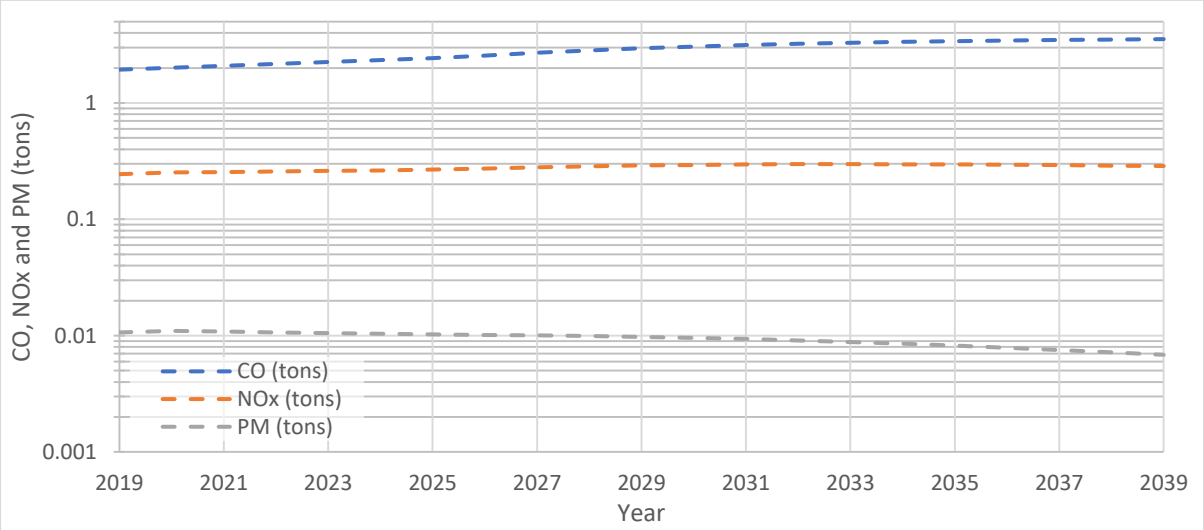
The emissions standards for CO, PM and NO_x (Table 7.2) were applied to the data presented in Figure 7.3, and future projections for emissions of these three pollutants is provided in Figure 7.4.

Table 7.2: Relevant vehicle emissions standards for Thailand

Standard	CO (g/km)	NO_x (g/km)	PM (g/km)
Euro IV (petrol)	1	0.08	
Euro V (petrol)	1	0.06	
Euro VI (petrol)	1	0.06	
Euro IV (diesel)	0.5	0.25	0.025
Euro V (diesel)	0.5	0.08	0.005
Euro VI (diesel)	0.5	0.08	0.005

Source: https://www.rac.co.uk/drive/advice/emissions/euro-emissions-standards/

Figure 7.5: Future projections for vehicular emissions of CO, PM and NOx



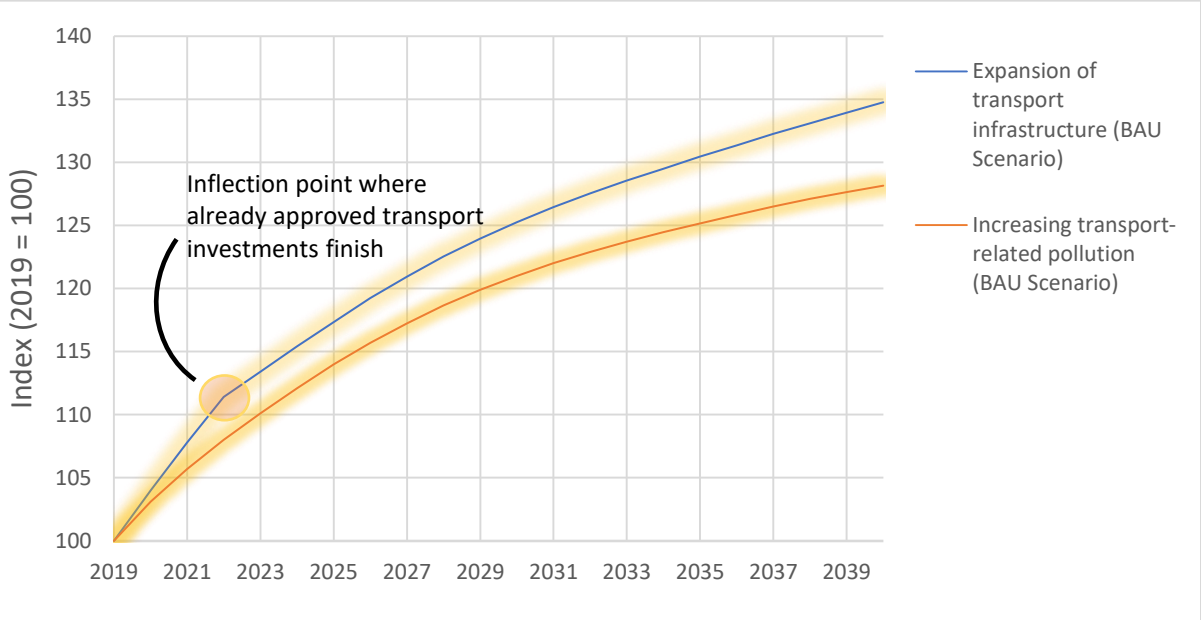
Source: ICEM (calculated based on emissions standards and vehicle numbers detailed in this chapter)

With the advent of new emissions standards, and as old vehicles are taken off the road, the weight of particulate matter emitted by vehicles in Rayong is projected to decrease from 0.01 tons annually down to 0.007 tons annually (a 30% decrease), even while the number of registered vehicles is projected to grow 75% above the current number. NO_x emissions will remain relatively stable, with a slight increase over the next 10 years, but with some of this increase being reversed in the second half of the 2030s. CO levels will nearly double, with the increase being particularly noticeable in the coming 12 – 13 years, after which the increases flatten out.

However, emissions to air from vehicles are only a part of the transport related emissions in Rayong. As noted there are emissions from ships, as well as accidents and flushing of bilges. There are used tyres and engine oil that need to be disposed of. Therefore, despite the positive impact that emissions standards are expected to have on emissions to air from vehicles as they travel, under the BAU, it is projected that pollution levels will continue to grow, but the rate of growth will slow slightly as growth rates in shipping, freight and commuting traffic decline.

The trend line summary for the key sustainability issues for transport for the BAU scenario is shown in Figure 7.6:

Figure 7.6: Transport strategic issue trends for the BAU scenario



7.4 The impact of the RPDP

7.4.1 Expansion of transport infrastructure

The RPDP (2018 – 2022) includes around 12.2 Billion Thai Baht (of the 18 Billion total budget in the RPDP) for transport infrastructure projects. Many of these project are integral to the EEC development, and still others indirectly support the plan. For example, the RPDP includes a 6 Billion THB project to extend the Pattaya to Map Ta Phut motorway directly to the Map Ta Phut industrial area (referred to as the Map Ta Phut bypass),[27] which is designed to ease freight-related traffic congestion around the Map Ta Phut industrial estate. In addition, the RPDP includes several road widening and road upgrade projects. With full implementation of the RPDP, transportation infrastructure is projected to experience significantly greater expansion over the next 10 years than under the BAU scenario (Figure 7.7). Expansion of traffic infrastructure, and particular expansion of road networks is recognized as having environmental consequences. While there are a lack of studies in Asia or Thailand about the environmental consequences of road construction, a study of 86 road construction projects in the United Kingdom showed that more than 80% had negative impacts on the landscape and broader environment.[28]

7.4.2 Increasing air pollution due to increased transportation

While there is not a direct correlation, expanding and improved road infrastructure is likely to result in an increase in road traffic.[29] For example, research into new road construction shows that building new roads results in levels of traffic that are often far beyond the background trends in the longer term.

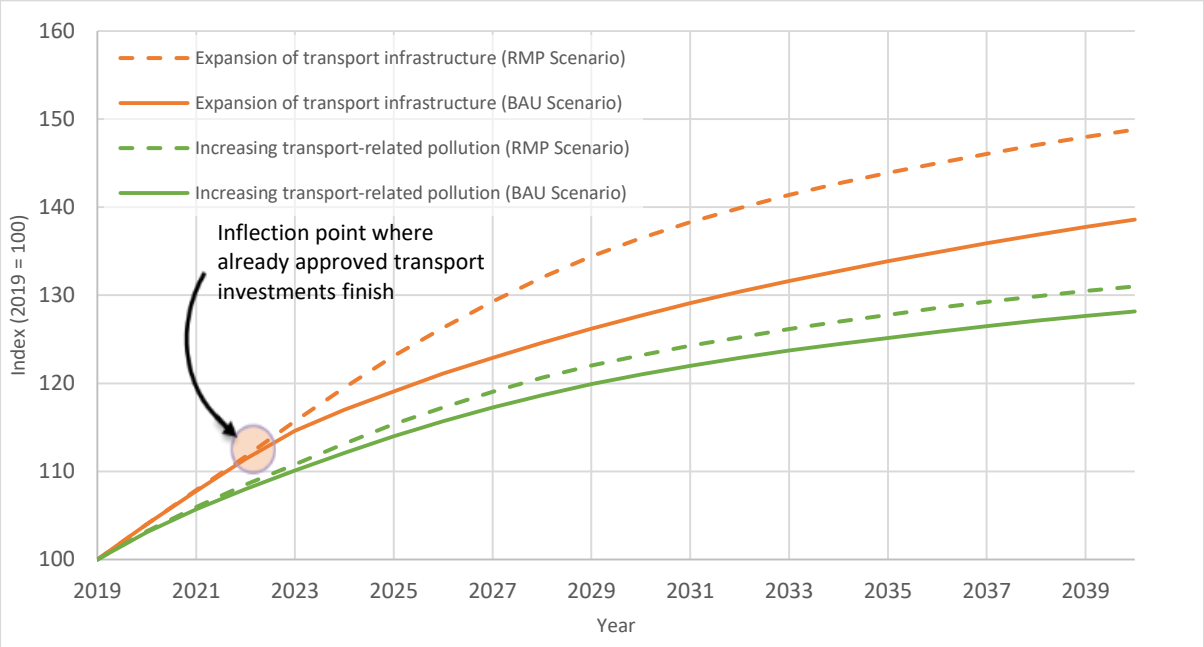
For Rayong, increased traffic levels will primarily result because the improved roads in Rayong will shorten travel time to and from Bangkok, making Rayong a more attractive short-stay getaway destination for Bangkok residents. The heightened attractiveness will be further supported by the planned RPDP investments for tourism, which include investments in new facilities and for

[27] See https://www.pattayamail.com/news/govt-approves-budget-highway-7-maptaphut-extension-137831
[28] See: https://www.cpre.org.uk/resources/transport/roads/item/download/4851
[29] See: https://bettertransport.org.uk/sites/default/files/trunk-roads-traffic-report.pdf (1994)

rehabilitation of existing facilities. Because transport infrastructure by itself will not have a significant impact on industrial expansion, growth in industrial traffic is assumed to follow the BAU trend projection.

The RPDP does not include any elements that would encourage alternative energy vehicles, or other means of decoupling road-based transport systems from conventional resource use. Thus, increases in transport-related pollution under full implementation of the RPDP follow past linkage between vehicle numbers and pollution loadings.

Figure 7.7: BAU and RPDP scenarios for strategic issue transport trends



The RPDP does not include projects designed to enhance public transport in the province, either road-based or focusing on alternative modes. Some additional public transport services connecting Bangkok to Rayong are likely to emerge with improved road conditions and growth in the tourism sector. Growth in road based public transport is likely because the classification of service type to Rayong means that it is open for the private sector to operate public transport services.[30] However the RPDP induced changes in public transport will be relatively minor, and will do little to offset the increasing number of people who will travel to and within the province.

The RPDP will result in a small increase in growth of road-related pollution, particularly in the 5 – 10 year time window (Figure 7.7). The drivers of this growth will be enhancing the attractiveness of road transport, particularly for existing industry in the Map Ta Phut area, which is likely to mean that a larger percentage of freight is moved by road than rail. The reduced congestion may also mean that container ships can be unloaded more quickly, thus increasing the number of ships and the port traffic at Map Ta Phut Port and related goods transport by road.

7.5 Other factors that influence sustainability in Rayong

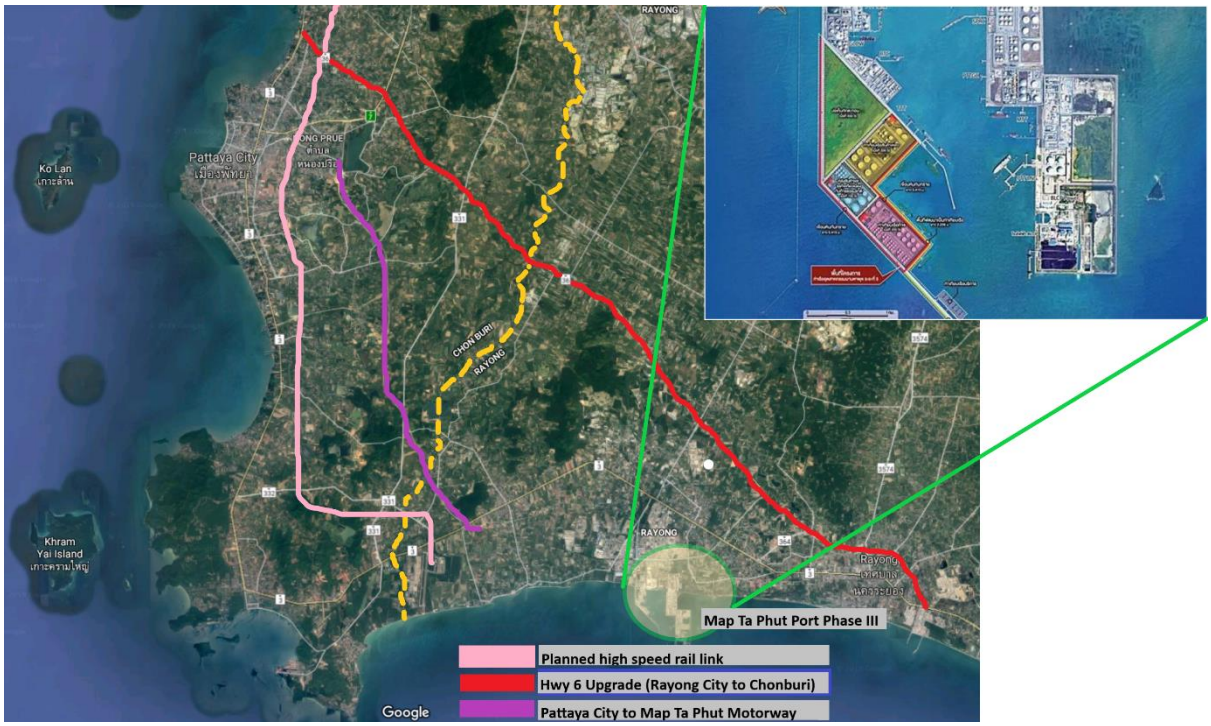
Because planners and decision-makers in Rayong do not have control over many aspects of development in the province, external factors tend to be the main drivers of change in Rayong.

[30] http://publications.apec.org/-/media/APEC/Publications/2011/1/The-Impacts-and-Benefits-of-Structural-Reforms-in-Transport-Energy-and-Telecommunications-Sectors/TOC/Road-transport-in-Thailand.pdf

7.5.1 Projects, programs and policies that will influence transport-related infrastructure growth, pollution levels and resource use

While not within the BAU or full RPDP scenarios, other substantial transport projects are planned and approved for the Province through national line agencies. These projects will have significant effects on environmental conditions. One is the approval in May 2019 by the Thai cabinet of a draft contract for 225 billion THB for the high speed rail link connecting U-Tapao airport with Suvarnabhumi and Do Mueang airports.[31] Another is cabinet approval in June 2019 for the 3rd phase of the Map Ta Phut port for a bid from PTT and Gulf Energy Development for 55.4 billion THB.[32] The location and extent of those projects are shown in Figure 7.8.

Figure 7.8: Major approved, commenced and just completed transport projects in Rayong



Source: base map,[33] insert[34]

Those approved projects are major additions to the transport infrastructure in Rayong, although, as can be seen in Figure 7-8, the high speed rail link and the Pattaya to Map Ta Phut motorway are mostly located across the provincial boundary in Chonburi Province. Nevertheless, these projects have important implications for sustainability in Rayong because they will have an impact both on traffic flows and transport-related resource use in the province. For example, the high-speed rail link is likely to result in a reduction in road vehicle numbers, primarily because it will faster for tourists and business travelers to get from Bangkok to U-tapao by train.

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[31] https://pattayaairportguide.com/high-speed-rail-link-airports/
[32] https://www.bangkokpost.com/business/1693408/cabinet-okays-map-ta-phut-3rd-phase
[33] https://www.google.com/maps/place/Rayong,+Mueang+Rayong+District,+Rayong,+Thailand/@12.7811821,101.0230984,55910m/data=!3m1!1e3!4m5!3m4!1s0x3102fbf483756449:0xe76f94002d45fa8c!8m2!3d12.6813957!4d101.2816261
[34] https://www.nationthailand.com/business/30373846

There are two other factors that will influence the expansion of transport infrastructure in Rayong. The first is that Thailand's Environmentally Sustainable Transport System Plan (ESTSP)[35] and Thailand's Transport Infrastructure Development Strategy (2015-2022)[36] have objectives to shift transport modes from road to rail for both passengers and for freight. The high speed rail link to U-Tapao airport is one Rayong specific manifestation of this modal transition, and is indicative of what is likely to come in the future. The second influencing factor is also related to efforts to mitigate climate change. Globally there is a growing shift towards electric and other alternative energy vehicles. While electric vehicles in Thailand remain an insignificant portion of the overall transport mix at present, there are some initial signs of change, including in Rayong. For example, the Rayong Provincial Energy Office, which focuses on reductions in energy consumption and alternative energy sources, has two electric vehicle charging stations in front of the office.

Currently, the future of alternatively powered vehicles in Rayong is far from certain, but it is being driven by factors including the growing global, regional and national interest in avoiding the worst impacts of climate change. In addition to alternative power sources for vehicles are issues like growing concerns about (i) Air quality across Thailand and the region (which may dampen growth in pollution and resource use related to transport through consumer choice about vehicles and public transport), and (ii) Lowering prices of new and emerging technologies (which should lead to a decrease in average emissions per vehicle, but which may also lead to an increasing number of vehicles on the roads).

Use of electric vehicles address a number of pollution and resource related issues. For example, because they use regenerative braking, brake pads on electric vehicles can last up to twice as long as those on conventional cars, which will also reduce the amount of brake dust in the air. A second difference is that electric vehicles do not use oil in the engine, and many do not have gear box oil, so oil usage is reduced. This also means that there is no requirement for disposal of used engine oil (improperly disposed of oil was identified in the transport baseline chapter as a source of terrestrial and water pollution). However, batteries in electric vehicles have a limited lifespan of around 8 - 10 years (or, for heavily used vehicles, around 200,000km). Once the useful life of a vehicle's battery is finished, it has to be replaced, and something has to be done with the old battery.[37] Batteries could be disposed of, however used vehicle batteries could be usefully used for electrical energy storage in instances where energy density levels are no so important.

As a final influencing factor on transport in Rayong, EEC development plans include significant transport-related infrastructure development to support industry. For example:

- New industrial estates and corridors are being planned, as well as new urban areas (for example the EEC plans include development of an urban centre around Utapao airport). These estates will all include roads for freight, maintenance and for workers to get between their work places and their homes. In new urban areas roads, traffic lights and other intersection management systems (including overpasses and tunnels) will be developed, and vehicle servicing centres and fuel stations will also be established in these areas.

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[35] See: https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Thailand/1/Thailand_INDC.pdf

[36] Office of Transport and Traffic Policy and Planning (http://www.bccthai.com/asp/view_doc.asp?DocCID=2743) Thailand's Transport Infrastructure Development Strategy (2015-2022) has the following national targets, which will influence transport in Rayong:

- Increase the percentage of trips via public/mass transit modes grows from 5% to 30% of trips.
- Railways in Thailand grow from carrying 45 million person-trips/year up to 75 million person-trips/year, equivalent to an increase of 66%.
- The proportion of freight carried by rail will grow from 1.5% to 5% of freight
- The proportion of intercity travel done in private vehicles will drop from 59% to 40% of trips
- To reduce transport-related oil consumption by 100,000 million THB/year [~50 million barrels].

[37] http://knowhow.napaonline.com/electric-car-maintenance-need-know/

- EEC development plans include installing a double track freight rail system linking Map Ta Phut with major ports in Chonburi as well as with Bangkok. This will also consume resources during construction. However, once operating, should significantly reduce the amount of resources consumed (and pollution produced) in transporting freight in the longer-term.
- Utapao airport is scheduled for significant upgrades under the EEC plan. This upgrade includes significant infrastructure development for transport, including expanding the airfield, terminal buildings, aircraft maintenance areas (the Utapao Maintenance, Repair and Overhaul Centre (MRO)), as well as supporting services for airlines such as catering, fuel supply services, and baggage handling.

7.6 Conclusion

Despite the large transport related investments included in the RPDP, the main influences on Rayong's transport sector come from external sources. This is for three main reasons:

(i) The expense of transport infrastructure (for example, even the 6 billion THB budgeted for the Map Ta Phut By Pass is only to build around 10km of road);
(ii) Much of the transport infrastructure that impacts on sustainable development in Rayong is infrastructure that links Rayong to other provinces or for other nationally strategic purposes (e.g. the widening of Highway 6 is being done to increase transport capacity between Rayong City and Chonburi, and the expansion of the Map Ta Phut Port);
(iii) Strategies to transition to modes of transport other than road, and strategies to increase the percentage of vehicles using alternative energy sources are all being driven at the national (and international) levels.

Even though much of the influence on Rayong's transport is external, this chapter highlights a number of areas where the RPDP is not achieving its potential in terms of enhancing transport related sustainability in the province. There are four key gaps identified in the RPDP:

(i) The RPDP has not attempted to ensure integration of transport planning with broader spatial planning. This is reflective of the broader spatial planning issues identified in the urban development impact assessment chapter of this SEA;
(ii) The RPDP does not include projects to realize national goals to shift modalities of transport (e.g. private transport to public and road-based transport to rail based transport);
(iii) The RPDP does not offer any measures relating to modelling and comparing different transport development options; and,
(iv) The RPDP does not include any measures to ensure that transport infrastructure developments in Rayong are subject to environmental assessments and controls.

In the following volume of the SEA, on sustainable development pathways, the transport chapter addresses these gaps in the RPDP and provides recommendations that can be incorporated during the mid-term review of the RPDP as well as for incorporation in future iterations of the RPDP.

8 URBAN DEVELOPMENT

Strategic theme	*Strategic issues of critical concern for sustainable development in Rayong*
Urban development	• Urban expansion • Waste management (solid and liquid)
The sustainability objectives for the urban theme are that: • Urban areas are planned for energy and water conservation, transit oriented design and equity, emphasizing green infrastructure and nature based approaches. • Pollution and waste streams in urban areas are effectively managed, creating a pollution free environment.	

8.1 Introduction

Urban areas and populations in Rayong province have expanded significantly mainly as a consequence of rural-urban migration and in-migration from other provinces. This has been driven, in turn, by the employment and economic opportunities fostered largely by rapid industrial development in the province. The rapid expansion of the urban area and urban populations has led to a number of chronic environmental issues. The largely unchecked and unplanned expansion of the urban area and the lack of treatment of municipal solid waste and wastewater are the most pressing concerns.

This impact assessment chapter begins with a summary of the urban development related contents of the RPDP. In section 3, a BAU scenario is developed to show what trends for the two strategic urban issues of critical concern for sustainability would look like without the implementation of the RPDP. The trends include urban expansion, as well as issues relating to municipal solid waste (MSW) and municipal wastewater (MWW). The BAU scenario, and its trends, provides a baseline, against which the likely influence and impact of the RPDP on the strategic issues is then compared and assessed. The final section of the chapter is a conclusion and summary of key results of the sustainability analysis.

8.2 Urban development in the RPDP

Despite the importance of urban areas and their development in the province, the planning principles and sectoral goals of the RPDP do not explicitly address urban concerns. Yet, the RPDP's objective of "Good health, welfare and environment" is important in promoting urban environmental quality and well-being. An increasing number of studies are linking urban livability[38] with economic viability so that investments in quality of life factors provide a foundation for a stable and healthy economy.[39] The goals set out in the RPDP for the natural resources and environment sector link closely to sustainable urban development goals such as:

- Increasing green areas in the province ;
- Conserving and rehabilitating marine and coastal resources;
- Managing water resources to ensure water supply is sufficient and of adequate standard;
- Managing solid and hazardous waste, by ensuring proper waste treatment/disposal, including through recycling and community garbage collection and disposal; and,
- Reducing greenhouse gas emissions and adapting to impacts of climate change.

[38] "Liveability" is the sum of the factors that add up to a community's quality of life—including the built and natural environments, economic prosperity, social stability and equity, educational opportunity, and cultural, entertainment and recreation possibilities.

[39] For example, see Ichikawa, H., Yamato, N., and Dustan, P., 2016, Competitiveness of global cities from the perspective of the global power city index. Procedia Engineering 198 (2017) 736 – 74

Similarly, the RPDP has the urban development related goal of ensuring the health of Rayong people through public health and environmental health programs, as well as through accessibility of health services.

In the RPDP, projects defined broadly as urban development constitute around 9% of the total budget plan (Table 8.1).[40] These include projects for community education, new medical facilities, a number of residential water supply projects related to EEC developments and existing settlements and a relatively small investment in a number of solid waste management projects.

Table 8.1: Urban sector investments from the RPDP

Urban subsectors	Number	Amount (million THB)
Public health facilities	4	645.5
Water supply/management	5	368.3
EEC related	5	344.5
Public safety	3	146.7
Waste management	3	137.8
Community education	3	32.5
Total	**23**	**1,675.3**

Source: RPDP

Investments in the RPDP that specifically address the strategic issues of concern - ie waste management and rapid urban expansion, are very limited.

8.3 BAU scenario for urban development in Rayong

The BAU scenario involves projecting forward established trends in the strategic issues of concern under current conditions of urban planning and management. Projections are developed based upon an assessment of the key drivers, as summarized in Table 8.2.

Table 8.2: Key issues and drivers

Strategic issues of critical concern for sustainable development	Drivers and assumptions	Direction of influence on sustainability
Urban expansion (urban sprawl)	Urban population growth – urban population growth is assumed to continue in line with established trends (3.1% per year between 2009-2018)	↓ -ve
	Land-use planning/regulation - limited effective land use planning and regulation of land use for residential development. Assumed no change in effectiveness of regime.	↓ -ve
Municipal waste – solid waste (inadequate treatment of solid waste)	Population growth – provincial population growth assumed to continue in line with established trends (1.9% per year between 2009-2018), with more people generating more solid waste	↓ -ve
	Changing consumption patterns – increased income and urbanization leading to greater solid waste generation per capita, assumed to continue in line with established national trends	↓ -ve
	Solid waste management – limited capacity of solid waste system, no change expected (assumed that treatment capacity will not exceed current 1,000 tons/day)	↓ -ve

[40] Although this excludes transportation projects which are of great importance for urban development.

Strategic issues of critical concern for sustainable development	Drivers and assumptions	Direction of influence on sustainability
Municipal waste – wastewater (inadequate treatment of municipal wastewater)	Population growth – provincial population growth assumed to continue in line with established trends (1.9% per year between 2009-2018), with more people generating more wastewater	↓ -ve
	Residential water use – likely to increase from current levels towards the Thai standard of 189 l/person/day which is assumed to be reached by 2040 (equivalent to a per capita growth in water consumption of 1.1% per year)	↑ +ve
	Wastewater management/treatment – no additional water treatment capacity is expected to be introduced.	↓ -ve

8.3.1 Urban expansion

The expansion of the urban area in Rayong has been driven by in-migration from other provinces, some immigration from other countries and some rural-urban migration within the province. Employment and other economic opportunities in Rayong are the attraction. These, in turn, are largely related to the success of the Eastern Seaboard (ESB) development program, in which heavy industry became an engine of economic growth in the region. Industrial development has had flow-on effects in the services sector, most notably, the tourism sector.

Urban population growth in Rayong is expected to continue unabated. Despite uncertainties concerning the rate of industrial development in the province, economic growth remains strong and differentials in employment opportunities between Rayong and other, more rural, provinces in Thailand persist. Thus in the BAU scenario urban population growth is expected to remain in line with established trends, which officially during the 2009-2018 period, was 3.1% per year.[41] It is likely that the growth rate was significantly higher reflecting two factors – the unregistered in-migrant population in Rayong which is now estimated to be around 500,000 people – close to a 50% increase on the estimated total official provincial population of 918,400 in 2019;[42] and urban growth in Bangkok which, between 2002 and 2015, increased at an average annual rate of 4.8% and provides a more accurate indicator of growth in Rayong.[43]

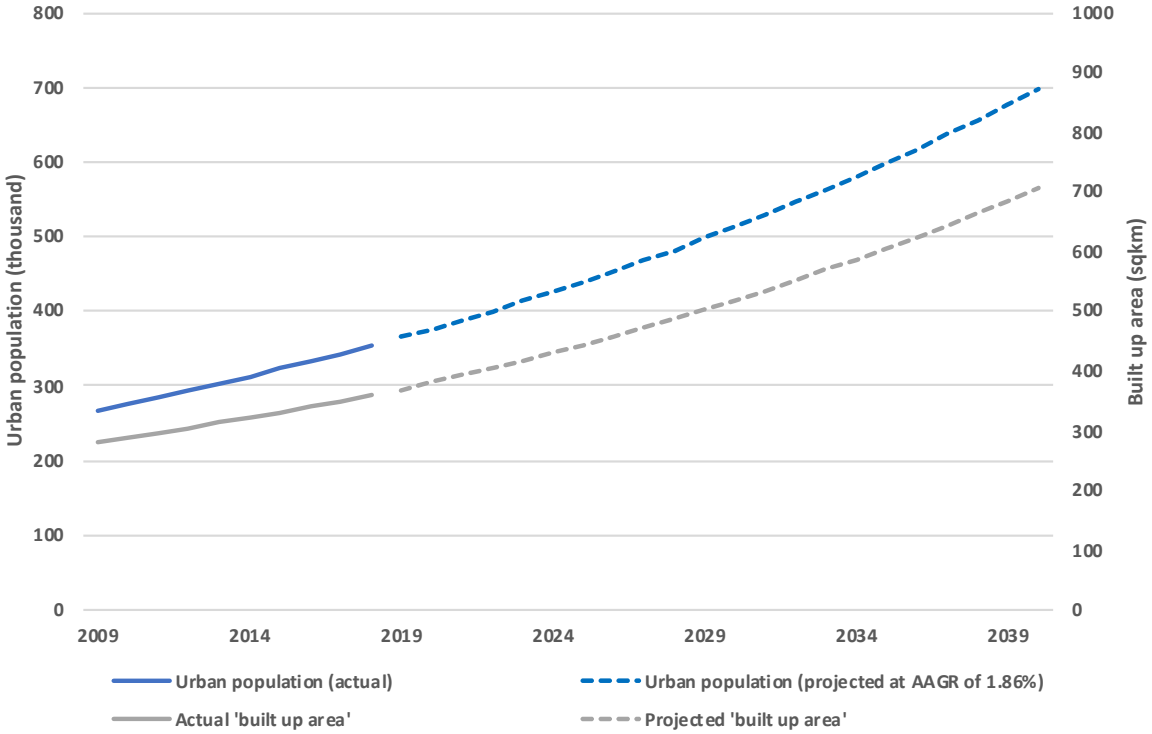
The other critical factor conditioning the extent of urban expansion and urban sprawl is the extent to which the provincial administration is able to effectively plan and control land conversion and land use. Under the BAU scenario, it is assumed that there is no changes to provincial capacities to effectively manage land use and thus there are few constraints on the pace of urban sprawl in the province. As a result, the expansion of urban area is expected to be consistent with established trends. Urban population density is expected to remain approximately the same in the BAU scenario with urban sprawl rather than infill accommodating the growing population. The expansion of urban area under the BAU scenario is therefore a direct reflection of population growth.

Stronger land-use planning capabilities at the provincial level would enable Rayong to develop medium and high density residential urban residential areas to house the growing population. However, without strong capacity in this area, low density ribbon development is expected to continue along transport corridors. There is potential for the situation to be significantly different under the full RPDP implementation scenario.

[41] Rayong Provincial Administration Office 2019
[42] https://www.citypopulation.de/php/thailand-prov-admin.php?adm2id=21
[43] http://atlasofurbanexpansion.org/cities/view/Bangkok

Expected population growth and expansion of urban area in the BAU scenario are given in Figure 8.1. These projections show the increase of urban population to around 900,000 by 2040, roughly double the current population. As a consequence, built up area is also projected to grow from 358 Km^2 in 2018 to around 700 Km^2 by 2040.

Figure 8.1: Expansion of built-up area (constant population density) 2009 - 2040



Source: ICEM calculations

8.3.2 Municipal solid waste generation

Municipal solid waste (MSW) generation is driven by population growth. Overall population growth in the province is driven by natural population growth and in-migration. A subsidiary driver of MSW generation trends is per capita MSW generation. Solid waste generation is linked to consumption patterns. With rising incomes levels and urbanization, national levels of solid waste generation per capita have grown. For example, national per capita levels of solid waste generation have increased from 1.04 Kg/day in 2009 to 1.15 kg/day in 2018.[44] Although the national solid waste management master plan (2016 – 2031) envisages a reduction in solid waste generation through the promotion of a 3Rs policy, the impact of this program to date has been insignificant. Particularly, at the provincial level in Rayong, there has been no observable impact on solid waste generation.

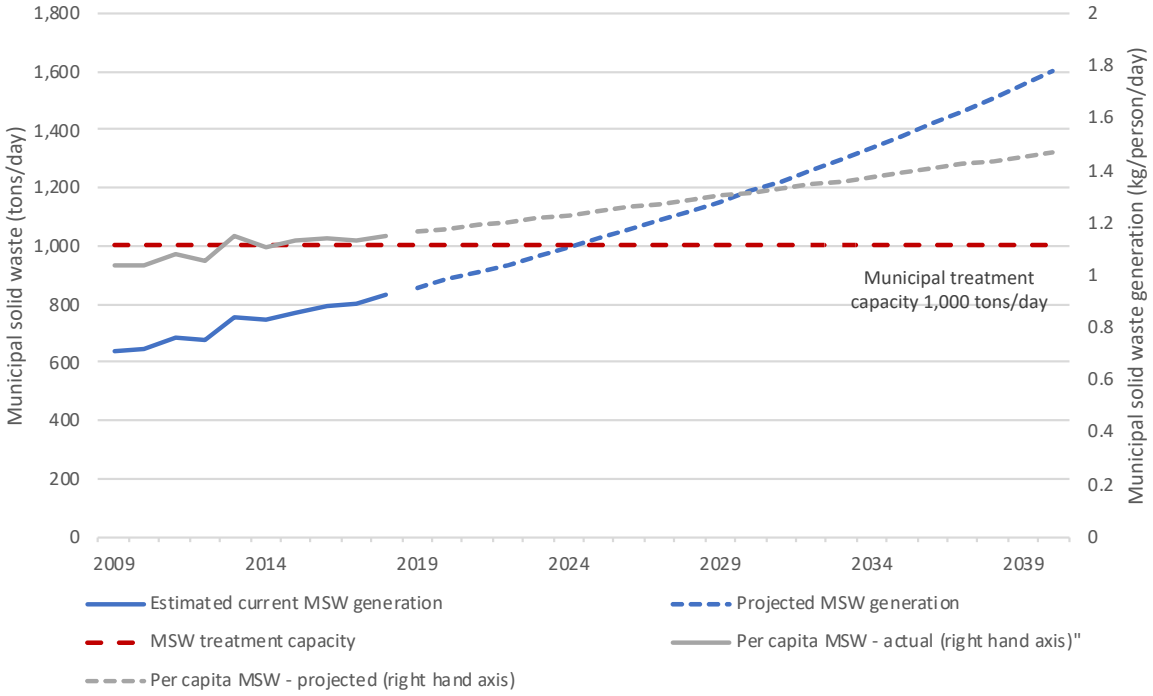
Therefore, for the BAU scenario, with the cumulative effect of both increased per capita generation, and increased numbers of people generating waste, MSW generation is expected to grow at 3% per year (Figure 8.2).

Policy programs have yet to reduce quantities of solid waste produced. Solid waste management in Rayong is also limited. Treatment capacity is currently around 1,000 tons/day. Indications are that the Rayong's solid waste treatment facilities are already working at capacity, at between 900 and 1,000 tons/day. That quantity of waste may include waste imported from other areas such as Pattaya City.

[44] PCD, 2018, Booklet on Thailand State of Pollution 2018

The capacity to manage and treat waste is not expected to increase in the BAU scenario. Thus, by 2024 solid waste generation in Rayong is expected to exceed treatment capacity. By 2040, MSW generation is expected to reach 1,600 tons/day.

Figure 8.2: Growth in MSW generation and municipal treatment capacity 2009-2040



8.3.3 Municipal wastewater generation

As with urban expansion and solid waste generation, municipal wastewater generation is driven by population growth and domestic water use. Population growth in the BAU scenario is expected to be consistent with established trends at 3.1% between 2018 and 2040.

Considerable uncertainty surrounds the estimation of per capita wastewater generation. Official estimates of 189 l/person/day of wastewater suggest a higher level of wastewater emissions than actual residential water supplied. Instead, here, wastewater estimates were based on residential water use in the province, with wastewater estimated to be around 80% of water supply. Planned water supply figures were available up to 2021. These were used to calculate wastewater effluent in the province to 2021. Residential water use varies greatly, typically depending on the extent to which household water use is subsidized.[45] However, for the purposes of these projections we assume the UN benchmark of 165 l/person/day is met by 2040. This allows an estimation of municipal wastewater generation in the province growing 60% from over 88,000 m^3 per day in 2018 to over 140,000 m^3 by 2040.[46]

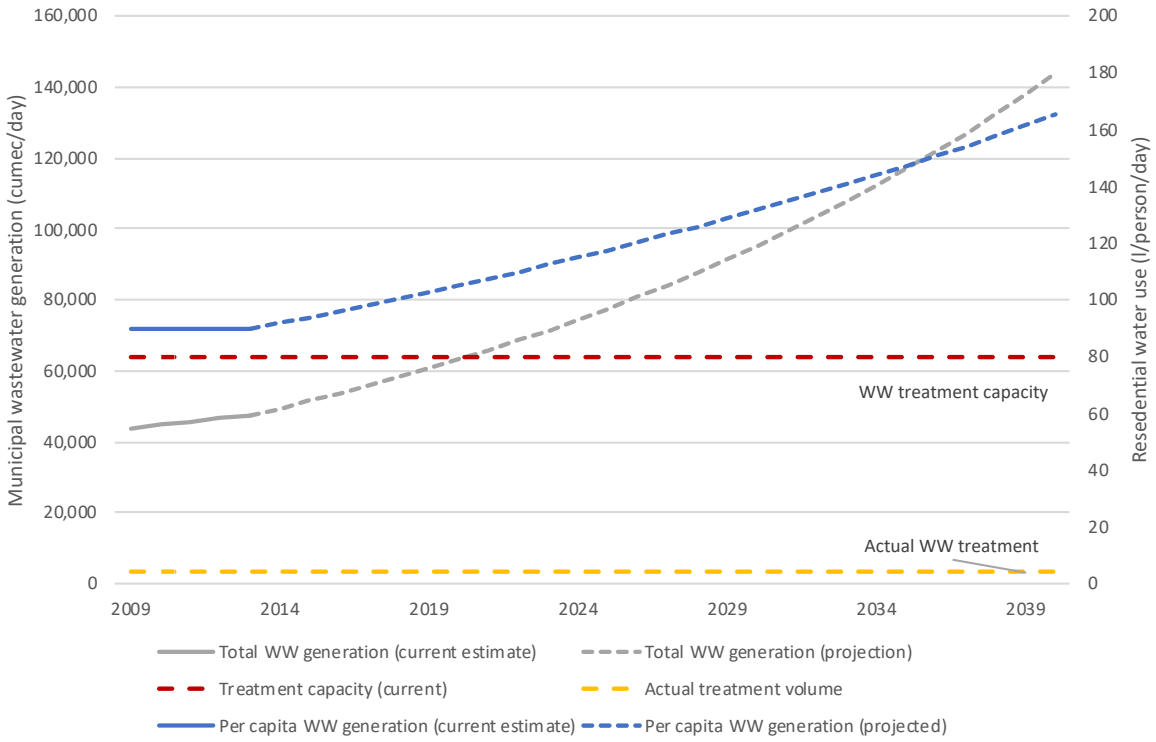
The extent to which future wastewater will be treated is hard to determine. Most households are not connected to the sewage system, and treatment capacity is well below demand. Also, the three wastewater treatment plants in Rayong are working at only a small fraction of capacity (Figure 8.3).

Under the BAU scenario no additional capacity is installed. A significant proportion of households rely on on-site treatment of wastewater in septic tanks, but many are properly maintained and functioning

[45] For example, in Japan water use is 322 l/person/day, in Taiwan 271, RoK 208 and Singapore 143.
[46] 165litres x ~540,000 urban residents/1,000 litres per cubic metre

effectively. Already significant amounts of untreated wastewater is discharged direct to the environment, and that these amounts will increase. However, there is no data on what share of domestic wastewater is currently untreated, or on trends in untreated wastewater.

Figure 8.3: Wastewater generation and treatment capacity 2009 - 2040



Source: ICEM calculations

8.4 The impact of full RPDP implementation

Most project investments in the urban sector under the RPDP do not address the critical urban sustainability issues identified during the SEA process (Table 8.1). There are no projects addressing land use and land use planning or municipal wastewater generation and treatment. Although there are plans for minor small-scale treatment facilities relating to wastewater generated from the tourism sector.

The projects in the plan to improve the management of wastewater and solid waste mainly consist of indirect support for waste management, focusing on public information and training programs and in some cases small-scale infrastructure. There are similar supporting projects and programs focusing on waste streams generated by the tourism and industrial sectors.

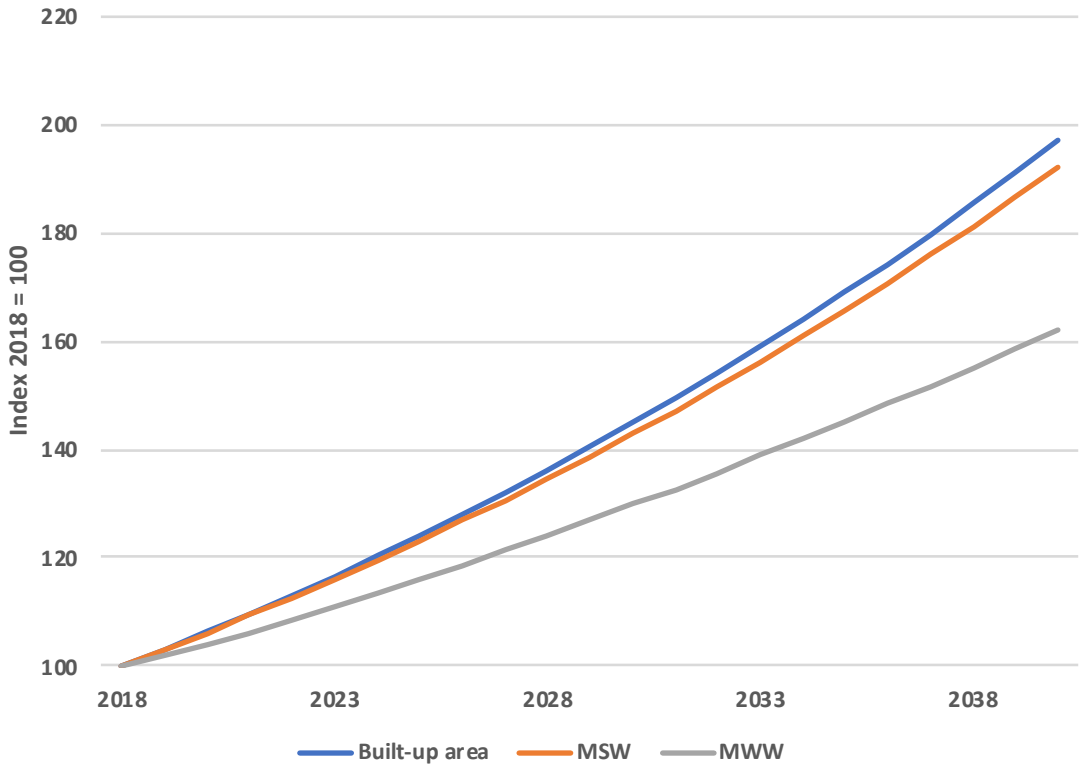
RPDP also includes, as a performance target, the reduction of solid waste generation by 12%, but it is difficult to see how the investments identified in the plan can achieve this goal. For example, while source separation of waste streams and composting of organic solid waste will be encouraged, this initiative is not supported by any new regulations or enforcement mechanisms and capacities.

Based on the contents of the RPDP, it is deemed unlikely that the full implementation of the plan will significantly affect the trends as described in the BAU scenario. Nor is there expected to be any appreciable improvement in treatment capacity. Therefore, **with full implementation of the RPDP, the generation of solid waste and wastewater, is expected to continue on the same trend as the BAU scenario**. Similarly, **expansion of the urban area is likely to continue as per the BAU scenario**. These trends are summarized in Figure 8.4.

In late 2019, the Rayong Town and Country Planning Department will introduce a transitional spatial plan for the province which gives practical expression to the new zoning under the EEC plan. The area

under industry and urban zones will be increased to accommodate anticipated expansions in both sectors. The spatial plan is an integral part of the broader RPDP, but this adjustment does not affect the main conclusions here – that the RPDP will have limited influence on sustainability in urban development beyond that anticipated under the BAU scenario.

Figure 8.4: BAU/RPDP trends in critical urban sustainability issues 2018 - 2040



Source: ICEM calculations

8.5 Conclusion

The RPDP does include some elements which may have a minor impact on ameliorating trends in the critical urban sustainability issues (urban expansion, MSW and MWW) identified as urban development concerns in the province. However, these investments are unlikely to appreciably alter the established trajectory in these issues. There are no major investments within the RPDP to directly address them. It is unlikely other measures (such as source separation of MSW) will have appreciable impact unless there is significant effort and resources applied to implementation and enforcement. This is particularly true for urban expansion, with land-use planning and control mechanisms either inadequate or unenforced. Similarly, for the case of MWW, where regulations on treatment requirements are frequently abused, there are no regulatory means of ensuring that existing water treatment facilities at dwellings are brought up to standard. Also, there is a lack of monitoring. Without significant investment commitment and supporting legislative changes the critical environmental and sustainability issues facing urban development will continue to grow and undermine the inclusive and environmental quality focused strategies and objectives of the RPDP.

9 TOURISM

Strategic theme	*Strategic issues of critical concern for sustainable development in Rayong*
Tourism	• Growth in tourist numbers and facilities • Environmental impact of tourism facilities • Marine and coastal debris and pollution, especially plastics and petroleum products, threaten tourism
The sustainability objectives for tourism are: • Promote ecological, community and agricultural tourism • Ensure that tourism related solid waste and waste-water is treated properly	

9.1 Introduction

The tourism sector in Rayong Province has been steadily growing over the past decade at around 10% per year. The coastline is particularly important for the tourism industry in the province, with the Eastern Seaboard Area being formally designated as a tourist area. With the Rayong development plan, infrastructural expansion such as the expansion of Highway 3, the IRPC port and a train connection to U-Tapao airport could facilitate a further growth in the sector.[47]

However, the expanse of tourism has not been without its costs. There is growing concern over increasing environmental impact, for example by the increasing amount of debris and plastic waste found on the beaches and in the stomachs of beached endangered animals. Thailand is ranked as the sixth largest contributor of marine debris in the world. The tourism sector contributes to that solid waste pollution load and suffers its negative effects. 80% of Thailand's marine debris has land-based sources. In response, in 2019, the Government announced a target to reduce marine debris by at least 50% by 2027, by applying the principle of the circular economy.[48]

The tourism sector in Rayong is linked to broader national tourism initiatives and goals. The sector contributes 12% of Thailand's GDP,[49] and seeks to contribute in reaching targets under Sustainable Development Goal (SDG) 8 - promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, and SDG 12 – ensuring sustainable production and consumption.[50]

The following sections describe tourism in Rayong and how effectively it is managing to implement the SDG objectives. That is done, first by assessing the sustainability of a BAU scenario which assumes that past and current practices and management strategies continue, and then assessing a full implementation of the RPDP scenario. Because of external influences on the province, a further section explores other factors influencing tourism sustainability in Rayong.

9.2 Tourism-related content of the RPDP

RPDP strategic priority 2 focusses on "developing tourism potential…with quality and sustainability." It emphasises the importance of the sector working closely with agriculture and industry to resolve problems and "create diversity and innovation for tourism" in expanding potential attractions. The seven strategic objectives supporting the priority call on Rayong to restore and conserve tourism attractions and development new products and capacities. Table 9.1 provides an overview of RPDP

[47] Rayong Development Plan 2018-2021
[48] https://www.bangkokpost.com/thailand/general/1639860/thais-plan-to-cut-sea-debris-by-50-
[49] https://thaiembdc.org/2019/02/04/thailand-sets-new-tourism-record-with-over-38-million-arrivals/
[50] SDG 8, Target 8.9: By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products
SDG 12, Target 12.B: Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products

projects of relevance to tourism. The total value of tourism related projects is about 860 million THB, or about 4.7% of the total proposed RPDP budget.

The relevance of the RPDP to each of the three issues of concern identified by SEA stakeholders are examined in the following sections starting with a listing of tourism related projects in the Plan (Table 9.1).

Table 9.1: RPDP Projects that support sustainable tourism development in Rayong

No.	Theme	Project details	Project size (millions THB)	Tourism type*	Waste/natural resource type
1	Agriculture	Project to promote and link the agricultural sector to the tourism sector	4.8	Agriculture	
2	Tourism	Restoration and new tourist development project	95.8	Cultural and nature-based	
3	Tourism	Project to develop and improve the route of the Pluak Daeng Development Service Centre (agricultural tourism)	25	Agriculture	
4	Tourism	Agricultural Tourism Development Project, Tourist Development Service Centre	90	Agriculture	
5	Tourism	Mangrove conservation tourism development project in the area of road Chalerm Burapha Chonlatit Is a sustainable ecological learning centre and development	92	Ecotourism	
6	Tourism	Project to create consciousness to conserve tourism resources	1.5	Ecotourism	Solid waste
7	Tourism	Development project for wetland ecotourism	20	Ecotourism	
8	Tourism	Conservation and restoration for mangrove forest and watershed tourism	5	Ecotourism	
9	Tourism	Artificial coral tourism development Koh Samet	10	Nature-based	
10	Tourism	Project to create a separate wastewater treatment systems for additional waste water generated by tourism development	10	Nature-based	Wastewater
11	Tourism	Rayong marketing and public relations project	120	all	
12	Tourism	Construction and infrastructure development for tourism services standard	138	Nature-based	
13	Tourism	Water management on Koh Samet	130	Nature-based	Water supply
14	Natural Resources	Cultivation project for coral propagation and transplantation for ecological restoration coral reefs that are affected by the oil spill situation in Koh Samet area	20	Nature-based	
15	Natural Resources	Buoy installation and repair, maintenance of reefs and reefs, water play frame in the major tourist attractions of Khao Laem Ya National Park Koh Samet	4	Ecotourism	
16	Natural Resources	Enhancing the efficiency of waste management in Koh Samet	93	Nature-based	Solid waste
COMBINED PROJECT VALUE			**859.1**		

***Agricultural tourism is tourism in agricultural areas, cultural tourism is tourism to man-made destinations, nature-based tourism is tourism in natural areas and ecotourism refers to tourism aimed at minimizing environmental impact*

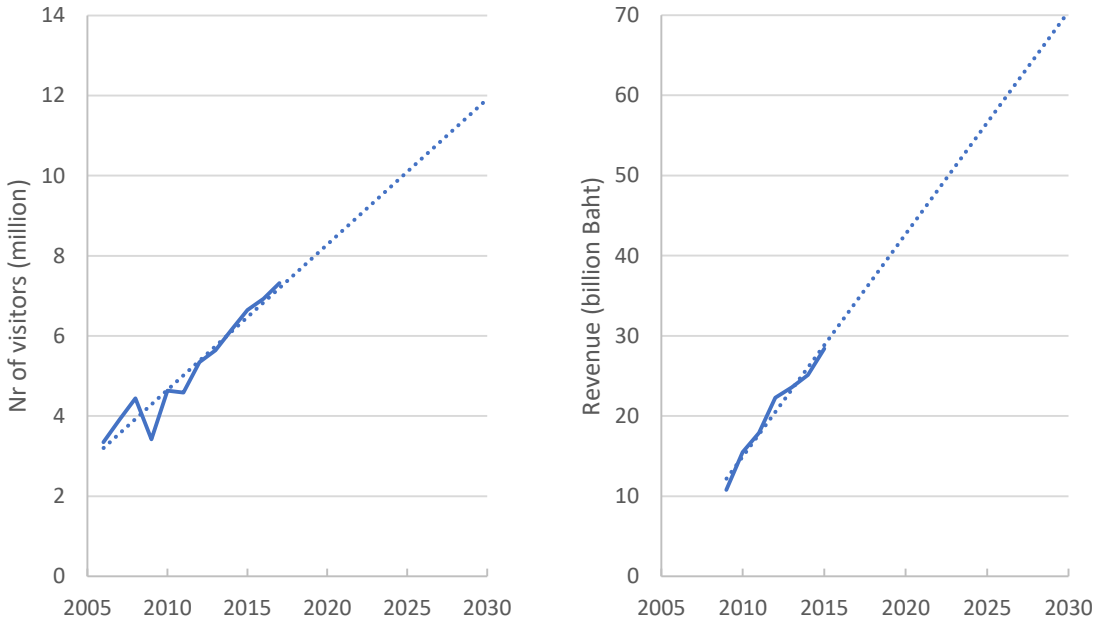
9.3 BAU scenario for tourism in Rayong

In 2017 the tourism sector contributed 33.6 million THB to Rayong's economy.[51]. Beach areas, mainly on Koh Samet, as well as in Rayong and Klaeng district, are the primary tourism destinations. Most tourists are domestic, mainly from Bangkok. While eco-friendly tourism is a minor component of the sector, at the national level, promotion of sustainable tourism is included in the Twelfth National Economic and Social Development Plan (NESDP) (2017-2021).

9.3.1 Growth in tourism numbers and facilities

Rayong's tourism sector has grown steadily over the last decade, both in numbers of visitors, and in revenue (Figure 9.1). Further tourism growth is projected, following campaigns led by the Tourist Authority of Thailand (TAT).[52] Improvements in transport connections is likely to further facilitate and stimulate tourism growth. If the trend of the last decade continues, tourism-based revenue will more than double by 2030, with tourism numbers increasing more slowly which reflects a growing expenditure per tourist visit (Figure 9.1).

Figure 9.1: Projections of continued trend to 2030 of increasing numbers of tourists[53,54] (Left) and increasing revenue[55] (right) from tourism in Rayong province



Tourism growth has been supported by increasing numbers of tourist attractions and a diversification into agricultural tourism on farms and ecotourism in natural areas, including marine and coastal areas

[51] MoT (2018) Tourism indicators: income from Thai and foreign visitors Fiscal Year 2018 Oct 60 - Mar 61 (31 May 2018). Ministry of Tourism and Sports. URL: https://www.mots.go.th/ewt_dl_link.php?nid=10459 (article_20180531114821.xlsx)
[52] RPDP (2018) The Development Plan of Rayong Province, 2018-2021 (review year 2020). Administrative office of Rayong province, Thailand
[53] NSO (2017) Domestic Travellers by Province: 2009 – 2017. National Statistical Office. URL: http://statbbi.nso.go.th/staticreport/Page/sector/EN/report/sector_17_19_EN_.xlsx
[54] NSO (2015) Number of visitors Classified by region and province, 2006–2015. National Statistical Office. URL: http://service.nso.go.th/nso/web/statseries/tables/00000_Whole_Kingdom/16.2.xls
[55] NSO (2017) Domestic Travellers by Province: 2009 – 2017. National Statistical Office. URL: http://statbbi.nso.go.th/staticreport/Page/sector/EN/report/sector_17_19_EN_.xlsx

as well as national parks.[56] While historical data is limited, between 2015 and 2017 the number of tourist attractions in Rayong grew from 300 to 400 with more ambitious targets to 2025.[57] Yet, under the BAU scenario, there are no systematic mechanisms being applied for ensuring quality in products and services and in the environmental performance of the sector. For example, in the last decade there have been no EIAs conducted on tourism development projects in Rayong with entrepreneurs avoiding thresholds which might attract environmental oversight.

National policies[58] promote community-based tourism and it has proved successful in some provinces of Thailand following arrangements in which local residents invite tourists to visit their communities with the provision of overnight accommodation. The residents earn income as land managers, entrepreneurs, service and produce providers, and employees. It is usually linked with poor and marginalised communities. There is no evidence of community-based tourism as a significant strategy in Rayong.

Agricultural tourism is being driven by the agricultural sector, which has suffered a steady decline in Rayong during the past decade. It has the potential to increase farm employment opportunities and enhance revenues and quality of life for farmers. Agro-tourism is also a means to promote integrated urban and rural development, improve the quality of agricultural products and services, and widen economic, environmental and social benefits. In Thailand, which has a long history in this field, agro-tourism and eco-tourism have become similar types of tourism attractions that represent an integration of development and conservation of rural cultural landscapes. However, fruit orchards tourism is also growing, and here the links to sustainability are not always as clear. To date only some localities have proved attractive to tourists, and only some farmers have the knowledge, skills, and resources to take advantage of the opportunities offered by tourism.[59] [60]

Ecotourism and nature-based tourism are also important in Rayong. Ecotourism uses the natural assets of a place to attract visitors, and generally depends on ecosystems being relatively intact. Ecotourism management seeks to minimize visitor-related environmental impacts, and ecotourism is also often linked to ecosystem conservation.

Nature-based and ecotourism destinations in Rayong include beaches, mangroves, forests, coral reefs, and the two national parks. Visitors also come to Rayong for the birdlife and to visit sea turtle conservation centres. Tourism developments such as these are increasingly considering the carrying capacity of ecosystems, with research being done to inform developments and to place realistic caps on maximum tourist numbers.[61]

On the surface, the growth in agricultural-based and nature-based tourism seems promising for Rayong moving both the agriculture and tourism sectors to more sustainable practices. Yet, a lack of clarity in “alternative” tourism regulations has been linked to “greenwashing”, with ecotourism

[56] https://www.bookdifferent.com/en/
[57] MoT (2017) Tourism in Thailand: Statistical Report 2017, Ministry of Tourism and Sports, Bangkok. (Table 2.6), Available at: https://www.mots.go.th/ewt_dl_link.php?nid=11588
[58] For example, the 12th National Economic and Social Development Plan
[59] Ariya Aruninta, 2011, *The pros and cons of agro-eco tourism development in rural provinces of Thailand*. The 2nd International Symposium of International Federation of Landscape Architects, Asia Pacific Region, Cultural Landscape Committee (IFLA APR CLC), http://www.land.arch.chula.ac.th/data/file_20111206210909.pdf
[60] NESDB (2017) The Twelfth National Economic and Social Development Plan (2017-2021). Office of the National Economic and Social Development Board, Office of the Prime Minister, Bangkok, Thailand. URL: http://www.nesdb.go.th/nesdb_en/ewt_w3c/ewt_dl_link.php?nid=4345
[61] NESDB (2017) The Twelfth National Economic and Social Development Plan (2017-2021). Office of the National Economic and Social Development Board, Office of the Prime Minister, Bangkok, Thailand. URL: http://www.nesdb.go.th/nesdb_en/ewt_w3c/ewt_dl_link.php?nid=4345

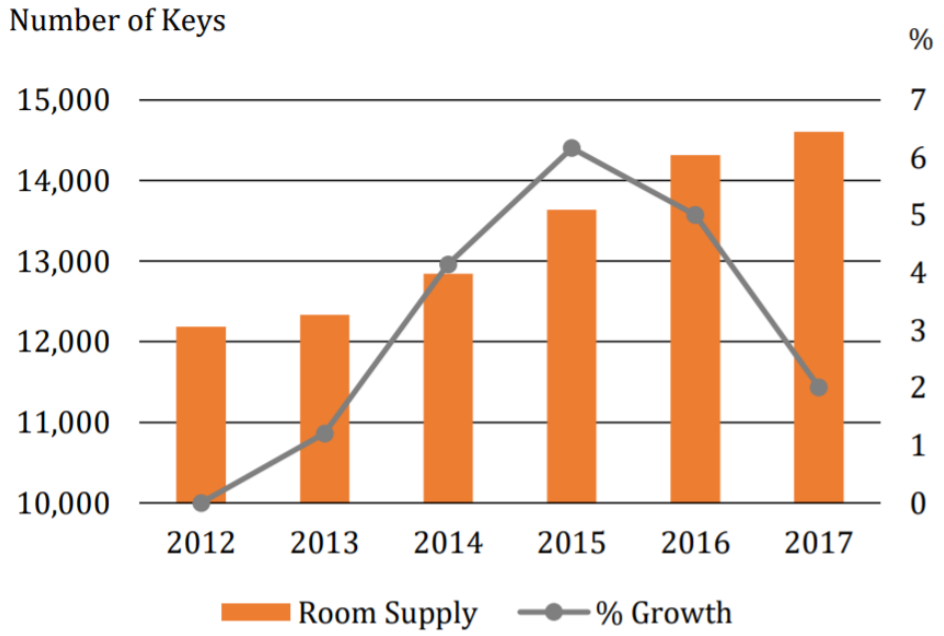
ventures causing damage to ecosystems and to neighbouring communities. Without adequate accreditation systems or monitoring greenwashing type issues are likely to continue undermining progress in tourism sustainability.

9.3.2 Environmental impact of tourism facilities

Tourism infrastructure in Rayong has often degraded natural resources including coral reefs, seagrass and coastal ecosystems and added to localised solid waste and water quality problems.[62] Poor land use planning and zoning enforcement has contributed to largely unmanaged sector development. Tourist boats, restaurants and hotels discharge waste directly into waterways and into the sea. Garbage in the water has led to fatalities in marine species such as Dugong, dolphin, the Hawksbill turtle,[63] and other marine animals, [64] and is linked to coral infections and die back.

Hotel expansion at around 3.5% each year (Figure 9.2) is leading to increasing water and energy consumption. The tourism-related water demand in Rayong is about 3.3 million cubic meters (mcm) per year, which is around 0.5% of annual provincial water consumption. This proportion is likely to grow on trend with tourism sector growth.

Figure 9.2: Rayong Province - increase in hotel rooms: 2012-2017



Source: Thailand Department of Tourism

For alternative forms of tourism to reach their sustainability potential, accreditation and monitoring systems need to be put in place. Without this regulatory and capacity building framework, there is a risk that sustainable tourism labels will not bring the livelihood and ecological benefits envisaged.

[62] NESDB (2017) Twelfth National Economic and Social Development Plan (2017-2021). Office of the National Economic and Social Development Council, Office of the Prime Minister, Bangkok, Thailand. URL: http://www.nesdb.go.th/nesdb_en/ewt_w3c/ewt_dl_link.php?nid=4345

[63] DMCR (2018) Rayong Province. Department of Marine and Coastal Resources, Ministry of Natural Resources and Environment. July 2018. and https://www.ibtimes.sg/coral-reefs-thailand-decaying-alarming-rate-scientists-blame-it-tourism-23799

[64] https://e360.yale.edu/features/the-toll-of-tourism-can-southeast-asia-save-its-prized-natural-areas

Tourists have higher consumption requirements than local communities. When they visit Rayong, they put higher per capita stress on provincial services than residents do. For example, tourists tend to generate more solid waste and more polluting waste-streams and consume more water and energy per capita than provincial residents. Rural populations tend to produce mostly organic waste, whilst tourists visiting from cities tend to generate more plastic wastes such as shopping bags, plastic drink bottles and disposable food packaging. Without effective management these waste-streams can negatively affect environmental quality and community health in tourism destinations.[65]

Tourism generates around 9% (~33,000 tons) of Rayong's MSW each year. The island of Koh Samet alone generates about 7-15 tons of garbage per day (about 1-2% of total MSW produced in Rayong), with most of this waste coming from the tourism industry.[66] Over one third of total waste generated in Rayong province is improperly managed. One of the main problems for tourism-related waste is a lack of garbage collection services.[67]

Based on past trends, under the BAU scenario, waste generated by tourism-related activities will rise from 35,000 to 69,000 tons per year between 2017 and 2030 (Figure 9.3). The projection relies on the following assumptions:

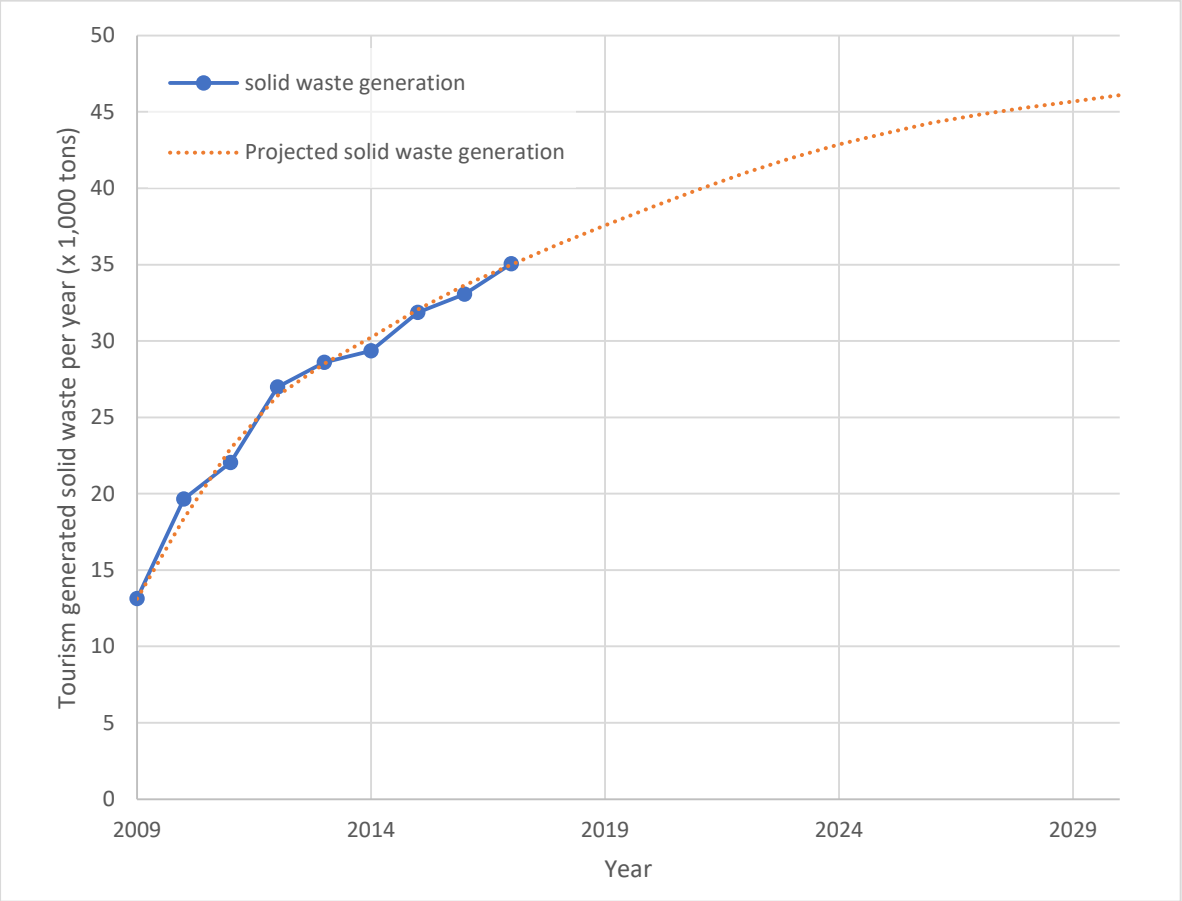
1. The increasing number of tourists and length of stay each year continues to 2025 in line with past trends,
2. That average solid waste generation per visitor continues to increase in line with past trends (ie an annual increase of 0.0146 kg/person/day between 2012 (1.76 kg/person/day) and 2025 (1.95 kg/person/day)).[68]

This projection is conservative, since the numbers are based on average municipal solid waste production in Thailand. Most visitors to Rayong come from Bangkok where waste generation per capita is more than 1.5 times higher than regional areas of Thailand.

There are some ameliorating factors that could influence tourism-related solid waste. For example, waste generation on Koh Samet is likely to decrease following the plastic bag ban announced in November 2018. Visitors who are caught in the Koh Samet national park using plastic bags or Styrofoam containers will be liable to a fine of up to 1,500 THB (~US$48). Similar consumption incentives are needed for all tourism destinations if mounting solid waste generation is to be contained.

[65] Konradsen, Flemming. "Tourism - a Major Generator of Solid Waste - Promoting Environmental Public Health." Online course website. Coursera, 2017. https://www.coursera.org/lecture/sustainable-tourism/tourism-a-major-generator-of-solid-waste-sWgbd.
[66] RPDP (2018) The Development Plan of Rayong Province, 2018-2021 (review year 2020). Administrative office of Rayong province, Thailand
[67] RPDP (2018) The Development Plan of Rayong Province, 2018-2021 (review year 2020). Administrative office of Rayong province, Thailand
[68] Hoornweg, daniel, and Perinaz Bhada-Tata. "What a Waste - a Global Review of Solid Waste Management." Knowledge Paper. Urban Development Series. Washington, DC: World Bank, 2012.

Figure 9.3: Estimated projections for solid waste generated by tourism in Rayong Province



Lack of wastewater treatment in Rayong is one of the most serious environmental quality concerns facing the province. It is compounded by the increasing tourist population and limited environmental controls over hotels, restaurants and other tourist facilities. While domestic and industrial sources contribute most to the wastewater loading, tourism plays a large role in the main tourism destinations. And, because tourism destinations are frequently located in important or fragile ecosystems, untreated tourism-related wastewater has disproportionate impact on these natural areas.

In Rayong, the quality of wastewater effluent required for hotels depends on the number of rooms. For example, hotels with less than 60 rooms need to adhere to one effluent standard, those with 60-200 rooms must adhere to a stricter standard, and hotels with more than 200 rooms have a stricter standard again.[69] Some hotels have circumvented this room number based standards system through the use of multiple receptions, so that each reception is only nominally responsible for a lower number of rooms. For example, a hotel with 100 rooms and two receptions need only adhere to the lowest-range standard, because each reception is responsible for only 50 rooms (Interviews, Rayong Pollution Control Centre, 28th May, 2019).

While there are national strategies to address these issues, there is little evidence of them being applied in Rayong beyond some small-scale awareness raising. Thus, under the BAU scenario, it is projected that waste water effluents and solid waste generation will increase on trend with the overall growth in tourism. Tourism activities will continue to degrade water quality in localised areas of

[69] "Water Quality Standards." Company Website. SECOT, 2016. http://www.secot.co.th/secot_ww/StandardSECOT/6.%E0%B8%84%E0%B8%B8%E0%B8%93%E0%B8%A0%E0%B8%B2%E0%B8%9E%E0%B8%99%E0%B9%89%E0%B8%B3.pdf.

Rayong where tourist facilities are concentrated. In terms of solid waste management, positive factors that will impact on tourism generated solid waste are (i) the plastic bag ban on Koh Samet, and (ii) broader trends in awareness about waste generation. However, the impact of these initiatives will not be significant in modifying existing trends.

9.3.3 Summary of BAU influence on sustainability

Under the BAU scenario, increasing numbers of visitors will increase natural resource demand and waste. Alternative tourism is in nascent stages in Rayong and, while promising, will not keep pace with conventional tourism. These is growing awareness among tourists and tourism sector managers of the negative consequences of current tourism practices. However, issues such as lack of environmental assessment and accreditation for tourist enterprises leave open possibilities for poorly performing development in terms of sustainability and for greenwashing that undermine other positive factors.

Solid waste generation from tourism is likely to increase substantially, with increasing localised impacts in tourist areas and on ecosystem health and biodiversity. Similarly, wastewater from the tourism industry is projected to increase, with little indication that wastewater management and treatment problems in the province are being systematically and convincingly addressed.

9.4 Impact of the RPDP on sustainability

This section explores the sustainability consequences of full implementation of the RPDP.

9.4.1 Growth in tourist number and facilities under the RPDP

The RPDP includes tourism promotion as a key element of Rayong's development. For example, THB 120 million is included as planned expenditure to market Rayong as a tourism destination. Despite the introductory sections of the RPDP embracing sustainable tourism, most proposed investments focus on conventional infrastructure development. It could be argued that the projects would enhance carrying capacity at key tourist destinations. For example, a THB 96 million project for 6 districts on Koh Samet includes substantial investment in bridges, shops and parking areas, and modest funding to improve existing nature trails and cycling routes (Table 9.1, project 2).

There are a number of other projects that focus on developing new natural and cultural destinations. If executed, these projects have the potential to stimulate tourism growth and to decrease pressure on existing destinations.

Agricultural tourism is being encouraged with the aim of bringing additional income into Rayong's ailing agricultural sector. Although currently at a small scale, it also has potential to contribute to sustainable development in Rayong's tourism sector. The RPDP has a range of measures that, if implemented, will support agricultural tourism growth. For example, THB 115 million is included for specific agricultural tourism initiatives (Table 9.1, projects 3 & 4), and investment to promote and encourage study visits on farms (Table 9.1, project 1). These types of initiatives are associated with a number of challenges relating to quality control, environmental quality and local capacities.

Ecotourism is also promoted through a range of projects in the RPDP. Some focus on rehabilitation and conservation of natural systems initiatives. For example, one project encourages visitors to plant natural corals and mangroves and marine grasses (Table 9.1, project 8). There are projects to establish artificial reefs (Table 9.1, project 9). Other projects seek to improve interpretation facilities, for example, a Chonlatit ecological learning and resource centre (Table 9.1, project 5). Other valuable projects aim to improved water management and enhance the efficiency of waste management on Koh Samet, and one to create separate wastewater treatment systems for waste water generated by tourism development (Table 9.1, projects 13, 16 and 10). While support for local entrepreneurs is included in other parts of the RPDP, it is conspicuously missing from the tourism related aspects of the plan, as is capacity building in management of sustainable tourism and guiding behavioural change in managers and visitors. Also lacking are projects to improve the environmental performance of hotels, restaurants and markets which are a growing source of serious localised pollution.

These agro-tourism and eco-tourism initiatives in the RPDP are important and point the way to establishing Rayong as a tourist destination based on diverse seafood, heritage and natural assets. But the relatively small investments within the RPDP are not sufficient to halt forces degrading those core attributes.

9.4.2 Environmental impact of tourism facilities

The RPDP includes projects to decrease the environmental impact of tourism. For example, using buoys to indicate no-go areas for tourists, to prevent further damage to sensitive ecosystems, with a linked ecosystems rehabilitation component in Khao Laem Ya National Park, Koh Samet (Table 9.1, project 15). Additional projects support restoration of natural areas and habitats, including construction of an artificial reef as a potential tourism asset (Table 9.1, project 9). Other projects relate to provision of freshwater and waste treatment.

Of the total THB 860 million of tourism focused expenditure in the RPDP, around 12% (THB 104.5 million) targets waste and wastewater management, all on Koh Samet. THB 93 million is proposed for increasing solid waste management, and THB 1.5 million targets environmental and conservation awareness raising as well as environmental monitoring. The remaining THB 10 million is a project to construct a series of tourism related wastewater treatment systems.

While the RPDP projects for tourism related water and waste management are important, the growing scale of the environmental quality challenges and trends identified in the BAU scenario linked to tourism will require more substantial and systematic investments engaging the private sector and regulatory authorities to offset.

9.5 Other factors influencing sustainability of tourism in Rayong

A number of other policies and plans could influence the tourism sector in Rayong and its sustainability. .

9.5.1 Growth in tourist number and facilities

The EEC Environmental Plan (2018-2021) prepared by MONRE, includes measures for community involvement in tourism facility planning and management, including sharing in the benefits. The plan aims to increase knowledge among tourism sector stakeholders (e.g. entrepreneurs, community guides and government officials) on ecotourism and its management.[70] It seeks to apply sustainable tourism standards, develop ecotourism management and to focus on the sensitive development of tourist attractions which can support and set guidelines for conservation, rehabilitation and sustainable use.[71] The EEC environmental plan also includes measures to improve natural coastal resources management in three of Rayong's districts, as well as to strengthen ecotourism in national park areas. Together the projects, initiatives and broader policy frameworks support continued growth of tourism in Rayong, but include an emphasis on decoupling tourism from environmental consequences.

9.5.2 Environmental impact of tourism facilities

There is a strengthening global focus on sustainable tourism, which has been picked up by Thailand's national tourism agencies and expressed in the 12th National Socio-economic Development Plan. In

[70] MONRE (2019) EEC Environmental Management Plan (2018-2021). Ministry of Natural Resources and the Environment, Royal Thai Government
[71] MONRE (2019) EEC Environmental Management Plan (2018-2021). Ministry of Natural Resources and the Environment, Royal Thai Government

2018, Thailand received international recognition from the Global Sustainable Tourism Council (GSTC) for its sustainable tourism standards framework. Those national standards will encourage and provide guidance for sustainability measures in the tourism sector in Rayong, although they lack legislative backing. .[72]

In the EEC Environment Plan there are measures to deal with pollution at its source through on site wastewater treatment and pollution control, for example, addressing waste from tourist boats and their cargo as well as controlling dumping at seaside tourist attractions.[73] The Plan includes goals to restore marine and coastal areas for tourism, with measures for management of marine pollution and beach cleaning.[74]

Most of those proposed investments for tourism sustainability and environmental management have not been picked up in the RPDP, which points to an underlying institutional, budgetary and policy failures linking national, regional and provincial environmental management authorities.

9.6 Conclusions

The RPDP tourism related focus is to develop new tourism destinations, and to rehabilitate existing sites. Implementation of the plan is likely to stimulate further growth in tourism numbers and facilities beyond the BAU scenario. However, the RPDP includes only limited investments that would address social and environmental factors. Important fields encouraged through the RPDP are agricultural and ecological tourism development. There is a gap in support for community tourism, which is likely to undermine the potential for agricultural tourism to lead to improved social and environmental outcomes.

The RPDP includes a number of investments that specifically promote tourism in natural areas. Additionally, projects support conservation and increased environmental consciousness, however the focus on increasing visitor numbers in the plan is likely to result in increased environmental effects. The plan recognises existing limitations in waste and wastewater treatment and management, but these issues are not adequately addressed. With the growth of alternative tourisms, and a growing awareness among tourist operators of ecological implications of tourism activities, it is important that those who use sustainable tourism labels such as ecotourism, community tourism, or agricultural tourism, are held to a set of environmental standards. That framework and management system is not in place, with sustainability initiatives being introduced in an ad hoc and reactive manner.

[72] https://www.tatnews.org/2018/05/thailands-sustainable-tourism-management-standard-is-now-gstc-recognised-standard/
[73] MONRE (2019) EEC Environmental Management Plan (2018-2021). Ministry of Natural Resources and the Environment, Royal Thai Government
[74] MONRE (2019) EEC Environmental Management Plan (2018-2021). Ministry of Natural Resources and the Environment, Royal Thai Government

10 FISHERIES AND COASTAL AND MARINE ENVIRONMENTAL MANAGEMENT

Strategic theme	*Strategic issues of critical concern for sustainable development in Rayong*
Coastal and Marine Environment	• Unsustainable fishing practices • Poor management of solid wastes and effluent discharges • Limited environmental monitoring and reporting to support effective evidence-based management
The sustainability objectives for the coastal and marine environment are: • Sustainably use marine and coastal resources • Restoration, enhancement and protection of marine and coastal ecosystems and resources	

10.1 Introduction

The baseline assessment of Rayong's coastal and marine management identified three strategic issues of concern for provincial development. Overexploitation of fishery resources have caused a downward trend in fish capture, and coastal shrimp aquaculture production is threatened by pollution and disease outbreaks. Coastal and marine ecosystems are degraded by solid wastes and effluent discharges from domestic, commercial and industrial sources. Physical damage caused by fishing to coral reefs, and impacts associated with the growth of the tourist sector including those arising from wastewater discharges and sedimentation from coastal development are a cause of concern. Marine debris, especially plastics, has become more widespread in Rayong's coastal environment and threatens endangered species – a pressing issue recognised at the highest level in government. Monitoring and reporting on environmental quality in estuarine and coastal waters is piecemeal with differing opinions and data on the situation across relevant government agencies. Local communities have expressed concern over the lack of information on water quality, especially with regard to industrial wastes and potential contamination of marine life.

Sustainable development in Rayong's coastal and marine areas depends on a hierarchy of policies and plans at national, regional and provincial levels, as well as on sector-based planning. Provincially, the RPDP has potential to play an important role in promoting and achieving sustainable development goals for Rayong's coastal and marine environment. This chapter builds on the baseline assessment of the strategic environmental assessment (SEA) to highlight the likely influence of the current RPDP on addressing the three key sustainability issues. A summary of coastal and marine-related aspects of the RPDP is presented, followed by an assessment of the BAU scenario which assumes a continuation of current management practices without the RPDP. Then the sustainability performance of a full RPDP implementation scenario is assessed. A final section describes policies and plans that are outside the scope of the current provincial plan but likely to affect Rayong's coastal and marine sustainable development pathways.

10.2 RPDP coastal and marine-related aspects

The marine and coastal environment is referred to only a few times within the RPDP. For example, the plan refers to economic hardship resulting from a decline in marine stocks under the first strategic priority, which focuses on ensuring fisheries-related and agricultural products meet international standards. The plan also includes a minor focus on conserving and restoring marine and coastal resources.

10.3 Impact on sustainability of the BAU scenario

The BAU scenario excludes the influences of the current RPDP (2018 – 2022), and also excludes policies and plans that have not yet been approved or implemented. Government policies, plans and strategies, as well as other influencing factors that are already shaping development in Rayong are

included in the BAU scenario. The scenario is developed here to provide a baseline against which to assess the influence of the RPDP.

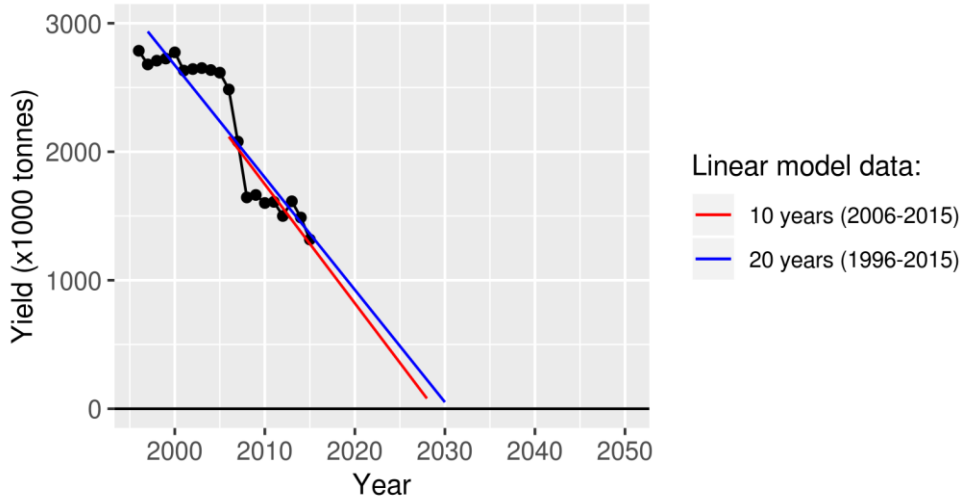
10.3.1 Unsustainable fishing practices

There is recent national legislation and plans designed to improve sustainability of coastal and marine fisheries catch, and to reverse the trends of decreasing yields. For example, the 12th NESDP promotes sustainable fisheries and aquaculture development to address a nationwide decline in fisheries that has resulted from overexploitation, pollution and ecosystem degradation. It reflects a generalpoor level of -compliance with international obligations on unreported and unregulated (IUU) fishing. Rayong is specifically mentioned in this context (Strategy 9, section 3.1.3). [75]

Figure 10.1 to Figure 10.5provide linear extrapolations of past trends in marine and inland capture fisheries, and marine and freshwater aquaculture nationally, as well as of marine capture in Rayong. The extrapolations consider trends using available data from the last 10 years. In this case, ten years is a suitable timescale for trend analysis, as near-future influences are more accurately represented. Linear extrapolations assume that factors influencing yield remain unchanged and are indicative only. Over long periods, the influencing factors are likely to change. For example, full implementation of the National Plan of Action to Prevent, Deter and Eliminate IUU Fishing (NPOA-IUU), is likely to change the quantities of fish caught.[76]

Marine and inland capture fisheries and coastal and freshwater aquaculture all are reporting recent downward yield trends, both nationally and in Rayong. Marine capture fisheries throughout Thailand and particularly within waters associated with Rayong's fishing activities show a significant reduction in catch projected to 2030 and 2045 (Figure 10.1 and Figure 10.2).

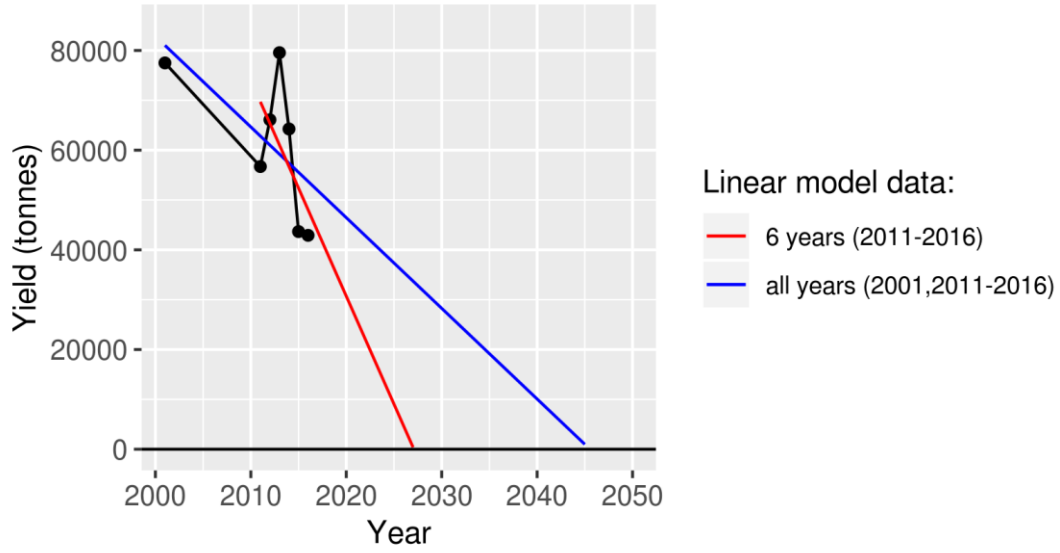
Figure 10.1: Linear extrapolation of marine capture fisheries in Thailand



Source: ICEM calculations 2019

[75] Twelfth National Economic and Social Development Plan (2017-2021) (NESDB (2017) (Part 2, sections 2.4.1)
[76] For more detail on the NPOA-IUU, please see section 11.4 in this chapter

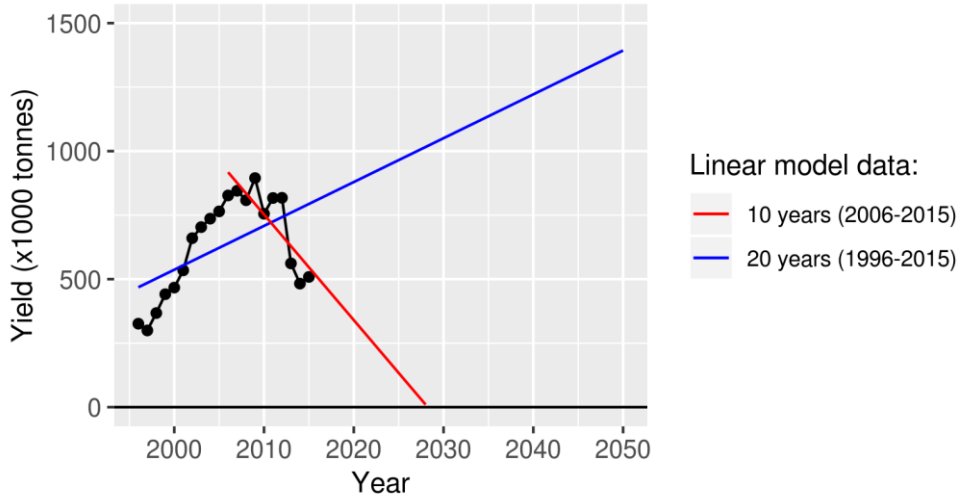
Figure 10.2: Linear extrapolation of marine capture fisheries in Rayong province



Source: ICEM calculations, 2019

Local authorities and fishers state that the national decline in coastal aquaculture is reflected in trends within Rayong although detailed data is not available for the province (Figure 10.3). The cause(s) of more rapid declines in recent years is due to continued overexploitation of capture fisheries, degradation of the coastal environment, as well as disease in the case of aquaculture. In Rayong, diminishing yields are reducing opportunities for local fishing communities, and also mean that fishery related contributions to Rayong's economy are declining.

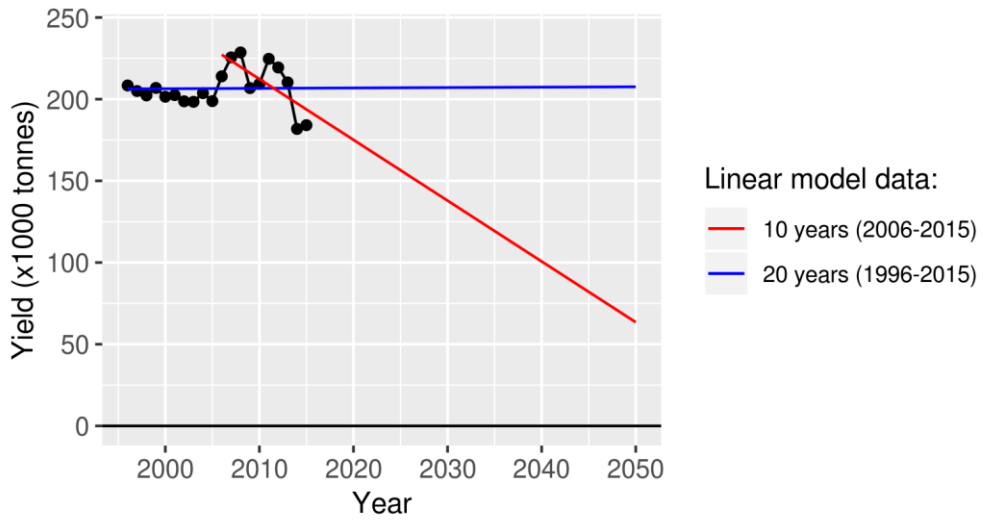
Figure 10.3: Linear extrapolation of coastal aquaculture in Thailand



Source: ICEM calculations, 2019

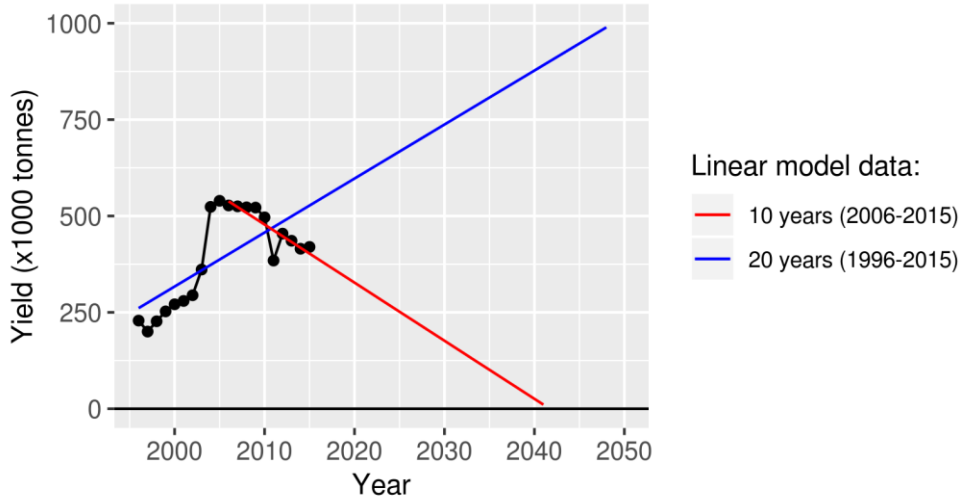
The trends for fresh water capture fisheries and aquaculture in Rayong supported by anecdotal evidence suggest an even more severe decline – although fresh water capture fisheries have not be significant within the province for some decades. The national projections extrapolated from the past ten years trends shown in Figure 10.4 and Figure 10.5 mask an even more serious situation in Rayong if the anecdotal reports from local fishers are to be relied on.

Figure 10.4: Linear extrapolation of inland capture fisheries in Thailand



Source: ICEM calculations, 2019

Figure 10.5: Linear extrapolation of freshwater aquaculture in Thailand.



Source: ICEM calculations, 2019

10.3.2 Poor management of solid wastes and effluent discharges

The BAU scenario in Rayong is likely to result in continued accumulation of waste and consequent pollution of the coastal and marine environment. This will have ongoing impacts on fisheries, tourism coastal community quality of life, and marine and coastal ecosystems.

There are various routes for debris to enter the marine ecosystem, from both within and outside Rayong province, including via rivers, from boats, storm water and sewage systems, as well as overtopping of flooded landfills. A serious form of localised pollution of coastal waters only recently identified is due to total petroleum hydrocarbons (TPHs) being transported from Map Ta Phut industrial areas via ground water.[77] The nationwide significance of coastal and marine pollution is recognized by the Government and reflected in the implementation of two national plans – the

[77] Bernett. W.C et al. 2019. Tracing underground sources of pollution to coastal waters off Map Ta Phut, Rayong, Thailand. Marine Pollution Bulletin [06 Aug 2019, 148:75-84], https://europepmc.org/abstract/med/31422306

National 3R Strategy and the National Master Plan for Waste Management (2016–2021) and Plastic Debris Management Plan 2017–2021.

10.3.3 Limited environmental monitoring and reporting to support evidence-based management

The need for environmental monitoring and reporting is stipulated in the 12th NESDP.[78] Measures in the plan under section 3.3.2 (Strategy 4) include encouraging local administrative organizations to monitor and evaluate the effectiveness of wastewater treatment systems. In important economic areas, the plan calls for the development of an environmental data monitoring and reporting system, designed to build trust between industry and local communities. Those good proposed measures are made without recognition of the significant capacities and resources required and which are inadequate to the task in local agencies in Rayong. The Pollution Control Department (PCD) monitors coastal water quality near Map Ta Phut, though the number of monitoring stations was reduced by half to 21 stations in 2016 and sampling is limited to once or twice each year.[79] Section 2.2.10 (Part 5) of the NESD Plan further proposes the development of databases and technological solutions to inform policy development. Under a BAU scenario, Rayong does not have the capacities or well defined mandate to assess temporal changes in the spatial extent and health of ecosystems.

10.3.4 Summary of BAU against sustainability development objectives

Examining the trends for the key sustainability issues for the coastal and marine environment under the BAU scenario, it is clear that Rayong's development pathway diverges from the sustainable development objectives. Most noticeably, in their current configuration, marine capture fisheries are unsustainable, even in the near term, and are likely to rapidly diminish to the point of being of negligible importance to the local economy. Continued accumulation of waste and pollution of the coastal and marine environment, and consequent impacts on fisheries, and on marine and coastal ecosystems, are predicted under a BAU scenario. Furthermore, pollution issues related to poor waste management are unlikely to be resolved without adequate environmental monitoring and reporting to guide more substantial and effective evidence-based investment and management.

10.4 Impact of the RPDP on sustainability

The RPDP should exert a positive influence on sustainability given the range of measures proposed. The potential impact of the RPDP on sustainability is addressed for each of the three identified strategic issues of concern under this theme identified by SEA stakeholders.

10.4.1 Unsustainable fishing practices

For marine and freshwater fisheries, the RPDP includes the aim of improving fisheries to meet international standards. The RPDP recognises past competition induced natural resource depletion, which has impacted on livelihoods of coastal fishermen – an equity, heritage and livelihood issue which has been strongly reinforced in the SEA stakeholder consultations. The RPDP also recognises the importance of rehabilitating natural coastal resources and assets.

The RPDP measures to improve fisheries standards primarily focus on (i) product development, (ii) marketing, and (iii) infrastructure. There is also a stated aim of promoting local participation, which could be a foundational component of sustainable development. At the project level in the RPDP, there are proposed investments to raise awareness, and to rehabilitate marine and coastal habitats, for example, rehabilitation post the 2013 offshore oil spill (Table 10.1). The RPDP also includes some investments to improve waste management and water quality, including addressing agrochemical

[78] Twelfth National Economic and Social Development Plan (2017-2021) (NESDB (2017)
[79] SEA Rayong Province, Environmental Quality Baseline Report

loads in coastal waters through promotion of organic fertilizers (Table 10.2). These projects are intended to rehabilitate and protect critically important marine and coastal ecosystems, including mangroves and coral reefs, which provide important feeding and nursery grounds for fish, crabs, molluscs and shrimp.

However, there are a number of omissions in the RPDP. For example, spatial zoning of the coastal waters with associated safeguards and development controls is not addressed, but something highlighted as a priority during the SEA consultations. Also, not dealt with systematically are land based pollution sources along the coastal strip including domestic, commercial, tourist and industrial sources.

Table 10.1: Projects supportive of sustaining fisheries in the Rayong Provincial Development Plan

No.	Project details
1	Tourism development project: Mangrove conservation near Chalerm Burapha Chonlatit
2	Tourism development project: Conservation and restoration for mangrove forest and watershed
3	Tourism development project: Artificial coral reef near Koh Samet
4	Crab bank protection in Ao Phe, Da Hoi Group (remediation post 2013 oil spill)
5	Shellfish conversion project Ban Phe Bay, Da Hoi Group (remediation post 2013 oil spill)
6	Marine and coastal resource conservation project
7	Rehabilitation of coral reefs affected by oil pollution near Koh Samet

10.4.2 Poor management of solid wastes and effluent discharges

The RPDP recognises the challenges of poor management of waste and effluent discharges, and of the environmental and health consequences of pollution caused by industrial development, such as from industrial effluent and solid waste. Construction of a comprehensive integrated solid waste disposal centre in Rayong, together with the development of waste-to-energy facility aims to improve waste management efforts in the province. Projects proposed as part of the RPDP that would improve waste management in the province are listed in Table 10.2. These projects are quite diverse in their focus, ranging from raising public awareness of waste management issues; addressing household and industrial waste treatment; to data management and early warning systems. Implementation of these projects will support reduced waste generation as well as improved household and industrial waste management, but are unlikely to have a significant overall impact on pollution loads in coastal and marine areas.

Table 10.2: Projects for improved waste management in the Rayong Provincial Development Plan

No.	Project details
1	Waste management project in Rayong province
2	Enhancing the efficiency of waste management in Koh Samet
3	Public relations campaign for reducing waste targeted at tourists and businesses
4	Supporting corporate social responsibility and environmentally friendly operations
5	Raising awareness for managing waste
6	Environmental governance in industrial enterprises
7	Study of hazardous waste management and disposal
8	Project to support waste sorting enterprises, composting of organic waste, and production of biogas at enterprises
9	Establishment of a system for sharing data, water quality measurement systems, and early warning systems for Map Ta Phut municipality
10	Project to increase efficiency in collecting waste in pollution control areas
11	Canal dredging project in Map Ta Phut municipality for improving water quality and pollution reduction from wastewater

10.4.3 Limited environmental monitoring and reporting to support evidence-based management

The RPDP highlights the need for monitoring and evaluation of natural resources (sub-strategy 7), and a series of supportive projects are proposed (Table 10.3), including environmental monitoring and the creation of a socio-economic and environmental database. Implementing these projects would help improve monitoring and reporting of environmental quality in the province. The establishment of a system for sharing data, water quality measurement systems, and early warning systems for Map Ta Phut municipality (Table 10.3, project 4) would be especially important given the proposed expansion of the port under the EEC Development Plan.

Table 10.3: Projects for environmental monitoring and reporting in the Rayong Province Development Plan

No.	Project details
1	Monitoring of water quality and fisheries in Rayong province
2	Project to strengthen environmental monitoring and early warning
3	Project for the creation of a spatial database on economic, social and environmental issues
4	Establishment of a system for sharing data, water quality measurement systems, and early warning systems for Map Ta Phut municipality (also mentioned in Table 10.2)

10.4.4 Summary of RPDP influences on sustainability

With regard to supporting the two sustainable development objectives under the coastal and marine theme, the RPDP improves on the BAU scenario by including 22 projects that address the three key sustainability issues of concern for Rayong. Of these three strategic issues, a strong emphasis is needed on further developing environmental monitoring and reporting initiatives in the province, as this would permit evaluation of the effectiveness of the proposed RPDP measures. Improved reporting of results should also alleviate community concerns on the state and health of the local environment.

10.5 Other factors that are likely to influence sustainability

Fishing practices in Rayong province are driven by policy and planning at the national level through the 2015 Marine and Coastal Resources Management Act, Royal Ordinance on Fisheries 2558 (2015), Marine Fisheries Management Plan (FMP) and the National Plan of Action to Prevent, Deter and Eliminate IUU Fishing (NPOA-IUU). The latter aims to improve the traceability of fish catch through electronic documentation schemes and improved port inspection measures.[80] Given that these instruments are relatively recent, and also the limited accuracy and reliability of capture statistics, it is too soon to judge their effectiveness on improving the rehabilitation and sustainability of fisheries in Rayong. However, a combination of measures addressing IUU fishing, protection and rehabilitation of coastal ecosystems (such as those listed in Table 10.1) and improved waste management and water quality within the RPDP (e.g., Table 10.1) would support sustainability of marine and coastal fisheries.

Current challenges for waste management at the national level are articulated in the 12th NESDP, which highlights per capita waste generation increasing over time, as well as inadequate industrial and municipal solid waste (MSW) management, and poor wastewater treatment (Part 1, section 2.1). The 12th NESD Plan proposes a target (Strategy 4, Target 3, indicator 3.1) to achieve (i) at least 75 percent of community waste to be appropriately treated or reused; (ii) at least 30 percent of hazardous waste from communities to be disposed of appropriately; and (iii) all industrial waste to be treated. The NESD Plan also supports the development of solid waste management plans at provincial and local levels.

[80] https://thaiembdc.org/wp-content/uploads/2015/11/Highlights-of-Thailand%E2%80%99s-National-Plan-of-Action-to-Prevent-Deter-and-Eliminate-IUU-Fishing-NPOA-IUU.pdf

Rayong is a long way off meeting those targets and putting in place appropriate plans with support of relevant national and regional line agencies.

At the regional level, the EEC Environmental Management Plan (2018-2021) addresses environmental issues associated with implementation of the Eastern Economic Corridor (EEC) Development Plan. Increased generation of waste is anticipated from future industrial expansion in Rayong, including expansion of Map Ta Phut port which is expected to double in size to 320 ha. The Eastern Region Development Plan (2018–2021) encourages participation of local administrative organizations in managing waste under Strategic Issue 5, although the related capacities and adjustments to institutional arrangements and budget allocation are not considered.

At the national level, sustainable development is guided by the adoption of Sustainable Development Goals (SDGs),[81] as well as by the Thai Sufficiency Economy Philosophy (SEP) which is strongly advocated in the 12th NESDP and RPDP.

Regarding coastal and marine resources, the overall objective of Sustainable Development Goal (SDG) SDG 14 is to 'conserve and sustainably use the oceans, seas and marine resources for sustainable development' and comprises a set of targets that are relevant within the context of economic development in Rayong Province[82]

- SDG 14.1: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.
- SDG 14.2: By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans.
- SDG 14.4: By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated (IUU) fishing and destructive fishing practices and implement science-based management plans.
- SDG14.5: By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information.

Achieving SDG 14.1 also depends on addressing the 12th SDG on ensuring sustainable consumption and production patterns, which includes the following SDG targets:

- SDG 12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
- SDG 12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse

In the sections which, some detail linking development and planning in Rayong with national and international goals and strategies is provided. The focus areas for these linkages are fishing practices, waste management and environmental monitoring.

10.5.1 Unsustainable fishing practices

Presently, the RPDP does not articulate how fishing practices and management of marine and freshwater fisheries could be made more sustainable. The plan does not appear to interlink with higher level plans to managing fisheries: i.e., *2015 Marine and Coastal Resources Management Act, Royal Ordinance on Fisheries 2558 (2015),* and *Marine Fisheries Management Plan (FMP)* or the *NPOA-*

[81] https://sustainabledevelopment.un.org/memberstates/thailand
[82] https://sustainabledevelopment.un.org/sdg14

IUU. Furthermore, spatial zoning to promote sustainable management of resources and avoid conflicts between users, for instance, by delineating marine protected areas and areas that permit tourism or industrial activities, are not mentioned. However, the RPDP does propose projects that are supportive of rehabilitation of coastal ecosystems (mangroves and coral reefs) that are known to be important habitats for fisheries.

10.5.2 Poor management of solid wastes and effluent discharges

At the national level two national plans – *the National 3R Strategy and the National Master Plan for Waste Management (2016–2021)* and *Plastic Debris Management Plan 2017–2021* (refer to Baseline Assessment report) offer potential to improve waste management issues.

10.5.3 Limited environmental monitoring and reporting to support evidence-based management

At the national level (Part 4, section 3.3.1) the 12th NESD Plan requires that the Eastern Seaboard Areas will develop an 'interconnected environmental data and monitoring system to be efficient and transparent in order to create trust and diminish conflict between the industrial sector and local communities'. The proposed measures in the RPDP (Table 10.3) provide important steps to achieving this NESDB guideline which is targeted at Eastern Seaboard Areas.

10.6 Conclusion

1.1.1 Main positive effects of the RPDP

To some degree, the RPDP is supportive in addressing all of the three strategic issues of concern to the marine and coastal environment. With regard to unsustainable fisheries, the RPDP primarily promotes greater protection of marine and coastal ecosystems, and proposed projects should translate into improved waste management efforts. In particularly, implementation of the RPDP should increase the levels of monitoring and reporting of coastal and marine environment issues.

10.6.1 Sustainability gaps in the RPDP

The proposed projects in the RPDP are limited in number, distribution and size and they fail to provide a comprehensive and integrated treatment of the three strategic issues for the province. Greater emphasis should be placed on environmental monitoring and reporting (e.g., of fisheries catch, environmental quality, waste management) to ensure that the effectiveness and performance of management actions can be evaluated. Improved monitoring of coastal waters is recommended to address pollution issues that are likely to accompany implementation of the EEC Development Plan.

Environmental targets and associated indicators should be specified in the RPDP. Spatial zoning to promote sustainable management of resources and avoid conflicts between users, for instance, by delineating marine protected areas, fisheries zones and areas that permit tourism or industrial activities, should be addressed.

PART II: IMPACT OF DEVELOPMENT SECTORS ON QUALITY OF LIFE THEMES

Part II of the sustainability analysis volume assesses the effects of the two development scenarios – the BAU and full RPDP implementation - on quality of life within the province. In the context of the SEA, ecological sustainable development is an essential foundation for quality of life. If ecological sustainability is lost, it will lead to depletion of natural resources, a loss of ecological services and a consequent degradation of the qualities which communities value in their life. Achieving a desirable quality of life requires a system of environmental management that ensures the consumption of natural resources at an acceptable and sustainable level while maintaining environmental quality, an economic system that enables equitable and appropriate consumption without environmental and social degradation, and a social system that maintains cultural and social diversity, heritage and fair access to ecological and economic services.

Countries that have a high per-person GDP also have a high ecological footprint. Rayong Province has the highest per capita GDP in Thailand, reflecting the total economic growth not necessarily the distribution of benefits. Consequently, the province has a large and unsustainable ecological footprint as reflected in Part I of this volume. The province is consuming and degrading more than nature's capacity to replenish and purify. Development is progressing beyond the provincial carrying ecological capacity with immediate implications for quality of life. The ecological footprint is a core indicator of sustainability and quality of life. SEA stakeholders identified quality of life and environmental quality as the two most important concerns facing development of the province.

In discussion, stakeholders described their understanding of quality of life through multiple factors, including physical living standards, health, education, and peace of mind and safety, and clean air, water and land. A pollution-free environment is the foundation for a healthy life, and a good environment with clean water and air, and abundant natural systems and biodiversity is a prerequisite for community well-being.

Part II of the SEA sustainability analysis covers social equity, environmental quality and natural systems and biodiversity. It examines the impact of the development sectors under the two development scenarios on those values which make up quality of life in Rayong Province.

11 SOCIAL EQUITY

Strategic theme	*Strategic issues of critical concern for sustainable development in Rayong*
Social equity	▪ Registered and unregistered population growth ▪ Availability of infrastructure and services ▪ Growing socio-economic inequality
The sustainability objectives for the coastal and marine environment are: Strengthen community resilience and inclusive development based on the sufficiency economy philosophy and environmental sustainability * * Derived from GoT (2015), NESDC (2017), and Paramethee (2016)	

11.1 Introduction

Since the discovery of natural gas in the Gulf of Thailand, and the rapid industrialization in Rayong, the demographic make-up of the province has changed significantly. Between 1993 and 2018, the rural population in Rayong remained static at around 380,000 people, while the urban population grew more than threefold, up to 354,000 people. This significant shift from a predominantly rural population to half the registered population living in cities has been driven primarily by in-migration of people looking for work, and by young people moving off their family farms to look for work in industrial and commercial sectors.

In this impact assessment chapter, the effects of the Rayong Provincial Development Plan (RPDP) on social and demographics related sustainability in Rayong, are assessed. As a "quality of life" theme, social and demographics is "impacted on" by what is happening in other sectors. Therefore, to create a baseline against which to assess RPDP influences, this chapter first examines the impact of the BAU scenario for the eight "development themes"[83] on social and demographics aspects of Rayong life.

The RPDP scenario for the productive sectors are overlaid on the BAU scenario to highlight how productive sector impacts on social and demographics alter as a result of a full implementation of the RPDP. In this way, the RPDPs contribution towards achieving the social equity and sustainability objective can be assessed. In addition, gaps where the RPDP currently has unrealized potential to contribute to social and demographics sustainability, are identified.

11.2 Summary of social and demographic aspects of the Rayong Provincial Development Plan

The RPDP vision includes the following elements that relate to social and demographics:

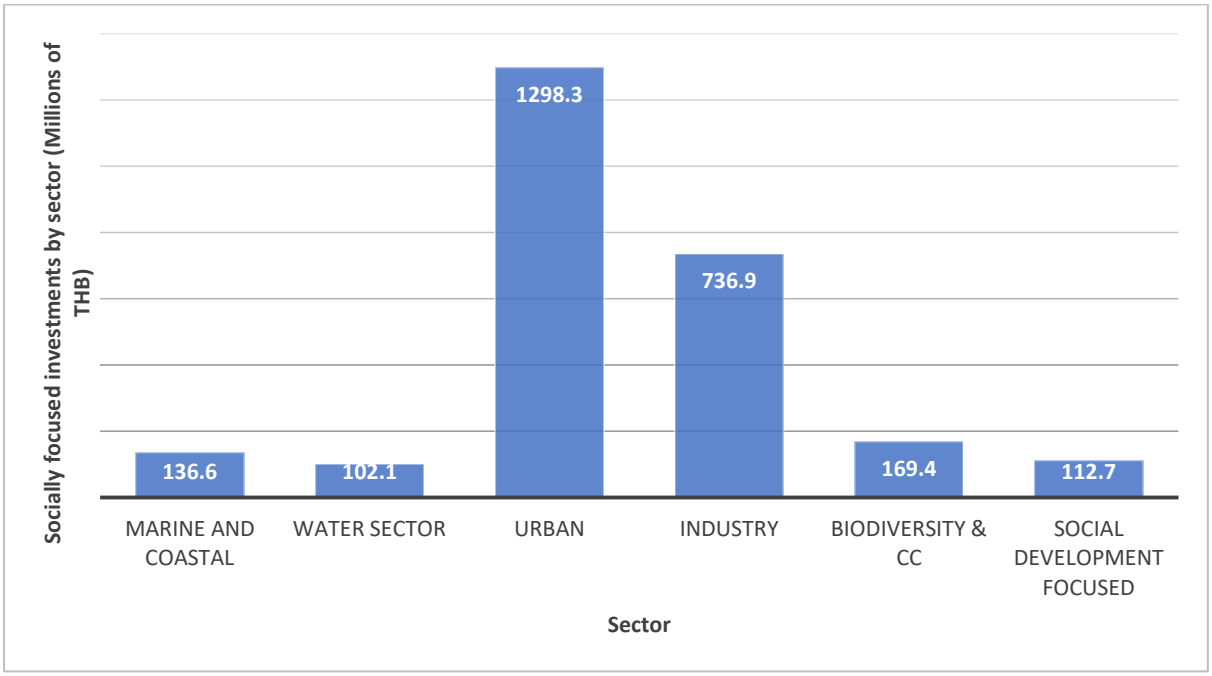
- That the people of Rayong Province will enjoy social stability, security and good quality livelihoods, through focusing on ensuring that environmental and social goals and needs continue to be met.
- That Rayong will be part of Thailand's push to become a knowledge-based economy, and to escape the "middle income trap".[84]
- That development will take a "middle of the road" path, as espoused by Thailand's sufficiency economy principles, in order to mitigate the impacts of future financial shocks.

[83]The eight development themes are: (i) industry, (ii) water, (iii) agriculture, (iv) energy, (v) transport, (vi) urban development, (vii) tourism, and (viii) coastal and marine environment (including aquaculture and fisheries)
[84] The middle income trap exists for some countries that make significant progress in reducing extreme poverty and experience structural change and growth but then find it difficult to make the climb from being a middle-income country to achieve high-income fully-developed status. GDP growth rates often slow down and a country can struggle to build and maintain international competitiveness.

The RPDP includes a variety of sustainability focused visioning statements. For example, it includes participatory development, balanced economic, social and environmental aspects (in line with Thailand's sufficiency economy philosophy)[85], with specific mentions of balancing development in industry with quality of life and environmental quality. In this context, for social and demographics there are three strategic issues of concern that were identified by SEA stakeholders during the baseline assessment. These issues are shown diagrammatically in Figure 11.2, including a summary of factors driving related trends.

In terms of projects, the RPDP includes just over 2.5 Billion THB (or 14% of the total budget allocation) on projects that should support improved livelihoods, and in services in areas like health, education, waste management and conservation. These investments take place mostly in urban areas, but there are also proposed investments for industry, water and biodiversity which have social equity and well-being implications (Figure 11.1).

Figure 11.1: RPDP – Social and demographics related investments



Source: Data sourced from RPDP (2018 – 2022)

Aside from the specific interventions that are social development focused, many of RPDP investments in development sectors will have direct and indirect influences on quality of life in Rayong. The purpose of this chapter is to assess the direction and magnitude of the influences of investments in development sectors as well as those directly targeting social equity and well-being.

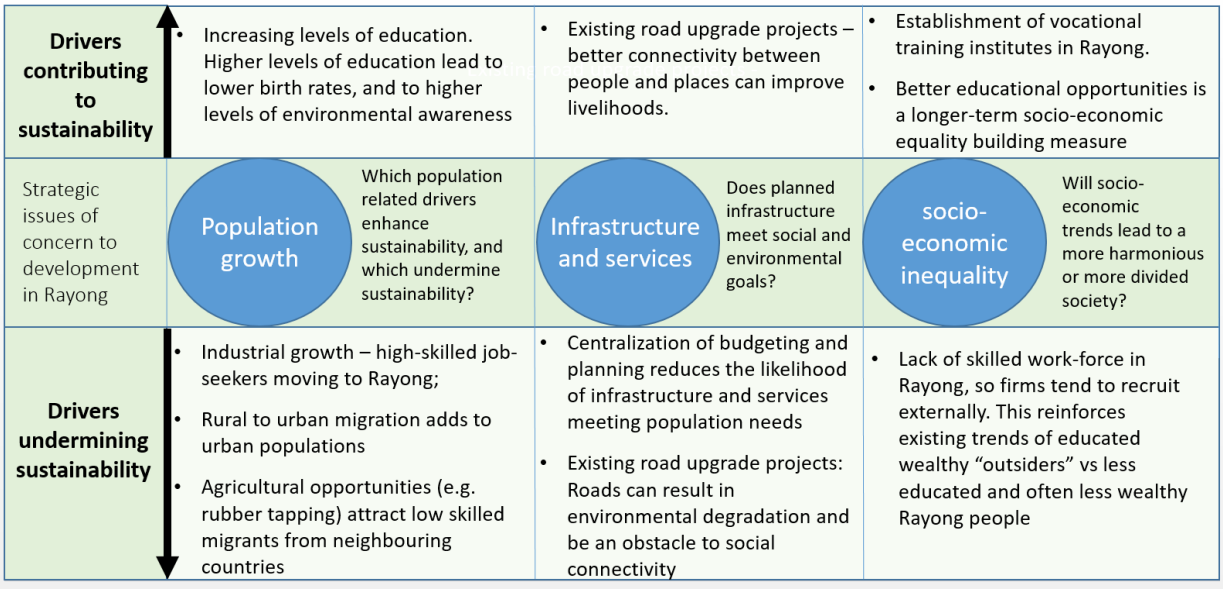
11.3 BAU scenario for the social and demographics sector in Rayong

Social and demographic issues in Rayong are closely tied to industrial development and growth in the province. Industry exerts a large pull factor, attracting migrants domestically, but also from around the world. This is particularly so for Rayong, which lacks a highly skilled workforce. Enterprises need to recruit externally for skilled positions. Consequently, socio-economic divisions between local people and migrants is large and growing. The rapidly expanding urban population makes it challenging for provincial authorities to provide adequate municipal services, especially as over 60% of the population is unregistered denying Rayong its fair share of centrally allocated budget based on

[85] http://www.tica.thaigov.net/main/en/information

official head count. The challenges are magnified because budgeting and planning in Thailand is so centralized. Public servants at the centre are making decisions affecting social and demographic issues in Rayong without strong on-the-ground information and knowledge of the local situation and needs (Figure 11.2)

Figure 11.2: Drivers affecting change in social and demographic issues under the BAU scenario



11.3.1 Registered and unregistered population growth

Rayong's population is unusual for the number of in-migrants from other Thai provinces and also international immigrants, most seeking work in the fast-growing provincial economy. It is also unusual because authorities are not sure how many people live in the province – it is estimated that more than 50% are unregister in-migrants still officially resident and paying taxes in their province of origin. Population growth in Rayong is being driven by three main factors (Table 11.1):

1. Domestic in - migration (high and low skilled)
2. International migration (high and low skilled)
3. Fertility rates

Table 11.1: Drivers of registered and unregistered population growth in Rayong

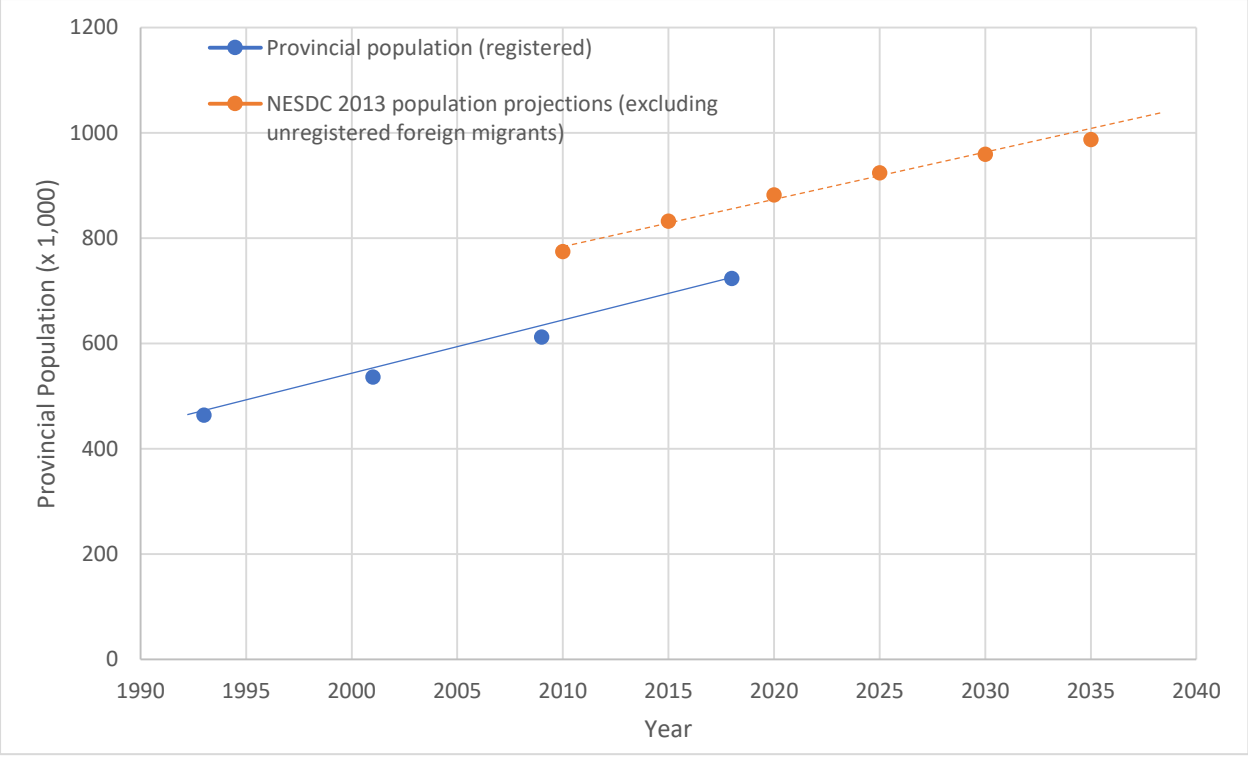
Drivers and assumptions	Direction of influence on sustainability
▪ Well educated international migrants from countries including Japan, South Korea, Germany and India come to Rayong to work in the industrial sector. ▪ Historical trends about migration patterns for these migrants is not available, but there are currently about 10,000 highly skilled international migrants living in Rayong.	↓
▪ Low skilled international migrants from neighbouring countries including Myanmar, Cambodia and Lao PDR come to Rayong to fill poorly paid opportunities in industry, agriculture, commerce and services. Historical data on low and unskilled international migrants is not available, however there are currently around 95,000 registered low skilled international migrants living in Rayong. ▪ It is likely that, in addition to those who are registered, there are illegal and informal immigrants from neighbouring countries living and working in Rayong.	↓
▪ Domestic migration into Rayong including from low skilled ethnic minority groups, who come to Rayong seeking similar opportunities to low skilled international migrants.	↓

▪ Knowing how many of these migrants are living in Rayong is challenging because many of them do not change their officially registered address – and a national census has not been conducted since 2010.	
▪ Natural fertility rates in Rayong are assumed to be similar to national levels (around 0.28% per annum and declining steadily).	⬆

Unregistered migrants in Rayong, such as domestic ethnic minority migrants, pose a significant challenge for the province. Rough estimates suggest that including unregistered migrants would bring Rayong's total population to over 1.2 million (or about 65% higher than the registered population). [86] This large number of unregistered residents are not budgeted for in the delivery of a wide range of municipal services including refuse removal, sanitation, electricity services, police, fire, storm water runoff and drainage, traffic control and parking. It also covers many aspects of health and education facilities and local libraries. Those are basic services that residents of a city and province expect the local government to provide in exchange for the taxes which they pay. Yet, taxes paid by unregistered in-migrants return to the provinces of origin. That situation is leading to acute under supply, overcrowding and inequities with a growing population competing for diminishing per capita services. These issues are explored further in section 11.3.2.

It is difficult to know how many people reside in Rayong, and population estimations and measurements rarely match. Partly this is because Thailand's last formal census took place nine years ago, in 2010. Figure 11.3 provides provincial and national population figures and forward projections, highlighting the discrepancies that can arise. Despite the differences in past and current population figures, the population growth rates estimated by national and provincial authorities are remarkably similar at 1.9% for the province as a whole and 3.8% for urban areas.

Figure 11.3: Rayong's registered population and projected population



Source: Registered population from RPAO (2019); Projected population from NESDC (2013);

[86] NESDC 2009; interviews, 2019; RPAO, 2018

11.3.2 Availability of infrastructure and services

Rayong's capacity to develop and maintain infrastructure and basic public services is limited by funding. For example, much of the RPDP will only be implemented if national line agencies deliver on project funding. The province does have its own budget provided by the national government and calculated based on Rayong's registered population. As industrial growth attracts more migrants, the provincial budget tends to grow accordingly. And, as industrial growth slows, so too will growth in the provincial budget, with a time-lag because the link is indirect.

In 2019, basic infrastructure and services in Rayong are not meeting demand. The most serious issues are that (i) most municipal wastewater is not treated and there is very limited monitoring of household septic systems to ensure they are functioning effectively, (ii) there is insufficient solid waste management capacity, (iii) medical services are not coping with demand, with too few hospital beds and medical staff per capita of population, and (iv) residents in urban areas have very limited access to public green space and amenities. The ribbon development and urban sprawl that has characterised urban development in Rayong over the last 20 years has exacerbated service delivery. To service this sort of development requires much higher levels of investment and maintenance, for example, with longer pipe systems for water supply and sewerage connections, more electrical cabling and solid waste management facilities.

Analysing satellite imagery of Rayong City and neighbouring areas highlights numerous areas where development has followed transport corridors (Figure 11.4), confirmed through analysis of changing population densities in the province.

Figure 11.4: Red lines are examples of areas where ribbon development in Rayong makes provision of public services challenging

Source: Google Earth (Analysis: ICEM)

The issue of ribbon development is considered in the urban development impact assessment chapter in this volume. Without repeating the analysis here, ribbon development is a symptom of ad hoc urban growth that has not been sufficiently managed and guided by town planning, monitoring and enforcement.

Another issue of concern to local authorities is that Thailand is fiscally highly centralized. For example, between 2015 and 2018, the growth in funding to national line agencies was 5 times larger than the growth in the Rayong provincial budget. That trend means that most decisions affecting development in the province are made in Bangkok. The centralised system constrains opportunities for local community input in shaping Rayong's development, leading to conflict and resentment. A prevalent view within the local community is that centrally located decision-makers do not always have the local

knowledge and sensitivities to effectively address local needs and aspirations. SEA stakeholders consistently raised this issue as a priority strategic concern for provincial development.

11.3.3 Growing socio-economic inequality

Growing inequalities within the Rayong community is another strategic concern identified by SEA stakeholders. The main drivers of inequality are (Table 11.2):

1. Farming is becoming less viable, particularly for small-holder farmers
2. Young people from farming families with low educational levels are seeking other employment opportunities, but can end up in slum areas because of lack of money and skills
3. Under-resourced health centres means long waiting times
4. More highly paid, educated migrants with health insurance can be prioritized in the health system

Table 11.2: Drivers of socio-economic inequality

Drivers and assumptions	Direction of influence on sustainability
Poor and poorly educated groups in Rayong are becoming poorer and have limited opportunities to improve their lives. This trend is driven by:	
▪ There is relatively low level of educational attainment among Rayong households and education aspirations.	↓
▪ As farming is becoming a smaller part of Rayong's economy, more farming families and young people from farming households are leaving their family farms and moving to urban areas. ▪ Rural-urban migrants like these tend to be from poorer families and tend to be poorly educated.	↓
▪ There is intensive competition, and very few opportunities, for poor and poorly educated people to find work in industry, commerce or services sectors. ▪ These groups are likely to reside in sub-standard accommodation, disproportionately exposing them to food-borne diseases (e.g. gastroenteritis), to water-borne diseases (e.g. diarrheal diseases), and to vector-borne diseases (e.g. dengue and malaria).	↓
▪ When these groups become ill, they face lengthy waiting times at Rayong's under-resourced health centres and hospitals.	↓
▪ In contrast, highly educated, well paid migrants tend to live in much more hygienic conditions with much less exposure to food, water and vector-borne diseases. ▪ They are more likely to be more mobile and have access to recreational opportunities. ▪ Wealthy migrants also tend to have health insurance included in their employment packages and are more likely to be prioritised by health services when they do become sick or are injured.	↓

Other factors that exacerbate the issues described in Table 11.2 relate to the environmental quality impacts of rapid development. Air and water quality are declining, with related health and well-being consequences affecting the urban poor more than affluent groups which have greater capacity to avoid and respond to worsening environmental conditions.

11.4 The impact of the RPDP on sustainability

The positive and negative influences of the RPDP on sustainability in the strategic social and demographic strategic issues of concern to SEA stakeholders are summarised in Table 11.3.

Table 11.3: The main RPDP influences on drivers of social and demographic trends

Drivers and assumptions	Direction of influence on sustainability
▪ The RPDP includes around THB 580 million (about 3% of the RPDP budget) for medical services including hospital and accident/emergency centre upgrades, as well as outpatient facilities. ▪ This will both improve infrastructure and services, and increase the levels of care available to poorer parts of the population.	↑

▪ The RPDP includes about THB 90 million (about 0.5% of the RPDP budget) for public health projects including encouraging community fitness. While this is an investment in basic services, poorer segments of the population are less likely to take advantage of these services unless they specifically address challenges associated with poverty (e.g. lack of time for non-income generating activities, need to look after children, distance from locations where community activities take place)	⬇
▪ Increasing tourism under RPDP will lead to some employment opportunities (e.g. in construction for new tourist attractions, staff for new restaurants, accommodation facilities etc…). This will enhance people's financial well-being, but good levels of education will be necessary to take advantage of many of these opportunities, thus the benefits of this will tend to increase inequality.	⬇
▪ Increased tourism will add additional strain to Rayong's overburdened MSW management and wastewater management capacities. The result of this (in socio-economic terms) will be that poorer segments of the population living in sub-standard accommodation close to wastewater outflows or areas where garbage is dumped will face higher levels of exposure to water, food and vector-borne diseases.	⬇
▪ Full implementation of the RPDP is projected to increase transport-related air pollution moderately, and this will tend to impact on the health and well-being of those living next to Rayong's main transport corridors. As with other environmental health issues, this will predominantly affect poorer groups, thus contributing to growth in socio-economic inequality.	⬇

Implementing the RPDP is unlikely to affect population growth. It will have some impact on availability of infrastructure and basic services, particularly in terms of health service provision. Yet, overall full implementation of the RPDP will exacerbate social inequality because benefits of the plan will tend to accrue to wealthier and better educated groups, while negative impacts will tend to fall more heavily on poorer groups.

11.5 Social and demographic gaps in the RPDP

The RPDP will not significantly contribute to achieving the SEA sustainable development objective to *strengthen community resilience and inclusive development based on the sufficiency economy philosophy and environmental sustainability*.

The RPDP includes little or no investments in:

- More frequent collections of census data, particularly in urban areas that could ensure service delivery matched the actual demographic profile of Rayong.
- Programs to help rural to urban migrants transition to a different way of life, including retraining and structural adjustment grants, assistance with locating housing, work search support as well as introductions to social support networks.
- Expansion of applied education and training programs along with additional teaching staff, facilities and attainment targets.
- Environmental and public health programs such as disease prevention, occupational hazards and safety, air and water quality management and living conditions, community solid waste management, recycling and clean-up programs targeting poorer areas, and environmental health awareness raising programs in schools and communities.
- Programs to enhance equitable access to parks, green space and public transport.
- Nature based solutions to, for example, reduce air pollution, temperature, water management and waste treatment.
- Strengthening community resilience and inclusive development by addressing issues of social inequality. Particularly, there are no programs focusing on
    - Supporting those with low educational attainment to take advantage of opportunities in industry and other sectors,

- Addressing issues relating to poor quality housing for poorer residents in Rayong
- Addressing differences in access to medical care and services for wealthy and poorer groups.

12 FORESTS AND TERRESTRIAL BIODIVERSITY

Strategic theme	*Strategic issues of critical concern for sustainable development in Rayong*
Terrestrial Biodiversity	• Fragmentation of forests • Very low forest cover
The sustainable development objectives for terrestrial biodiversity are to:[87] • Conserve, restore and enhance biodiversity in Rayong • Increase forest cover throughout the province with a target to contribute to the national goal of 40% forest cover	

12.1 Introduction

Between the 1960s and 1980s Thailand suffered extensive forest loss. In 1961, forests covered over half of national land area. Between 1981 and 1990 the rate of deforestation was about 515,000ha, or 3.3%, per year. In 1988, following serious landslides, a nation-wide ban on logging of natural forests was introduced. In 1991, the government revised the National Forest Policy to set a 40 percent forest cover target—25 percent conservation forest and 15 percent production forest.

Yet, between 1990 and 2005, a further 9 percent was lost or about 1.4 million hectares. Some areas of natural forest loss was offset by the expansion of plantations by about 460,000 hectares. From 2008 to 2013, a million rai of forest was lost every year due mainly to agriculture expansion along with population growth, infrastructure development, illegal logging and uncontrolled forest fires.

Over the past five years, the forest cover for Thailand has remained steady at 31 to 32 percent supported by rural to urban migration and tighter controls. Currently, forests natural and planted cover 31.6 percent of the nation's landmass. The goal of having 25 percent of land as conserved forests is within reach – already Thailand has reached 23 percent under this forest category.

Rayong's forest followed a similar history of loss – only much more substantial than the national average after the rapid industrial growth and relative affluence from the mid 1980's. Provincial forest area now stands at 7.8 percent which remains one of the lowest forest areas among Thailand's 76 provinces.

Rayong's protected areas: Rayong's remaining forests are concentrated in the North East of the Province as part of the Eastern Forest Complex (EFC). This includes a largely contiguous group of 8 individual protected areas covering parts of Chonburi, Chachoengsao, Rayong, Chantaburi and Sa Kaeo provinces, with a combined area of 3,024 km^2. Khao Chamao-Khao Wong National Park (KCKWNP), which lies mostly within Rayong Province; and Khao Ang Rue Nai Wildlife Sanctuary (KARNWS) lying partially in Rayong Province, both in Khao Chamao District, are important parts of EFC.

EFC encompasses some of the most pristine forests and wildlife habitats in Thailand and recognised as a World Heritage site. It supports over 800 species of fauna and important tropical forest ecosystems. Most known endangered and endemic species of Rayong Province are found in these protected areas, where they have the best chances of survival. The serious wildlife poaching and illegal logging of the past no longer appear to be major issues, and forest encroachment is negligible. EFC is home to 400 elephants and elephant numbers are growing by about 9% each year. While this significant recovery of elephant numbers is a great conservation success, the incidence of human-elephant conflict is steadily increasing. This is a growing problem in the area around Khao Chamao.

[87] NESDB (2017) Twelfth National Economic and Social Development Plan (2017-2021). Office of the National Economic and Social Development Board, Office of the Prime Minister, Bangkok, Thailand. URL: http://www.nesdb.go.th/nesdb_en/ewt_w3c/ewt_dl_link.php?nid=4345

That cap of forests within the EFC provides important watershed protection and regulation of water supply for agriculture, domestic consumption and industrial use. The forested areas help protect watersheds above reservoirs, and help to maintain environmental flows and water quality. Those services reduce the costs of water treatment, prevent saline intrusion in the downstream reaches of Rayon's rivers, and enable healthy shrimp production in the coastal area. Other benefits include tourism and recreation, provision of non-timber forest products (NTFPs), groundwater recharge and discharge, flood control, sediment and nutrient retention, habitat protection, biodiversity conservation, biomass production, and preservation of genetic stocks.

Forests in marine protected areas: In addition to KCKWNP and KARNWS, Rayong also has Laem Ya-Mu Koh Samet National Park, which although principally designated as a marine protected area (MPA), has important areas of forest on the various islands and a small part of the mainland that make up the park, spread across Muang and Klaeng Districts.

During 1961-2007, mangrove areas significantly declined because charcoal production and later shrimp farming with national policies promoting semi-intensive and intensive shrimp production. For example, during 1961-1996, 50-60% of mangrove forests were cleared for shrimp farming. Since then the government has supported mangrove rehabilitation with added momentum since introducing the 2015 Marine and Coastal Resources Management Act. Government funding to the Department of Marine and Coastal Resources has not been adequate to reach targets and is largely dependent on the private sector through corporate social responsibility (CSR) initiatives.

The entire Thai coastline along the Gulf of Thailand has an MPA extending three km from the shoreline. Rayong, Chanthaburi and Trat provinces are classified as a Zone 1 MPA. The marine park surrounding Koh Samet was established to protect particular marine environments, such as islands and reefs. Generally the marine protected areas including coastal forests support fisheries production by providing protective habitat and help maintain water quality. Adult fish and fry migrate from these areas, supporting artisanal and commercial fisheries. Rayong's MPAs are also economically important for recreation and tourism.

Rayong's National Forest Reserve: Beyond those protected areas, the province has some National Reserve Forests. However by 2004, the National Reserve Forest cover of Rayong had already declined from 822 km^2 to 313 km^2, and then declined more gradually to 282 km^2 by 2014, after which there appears to be a slight increase by about 10 km^2 in 2015.

The regulation requiring industrial estates to set aside 20% of their area for vegetation has the potential for incremental increases in provincial forest cover, but requires more effective standards, monitoring and enforcement, especially if landscape level benefits of additional forest cover are to be achieved.

12.2 Forest and biodiversity coverage in the Rayong Provincial Development Plan

The Rayong plan continues to support economic development within the province, which is led by continued industrial development as well as by the transport, energy, tourism and agriculture sectors. In addition, continued migration into the province, both from other provinces within Thailand, as well as from neighbouring countries, will lead to growth in the residential and service sectors.

The plan does however recognize the need to *"protect, conserve, restore and control use of natural resources and the environment in a participatory manner",* as its 4th development goal. Furthermore the indicators of success for the plan listed on page 150, includes: *"By 2021, total forest area is increased by 10% against a baseline of 182,276 rai".* On page 165 there are two additional indicators listed in relation to the different implementation strategies contributing to the 4th goal. These include: *"6% increase in green area (forest trees) across the whole province";* and: *"conservation and rehabilitation of forest area rising from current 8% to 20% of the province."*

The second target is supported by a development guideline which states: "*Increase the green area for all types of forest such as land forest, beach forest, mangrove forest and urban forest with the participation of communities and all sectors"*

Although admirable, those 3 indicators, all appearing in the same plan, are difficult to reconcile. Achieving the first, would require 3,000 hectares of new forest area or an increase to 8.8% of the province. The second indicator would require 22,500 hectares of new forest with forest and tree cover increasing from 14% of the province. For the third indicator, forest cover would increase to 20% of the province, i.e. requiring 45,000 hectares of new forest.

Under the natural resource management theme in the RPDP, a considerable amount of money is devoted to dredging of canals as well coastal restoration and development of eco-tourism, with very little funding for forest restoration or tree planting despite the aspirational indicators for increase in forest cover. A 3 million baht project for tourism development at a wetland includes planting of 1,000 trees. A 7million baht climate change resilience and adaptation project includes some tree planting. Other project are funding awareness raising activities and networking.

The Rayong Plan has a few small activities aimed at replanting forests, but is set up for failure in terms of its forest cover and rehabilitation indicators. Furthermore, the plan does not foresee the application of new policy approaches and tools such as the now relatively well-known PES or REDD+ to support forest restoration, let alone newer and more innovative financing tools such as "bio-credits" to support biodiversity conservation. The plan does not provide any mechanisms for mainstreaming biodiversity conservation in planning of other economic development sectors within the province, and it does not consider Rayong's ecological footprint on neighbouring provinces and internationally.

12.3 Impact of the BAU Scenario on sustainability

The key strategic issues of concern for forests and terrestrial biodiversity in Rayong province identified by SEA stakeholders are (i) forest connectivity/fragmentation and (ii) overall forest cover. The BAU scenario assumes that past resource use and management strategies and initiatives will continue.

12.3.1 Forest fragmentation and connectivity

Connectivity of Khao Chamao-Khao Wong National Park with Khao Ang Rue Nai Wildlife Sanctuary and the rest of EFC has been recognized as a priority by the Department of National Parks Wildlife and Plant Conservation (DNP). A DNP research team has identified suitable corridor areas between Khao Chamao and Khao Ang Rue Nai, where there is habitat fragmentation and patchy forests are interspersed with small-holder farmlands. These are areas where many animal signs were found. Rehabilitation work is being supported through modest CSR initiatives involving the Kubota Farm Machinery Company, with True Telecommunications Corporation supporting development of a camera-trap and SMS message-based early warning system to address elephants coming out of Khao Chamao National Park.

In the broader EFC landscape, DNP and the Highways Department are working on approaches to re-establishing connectivity through tunnels and fly-overs. A further initiative is under way to reconnect forests on either side of the highway running through EFC linking Chantaburi to Sa Kaeo.

The highest priority is to ensure good connectivity between Khao Chamao and Khao Ang Rue Nai in Khao Chamao District, as this is the key to maintaining links between Rayong and the rest of the Eastern Forest Complex in 4 other provinces (and with forests in Cambodia) which significantly adds to the biodiversity value of these forests. At present, a minor road runs between the two protected areas but there has been discussion on upgrading this route which would decrease habitat and landscape connectivity.

Under the BAU scenario, if current DNPs initiatives and strategies receive adequate funding from government central budgets and the private sector, connectivity between the forests of Rayong and the wider EFCOM landscape covering parts of five adjacent provinces will be rehabilitated and

maintained. It will ensure the survival of significant populations of large wide-ranging mammals, and the maintenance of large-scale ecosystem processes and the services they provide.

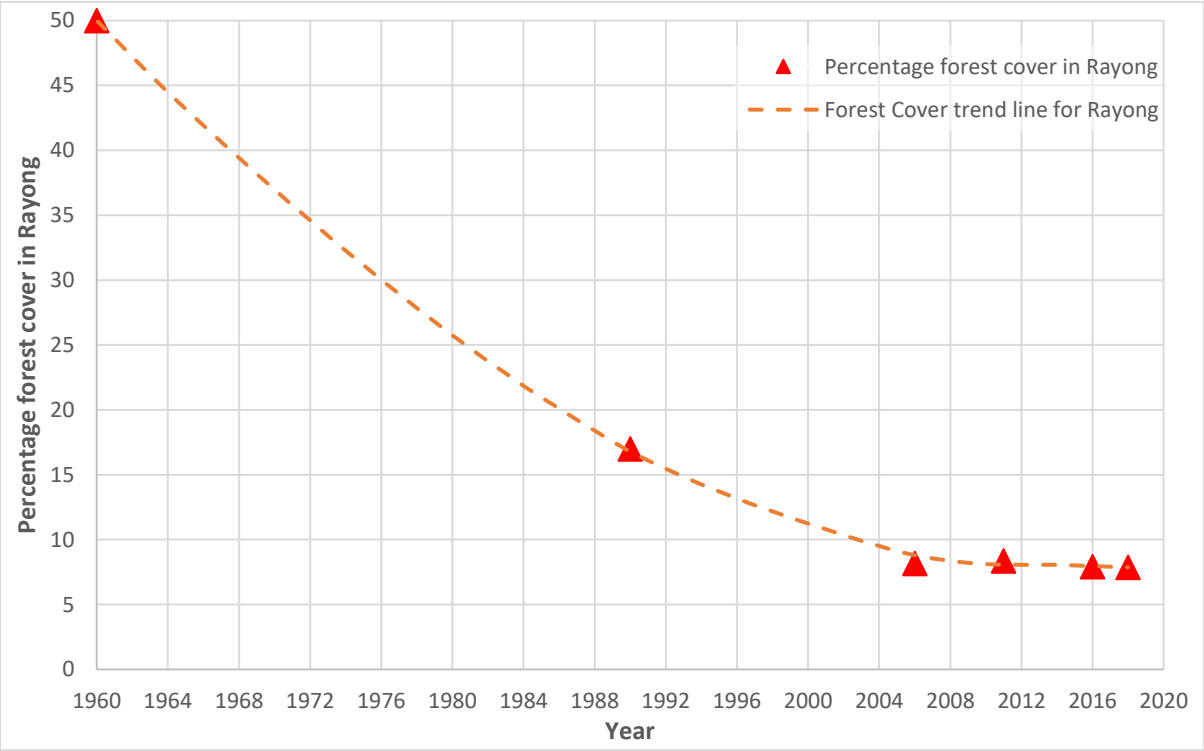
There are no plans for establishing forest and vegetated corridors throughout the province – including along waterways, within industrial and urban areas and across the agricultural landscape. Therefore apart from the initiatives within the protected areas complex in the North East of the province, the BAU scenario would not re-establish forest connectivity across most of the province. The exception may be along parts of the eastern coastal strip which has been the focus of mangrove replanting.

12.3.2 Forest Cover

The disappearance of forest and other terrestrial vegetation in the province, has included the removal of riverine forests along large parts of Rayong' watercourses and of mixed forests in agricultural areas. From the 1970's, coastal forests were cleared as infrastructure and the provincial population and settlements expanded.

Figure 12.1 shows the trend in forest loss from 1960. The 1960 cover is an estimate based on national figures. At that time, which is prior to the push for industrial expansion, it is likely that forests covered more than 50% of the province. From then until the 1990's there was a precipitous decline in forest cover. Over the 12 year period from 2016, there was an average loss of around 0.90 km^2 per year or about 0.3% of the remaining forest cover each year. When compared to past decades, this rate of loss appears relatively small. Yet, Rayong has so little remaining forest cover, any further losses is significant.

Figure 12.1: Forest loss in Rayong province (1960 - 2018)



In recent years there have been significant efforts to restore mangrove forest cover, but it still makes up a small fraction of the province and of total forests in Rayong.

Some small patches of National Reserve Forest scattered across the province are being managed as community forest. Some reforestation activities are being conducted.

Effective management of Rayong's protected areas will ensure no further loss of forest or terrestrial biodiversity. Together with forest restoration and other forms of tree planting across the province,

this will enhance the availability of natural capital and provision of ecosystem services to support economic development; contribute to climate change adaptation and mitigation; and provide nature education and recreation opportunities that support the mental and physical well-being of Rayong's population.

Projections of forest cover under the BAU anticipate only small increases from the current 7.8% to around 9% of the province stemming from restoration of forests within existing EFC protected areas, rehabilitation of coastal forests, and ad hoc contributions due to greening of industrial estates (Figure 12.2).

12.4 Impacts of the Rayong Provincial Development Plan on sustainability

The second development scenario assessed under the SEA assumes full implementation of the current Rayong Provincial Development Plan.

12.4.1 Forest fragmentation/connectivity

Most planned investments in the Rayong Plan are for the transport sector. Widening and upgrading of roads that are already fragmenting forests in the province will further reduce the possibilities for enhancing natural system connectivity in the future. The Rayong plan does not contain activities or guidance to minimize impacts on forest fragmentation from road construction.

Khao Chamao-Khao Wong National Park is bounded by minor roads including road # 4023 to the south and southeast; road # 3377 to the west and northwest of the park; and road # 4060 running from west to east between Khao Chamao and Khao Ang Rue Nai. The most important of these in term of connectivity is road # 4060 which has been identified for potential upgrading. Presently the forests of Khao Chamao and Khao Ang Rue Nai are nearly contiguous in some places, and the landscape between them is a mixture of forest patches and interspersed farmland. Along significant stretches of the road there is little habitation, and the vegetation on both sides of the road comes right up to the edge of the road. Any improvement or widening of this road could have very negative consequences for connectivity between these important protected areas, which would be detrimental to its ecosystem and biodiversity conservation value.

The transitional spatial plan for Rayong to be completed late 2019 will become an integral part of the RPDP. It is being prepared to reflect the EEC spatial plan transport corridors and increases in industrial and urban zones. It also reinforces buffer zones around reservoirs and along rivers. The riverine buffers require a 12 metre set back from the river. While the industrial and urban zone expansion would reduce potential forest area, the water body buffers could create important forest corridors. In the past the provincial authorities have not been able to enforce the buffers – so successful implementation would require substantial increases in capacities and resources including for potential compensation claims.

12.4.2 Forest Cover

Planned expansion of industrial development in Pluak Daeng District together with a new 2.65GW power plant may have negative impacts on some small remaining patches of forest in this area, and the continued expansion of tourism on Koh Samet Island may put more pressure on the remaining forests on the island.

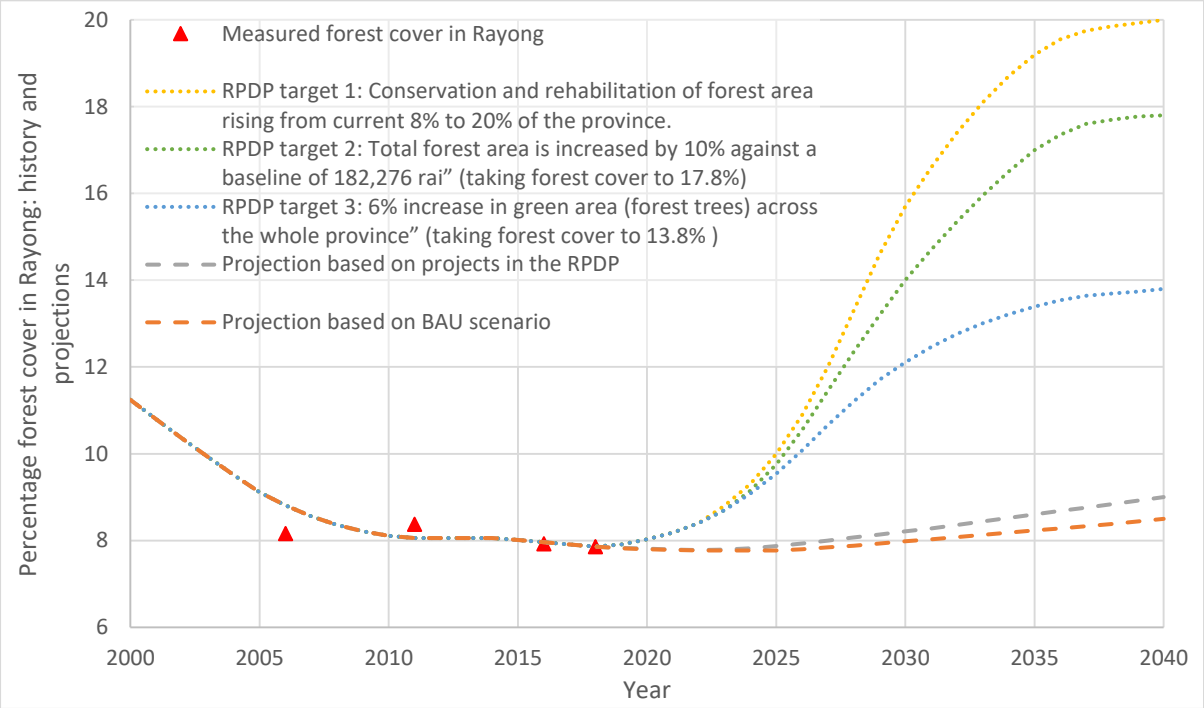
Generally, planned urban and industrial expansion may also have impacts on forest cover. As land prices adjacent to the expanding industrial and urban areas increase, farmers in those areas may be induced to sell their land. Some farmers look to buy cheaper agricultural land a little further away from the epicentre of development. The progressing selling off of farm land might lead to encroachment into forest areas. Where that forest is a well-protected National Park or Wildlife Sanctuary that is quite difficult – but more likely in remaining unprotected National Reserve Forest.

The RPDP does include small projects for mangrove replanting involving local communities. That will have a small but important influence on provincial forest cover. The designation of water body buffer

zones, if implemented, would increase forest area as would more effective management of the green space requirement in industrial estates. The ongoing restoration work for the EFC protected areas reflected in the BAU scenario would also increase and consolidate forest habitat.

Yet, those additions, in total would have only a small impact on forest cover with projections in Figure 12.2 showing a plateauing at around 9.5% of the province. The Figure also provides projections for the three forest and green area indicator targets set out in the RPDP, which under the plan portfolio of investment projects, would not be achieved.

Figure 12.2: Projected forest cover in Rayong province under the BAU and full RPDP implementation scenarios



12.5 Other factors impacting terrestrial biodiversity

12.5.1 Forest connectivity/fragmentation

In the broader EFC landscape, DNP and The Highways Department are working on approaches to re-establishing connectivity through tunnels, fly-overs and other road ecology innovations. A model for this already exist in Thailand between Khao Yai and Thaplan National Parks. A further initiative is under way to reconnect forests on either side of the highway running through EFC linking Chantaburi to Sa Kaeo. Those are very important programs of work for the maintenance of ecosystem services to the province and for biodiversity maintenance and enrichment.

12.5.2 Forest Cover

While the government has a national target for 40% forest cover, the new EEC land-use plan suggests that average forest area for the 3 EEC provinces will be reduced to 10%. Forest cover in Rayong is already lower than this, and it is unlikely that EEC developments will provide any stimulus to increase forest cover.

One result of the EEC planned development in Rayong, Chonburi and Chachoengsao is growth in water demand. Part of the way in which this water demand is set to be met is through the construction of new reservoirs, and inter-basin transfers, including transfers from Chantaburi Province to Rayong, and transfers from Rayong to Chonburi and Chachoengsao. Plans are even being developed to transfer water from Cambodia 10 years from now. Construction of new reservoirs, pipelines for inter-basin transfers and maintenance corridors will cause additional degradation of forests – both directly in Rayong Province, and in the interconnected forests of the EFC as a whole.

12.6 Conclusions

Overall, the forest cover of Rayong Province accounts for 7.8 % of total provincial area. Most of the remaining forest cover is inside protected areas where threats of illegal logging and poaching are increasingly well-managed. Small areas of National Reserve Forest remain scattered throughout the province, and some of this is managed as community forests. Under the BAU scenario tree cover increase very slowly by a small amount each year. Under the implementation of the Rayong Provincial Development Plan there will be some tree planting which may offset small losses expected due to infrastructure development and industry and urban expansion, but is certainly not enough to increase overall forest cover of the province significantly. Increased water demand under the RPDP scenario and especially as a result of EEC developments will require construction of new reservoirs and pipelines which may cause some forest destruction, encroachment or degradation.

Road developments planned under the RPDP and the EEC may cause increased fragmentation of the remaining forests in some places. On the other hand the Department of National Parks and the Highways Department are working closely together to restore connectivity between large forest blocks through corridors which would see sections or road elevated and other section tunnelled to allow forest to be replanted above or below the roads.

The main issues for terrestrial biodiversity in Rayong are the low overall forest cover of the province and the increasing fragmentation of its forest estate. The main ways in which these issues will be addressed are through re-establishing connections between the most important protected forests through corridors; improving protection and management of protected areas; and replanting forests outside of protected areas (e.g. in community forests). Additional tree planting can be carried out for a number of different reasons including restoration of degraded lands, erosion protection, disaster prevention, and increasing urban and industrial zone green space. As long as this is carried out in line with clear guidelines, then these forms of tree planting can also have significant benefits for biodiversity as well as provision of ecosystem services.

13 ENVIRONMENTAL QUALITY

Strategic theme	*Strategic issues of critical concern for sustainable development in Rayong*
Environmental Quality	• Hazardous waste • Solid waste • Water quality • Air Quality (emissions from transport and industry)

The sustainability objectives for environmental quality are*:

- Establish effective measures for the prevention, control and abatement of water pollution
- Hazardous wastes from industry, domestic and agricultural sources are identified, minimized and disposed without negative environmental impacts
- Replace open dumping sites by sanitary landfills, green space, incineration and waste to energy and recycling schemes.
- Establish and enforce point source air pollution standards, especially relating to the industry, energy and transport sectors.

** Summarised from Thailand's Environmental Quality Management Plan 2017-2021, the National Master Plan for Waste Management 2016-2021 and MONRE's EEC environment plan 2018-2021*

13.1 Introduction

Prior to the 1980's, Rayong's environment and land use reflected agricultural and fisheries livelihoods and a small population of less than 20,000 people. In the last thirty years, the industry, energy and transport sectors have been the main forces shaping the environment and natural resources of the province. In that time, the population and human impacts have increased dramatically, changing the character of the province from a mixed rural and natural landscape to one dominated by industry, infrastructure and urban development.

Rayong has become a national energy hub, a major producer of electricity for Thailand as well as the main centre for Thailand's oil refining and petrochemicals industries. The province has experienced strong in-migration with close to 50% of its population coming from other Thai provinces seeking work.

Rayong's waterways are now a sink for high organic and chemical pollution loads with an increasing proportion of hazardous wastes. Rayong's main river – the Klong Yai – is severely polluted in part due to very low environmental flows released by the Royal Irrigation Department from upstream reservoirs. Water is redirected at low prices to supply industry which is not being required to rigorously adhere to the government's polluter pays principle or to any form of payment for ecosystem services, despite a Pollution Reduction and Mitigation Action Plan covering the main industrial area.

Air pollution from industry, power facilities and transport is now better understood as a significant threat to public health with emissions of SO_2, and SOx and more than 40 types of volatile organic compounds (VOCs) - 20 being carcinogenic, including benzene, butadiene and 1,2-dichloroethene. Generally monitoring and reporting on pollution levels is piecemeal and not a sound basis for systematic ambient or point source management.

These issues are considered in this chapter through four strategic issues of concern identified by SEA stakeholders during the baseline assessment phase. They are hazardous waste, solid waste, water quality and air quality. Of all 12 themes addressed in the SEA, stakeholders gave environmental quality the highest priority for attention.

As for the other quality of life themes, this chapter considers the impacts of the 8 development themes on the strategic issues of concern to environmental quality. The trends and drivers for the issues are identified under the BAU scenario and then assessed for the full RPDP implementation scenario against the three SEA sustainable development objectives for this theme. Governance issues are

particularly important for effective environmental management and, for that reason, are addressed at various points throughout the chapter.

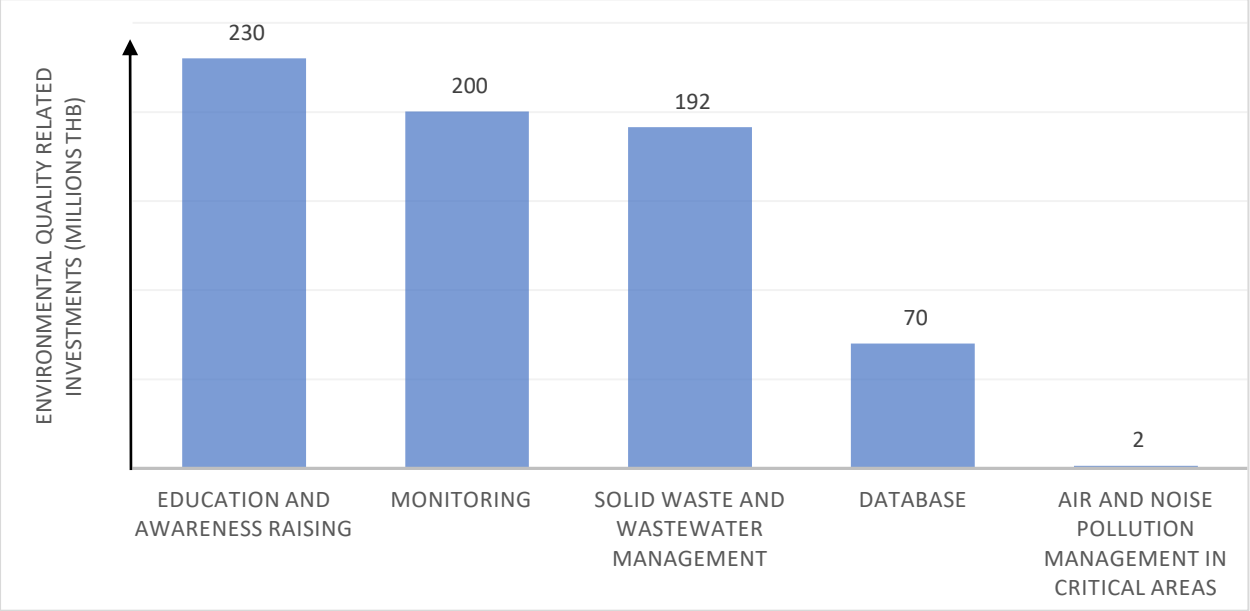
13.2 Summary of the environmental quality related aspects of the RPDP

The RPDP recognises environmental quality as a high priority and identifies the following development guidelines which address some of the issues of concern:

1. Improve solid and industrial waste management, including developing a system management according to best practice sanitation principles;
2. Promote awareness, knowledge, and understanding about the environment, including through creating learning resources;
3. Ensure active community participation in preserving natural resources and the environment;
4. Prepare a comprehensive database of natural resources, environment and pollution that can used for tracking environmental progress.

Those development guidelines are only partially reflected in the portfolio of investment projects included in the plan. For example, there is a THB 70 million project to develop a GIS database of economic, social and environmental issues. THB 200 million is allocated for environmental monitoring and some small projects are included to encourage cleaner technologies in industry. Other projects are aimed at enhancing awareness for limiting pollution and waste streams at the source by, for example, promoting reduced waste production and source separation of waste. One awareness raising project targets tourists on Koh Samet. Also, there is a THB 93 million waste management project with an objective to enhance Koh Samet's solid waste management capacities, as well as five smaller projects covering composting, biogas production, research into hazardous waste disposal and tourism focused wastewater treatment. The total value of environmental quality projects that address environmental quality concerns outlined at the beginning of this chapter is about 3.8% of the total proposed RPDP budget (or about THB 694 million) (Figure 13.1).

Figure 13.1: Environmental quality related projects in the RPDP by investment type



13.3 BAU scenario for Rayong's environmental quality

13.3.1 Governance

There are numerous governance factors that affect how well environmental quality is addressed in Rayong. The complexities and inter-linkages between those factors are explored more fully this section and in Table 13.1.

Table 13.1: Governance issues that influence Rayong's environmental quality

Drivers of change in governance reducing sustainability in Rayong
1. The regional environmental management plan covering Rayong is not picked up and expressed in the RPDP reflecting inadequate collaboration between national, regional and local agencies.
2. Parallel rather than joint reporting of the Regional Environment Office in Chonburi, and the Provincial Environment Office in Rayong to MONRE
3. Fines for environmental pollution are minimal and not acting as an incentive for improved performance. Even so, there is a culture of "treading softly" in terms of levying fines
4. Environmental monitoring agencies are seriously under-resourced meaning management action plans are not based on a thorough and precise science evidence base
5. Industrial estates do not share monitoring data, and environmental monitoring agencies do not have access to the estates for monitoring purposes.
6. Rayong's three municipal wastewater treatment systems are together operating at about 5% of their combined capacity reflecting a serious malfunction of infrastructure planning and of national – provincial agency cooperative arrangements
7. Application of an ambient environmental standards approach is not adequately informed by system wide studies and is not working effectively to holt pollution leading to loadings well beyond land, air and water body assimilation capacity
8. Responsibility for monitoring lies with environmental offices, but response and enforcement is the responsibility of the Department of Industrial Works (DIW)

Managing pollution to air, land and water in Rayong will continue to be a problem while governance, budgetary and staffing issues are not addressed effectively. A key challenge is the largely centralised approach to environmental management in Thailand and the relatively poor institutional connections between national, regional and local levels for planning, implementation and enforcement. Also, the role for environment agencies as monitors but not enforcers inhibits rapid and well informed responses to pollution problems. Underlying those constraints is a weak legislative foundation which inhibits more concerted and punitive action by regulatory agencies such as the Department of Industrial Works.

Thailand has in place a system of fines for environmental pollution. , However, in creating a business friendly environment, the fines that can be levied for exceeding pollution standards are negligible. For example, factories that are caught discharging out of standard effluent face a maximum penalty of THB 5,000 (~US$160) per day. A wide range of other economic measures have been proposed for inclusion under the Environment Act, but still under consideration.[88]

Given such a weak backing for punitive action, DIW tends to tread softly, and to look for ways to encourage factories to improve their environmental performance, rather than litigating. That approach of relying on negotiated programs for factories to self-regulate and improve performance over time works when supported by strong legislation as the ultimate disincentive for recalcitrant behaviour. It is absent in Thailand.

Yet, within the current legal framework DIW considers the approach to pollution control is the best that can be achieved. The Department points out that factories are regularly monitored for their wastewater management. Also, almost all big factories generating more than 7,500 cubic metres of wastewater were under real-time monitoring systems. Three to four times a year DIW conducts

[88] The Fiscal Policy Office of the Ministry of Finance, together with the MONRE Pollution Control Department, plans to introduce a range of economic instruments under the Thai Environment Act including environmental taxes, pollution management fees, product surcharges, performance bonds and subsidies.

surprise inspections of wastewater treatment and disposal systems. DIW considers that large factories tend to be better monitored and managed – but the thousands of smaller scale enterprises present in Rayong, for example, are not. The cumulative effects of those many point sources are where the main problem lies. That does not apply to air pollution which is proving more difficult to reign in for all sizes of factory.

If factories are found discharging more polluted water than the ambient average, they receive a warning. If they do not comply, the factories will be shut down.[89] In Rayong there are few instances of factory closure due to pollution concerns. In 2014, the IRPC petrochemical plant was closed for 90 days following an explosion. In 2019, the government ordered the temporary closure of about 600 polluting factories nation-wide and warnings to 1,700 more identified as at risk of producing pollution following onsite inspections.90 The SEA does not have the details of which if any of those factories are located in Rayong Province.

Factories are not required to report on pollutants they release to the environment. It is therefore difficult for monitors and regulators to take a point source approach focussing on those which consistently breach standards. The ambient standards framework makes it hard to ensure point source control.

Government environment agencies are significantly under-resourced especially at the provincial and regional levels. That affects the capacity to set in place comprehensive monitoring and reporting programs with adequate networks of monitoring stations covering a wide range of parameters. Again the law is inadequate in meeting the need. It requires only a few water pollution indicators to be monitored, while many dangerous substances, such as heavy metals, pesticides, PCBs and VOCs are left largely unnoticed. It skews the priority for management to organic pollution from agriculture and domestic sources.

. For this reason, the key trigger for investigations is public complaints rather than routine monitoring. Even with appropriate levels of funding, environmental monitoring of much of Rayong's industry would still be constrained, because IEAT has the mandate for monitoring and control within industrial estates. It does not publish monitoring results. Other agencies such as PCD and DIW cannot monitor and report on point source emissions from factories inside estates. While factories inside industrial estates tend to perform better than those outside, in places like Map Ta Phut, pollution coming from estates remains a serious health and environmental issue, especially for toxic pollutants rarely monitored.

Complicating environmental governance in Thailand are the ambient standards used for regulating air and water quality. This type of standard is challenging to set and apply. First, it requires detailed field studies and modelling to determine the carrying capacity of receiving bodies. PCD has conducted modelling of air and water systems in Rayong – but ultimately setting the level of ambient standards comes down to expert judgement and a determination of what are acceptable levels of risk given other national priorities.

For example, if an ambient water quality standard states that dissolved oxygen levels in a river cannot fall below 3 parts per million, the PCD needs to determine the kinds of pollutants which affect dissolved oxygen, the quantities of those pollutants the receiving body can assimilate, and then what each polluting enterprise is allowed to contribute to that ambient load. Fixed or point source emissions standards (FES) are much simpler to apply and regulate, although they are more difficult to tie directly

[89] Call for Thailand's 'unacceptable' water pollution problem to be tackled, The Nation, Thursday, October 17, 2019, Accessed from https://www.nationthailand.com/national/30309876

[90] Fix lax rule on factories, 2019, Bangkok Post Editorial. Accessed from - https://www.bangkokpost.com/opinion/opinion/1625558/fix-lax-rules-on-factories

to environmental outcomes. For this reason, FES are often used as an early step in a phased environmental management approach. Air pollution is especially difficult to deal with using ambient standards and may require a phased approach to control. For example, power generating facilities could be subject to emissions standards limiting their sulfur oxides (SO_X) production per kWh of electricity produced. For water pollution factories may be subject to concentration standards for their effluent. In later stages, as industry performance and government management capacity improves, ambient standards can be more readily introduced. In Thailand's case, and given the serious situation in Rayong province, it would make sense to move forward with a system of both point source and ambient standards.

Rayong has three operating municipal wastewater treatment systems, although none of them are operating anywhere near their design capacity. The plants were designed and built with limited consensus and involvement of local authorities or well defined management strategies for their operation and maintenance. Consequently, they have fallen into disrepair. In terms of total loading, domestic and municipal wastewater is the main source of pollution in Rayong's waterways. Less than 4% of Rayong's total municipal waste water is treated. Most domestic waste water enters septic tanks which are poorly monitored and maintained. Under the BAU and RPDP scenarios the projected continued increases in population and urban expansion will lead to a commensurate increase in untreated waste water load to the environment.

13.4 Ground water

Drivers of change reducing sustainability in ground water
▪ Illegally dumped solid and hazardous waste - leaching of toxins, heavy metals and VOCs into groundwater
▪ Improperly decommissioned factories - leaching of toxins, VOCs and heavy metals into groundwater
▪ Leaching from landfill sites that are over capacity and incorrectly designed and managed
▪ Power station fly ash is leaching into and contaminating groundwater
▪ Natural weathering of local rock formations - leaching of some heavy metals into groundwater

Testing of water in boreholes around the province show that toxins, heavy metals and VOCs are leaching into the groundwater. The main sources of groundwater pollution are:

(i) *Illegally dumped solid and hazardous waste:* dumping occurs both into waterways and into open dumping sites. For groundwater leaching from open dumping sites is the main source of contamination.
(ii) *Improperly decommissioned factories:* factories in Rayong often do not report if they are ceasing operations. The owners/operators just pack things up and lock the doors. Because provincial and regional authorities are under-resourced these facilities often go undetected and are a common source of leakage of chemicals and other toxins from storage drums and decomposing materials left on site.
(iii) *The municipal waste site is operating beyond capacity*, and because hazardous waste cannot be stored correctly there is a high risk of spillage and leaching into groundwater.
(iv) *Leaching from landfill sites*
(v) *Leaching from power station fly ash dump sites*

Contamination of groundwater is having observable impacts on the broader environment. For example, piling work in the Map Ta Phut port area was reported to have pierced an underground aquifer, allowing contaminated groundwater associated with power station fly ash to leak into the

ocean.[91] The leakage of groundwater pollution into the broader coastal environmental will impact on sea life and will soon begin to impact on fisheries, particularly as fisheries are looking more to high quality export markets, as well as on tourism as tourists are deterred from visiting places where pollutants are routinely reported.

Those drivers of change in ground water quality will all have a negative effect on sustainability in Rayong under both the BAU and RPDP development scenarios.

13.5 Rivers, canals and reservoirs

Drivers of change reducing sustainability in surface waters
▪ Continuing industrialisation particularly small-scale industry outside industrial estates will increase untreated and poorly treated industrial wastewater being discharged into Rayong's waterways.
▪ Population growth adds to the quantity of effluent being discharged from domestic sources.
▪ Limited monitoring of effluent from industry and domestic sources means that much domestic waste water and industrial waste water is untreated.
▪ Increasing cars on the road. Most vehicle pollutants come from the exhaust but brake pads, tires, oil, grease, anti-freeze, hydraulic fluids, and cleaning agents also contribute pollutants to the environment.
▪ Insufficient environmental flows mean that aquatic biodiversity is compromised and concentrates pollutant loads per volume in the water.
▪ Solid and hazardous waste being illegally dumped into waterways undermines the ecosystem health and raises short and long term public health risks in the immediate and downstream areas.
▪ Power station cooling water being discharged in to the environment changes the local water temperature and carries industrial contaminants picked up during the water's passage through the cooling system.

With continuing industrialisation particularly small-scale industry outside industrial estates and associated urban development and population growth, contamination of surface water will continue to rise. The pollution is the result of (i) inadequately treated wastewater from all sources, (ii) illegal dumping of solid and hazardous waste into water courses and into open dumping sites, and (iii) runoff of agricultural chemicals from farmlands into watercourses.

Climate change highlights the important links between water availability and water quality. With climate change projections showing continuing decreases in annual rainfall including longer and dryer dry seasons and increasing temperatures. Those changes would tend to concentrate contamination in surface waters and increase its toxicity.

Even under current management, environmental flows are inadequate to flush out pollution loads in Rayong's rivers and to sustain healthy aquatic ecosystem functions. Only seven percent of water releases from Rayong's reservoirs are allocated for environmental flows, this figure apparently based on industrial and agricultural requirements, rather than ecological considerations. Under the BAU and RPDP scenarios there is no consideration of increasing environmental flows. Consequently, that practice will continue to aggravate pollution levels in rivers.

Climate change related sea level rise will result in salt water intrusion into riverine areas, with inland reach exacerbated by inadequate environmental flows.

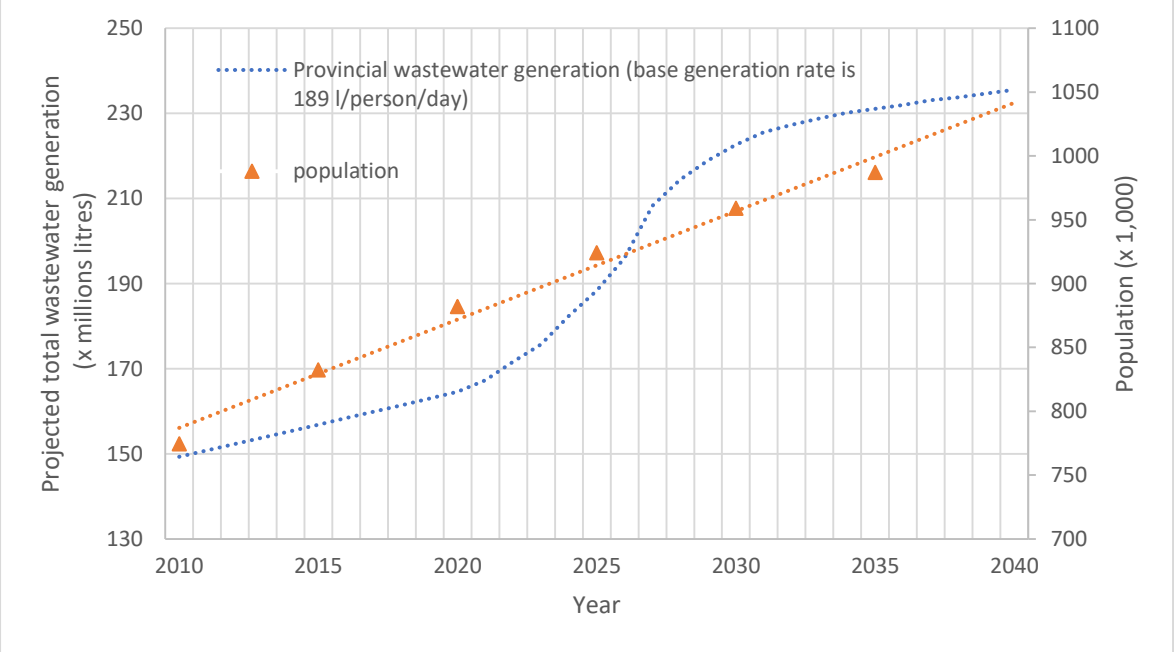
[91] See https://doi.org/10.1016/j.marpolbul.2019.07.071. Sediments in the vicinity of the piling tested positive for radium, indicating that the original source of pollution to the groundwater was likely fly ash from a power station, with other water quality parameters consist with this hypothesis. In addition, diffuse seepage of groundwater appears to be discharging more contaminated water than the point source (where the underground aquifer has been pierced). That broader seepage is discharging significant quantities of contaminated water highlights the gravity of the situation for the marine and coastal environment, and for the economic activities that rely on it (e.g. fisheries and tourism).

Industrial waste water tends to be more toxic than from other sources so the immediate and long term consequences are more serious if released untreated to the environment. Factories inside industrial estates are obliged to pre-treat wastewater before it is channelled into estate managed wastewater treatment systems. But, there is very limited monitoring of factories outside industrial estates. The ambient condition of surface waters would suggest that many factories outside estates discharge wastewater that is either improperly treated, or not treated at all. This practice leads to significant pollution loads entering Rayong's waterways, particularly in the case of factories with high water consumption such as paper and cardboard manufacturing and leather processing. .

The cumulative effects of many small scale enterprises outside industrial estates polluting water courses will become more serious under the BAU scenario, where large scale investments in industry within estates will tend to decline. Under the BAU scenario, an increasing proportion of new industry will relatively small and more likely to be located outside industrial estates where start-up costs are lower, and where environmental regulations are not being well enforced.

Wastewater in Rayong urban areas is generated at an approximate rate of 189 litres per person per day. That coefficient is likely higher than actual wastewater generation quantities per capita[92] but is being used here in estimating future projections. To the mid-2020s per capita wastewater generation will increase, driven by increasing urbanisation and wealth in the province and growth in tourism.[93] However, water shortages are likely to occur in the medium to long-term and would suppress domestic waste water generation (Figure 13.2). As water consumption per capita decreases, the overall growth in water usage will begin to flatten out in the late 2020s and early 2030s.

Figure 13.2: Trends in domestic wastewater generation in Rayong



[92] As noted in the urban development baseline chapter of this SEA, residential water supply in Rayong in 2018 was 153 litres per person based on population figures that exclude the numerous unregistered residents, and thus is likely an overestimate. Therefore the wastewater coefficient used here is an approximation which needs to be checked against more recent calculations for Rayong by the Office of National Water Resources.

[93] Tourist tend to use more water per capita than local residents. Also more affluent communities tend to use more water and thus produce more wastewater than poorer people (See e.g. case studies in https://sustainabledevelopment.un.org/content/documents/1711Water%20for%20a%20Sustainable%20World.pdf)

Decentralised and large scale power producers will continue to discharge cooling water that is hot and contaminated Power station cooling water discharged into waterways changes the local water temperature and carries industrial contaminants picked up during the water's passage through the cooling system. Power plant discharges are contributing to reduced quality in Rayong's waterways with contaminants including heavy metals such as arsenic, mercury and lead.[94]

In agricultural areas, the downturn in this sector, accompanied by more water intensive cropping, could keep waste water from this source at similar or slightly elevated levels. Examples of agricultural wastewater include manure, piggeries and intensive poultry wash water, barnyard and feedlot runoff, slaughterhouse wastewaters, horse washing waters and runoff associated with composting. Additionally, runoff from croplands contribute sediment, fertilizers and pesticides into surface waters.

13.6 Coastal Waters

Drivers of change reducing sustainability in coastal waters
▪ Increasing shipping raising the chances of accidental spills from oil and gas vessels
▪ Increasing shipping leading to increasing pollution load from bilges
▪ Untreated municipal and domestic effluent being discharged directly and indirectly into coastal waters
▪ Increasing waste generation and insufficient collection and treatment capacity means more garbage including plastic bags, bottles, straws and Styrofoam containers ending up in coastal waters
▪ Power station cooling water being discharged in to the environment changes the local water temperature and carries industrial contaminants picked up during the water's passage through the cooling system.

The BAU scenario includes the recently approved phase III extension of Map Ta Phut port, which will primarily be LNG import facilities. These expanded port facilities (combined with projected decreases in natural gas from the Gulf of Thailand) will mean more shipping, and potential for increased incidence of spills and accidents affecting coastal waters near Map Ta Phut. Also, ships flushing and cleaning their bilges will be a source of increasing pollution loads to coastal areas.

The lack of treatment of municipal wastewater was described in the governance section of this chapter (section 16.3.1). This is having a large impact on Rayong's coastal waters. Rayong City's municipal wastewater treatment facility is being bypassed, with untreated municipal wastewater discharged directly into waterways leading to contamination of coastal waters.

Overflowing waste treatment facilities, and limited garbage collection and treatment in urban areas, are combined with a growing population and growing per capita waste generation. This means that the trend line for garbage entering Rayong's waterways and finding its way into coastal waters is steadily going up. There is nothing in the BAU scenario to offset that trend

There is inadequate environmental monitoring and reporting to address issues of coastal pollution, including garbage and wastewater from shipping, industry, domestic wastewater, and runoff of agricultural chemicals, or the large quantities of used and polluted cooling water that is discharged from power plants directly into the sea.[95]

[94] Power plants are among the largest contributors of water pollution in the United States. See: https://earthjustice.org/cases/2014/cleaning-up-power-plant-water-pollution

[95] For example, satellite imagery in the industry baseline chapter of this SEA shows discharge of cooling water from two of Map Ta Phut's power generation facilities.

13.7 Air quality

Drivers of change in air pollution reducing sustainability
▪ Growing numbers of vehicles on Rayong's roads means more emissions of carbon monoxide, hydrocarbons, nitrous oxides, carbon dioxide, and particulates.
▪ Increasing electricity generation in Rayong will be associated with increased emissions of greenhouse gases, and particulate matter.
▪ Lack of structural change in industry means that emissions of VOCs, PM, SO_x and NO_x will continue to be emitted at their current levels by heavy industry like petrochemical factories.
▪ New investment in small scale enterprises outside industrial estates under the BAU scenario will mean more emissions of PM, SO_x and NO_x.

The main impacts on air quality in Rayong come from the transport sector, despite national government policies promoting a modal shift from road to rail and significant initiatives to improve emissions standards between 2019 and 2039. Until mid-2030 under the BAU scenario, there will be continuing increases in carbon monoxide, particulate matter and nitrogen oxides emissions, related primarily to motor vehicles. For example, between 2019 and 2039, despite improving emissions standards, CO emissions are likely to rise by a factor of around 2.5 plateauing around 2035. By 2039, under the BAU scenario improving emissions standards means that particulate matter will drop to about 70% of current levels.

While industrial growth is expected to slow, its continued growth will be accompanied by further installations of decentralized electricity generation systems, encouraged under Thailand's small power producer (SPP) program, promoting cogeneration facilities that can sell electricity to the national power grid. As an important energy hub, Rayong will continue to produce significant electricity for distribution to other parts of Thailand. For example, a 2.65 GW gas-fired power plant will be constructed in Pluak Daeng with commercial operation dates of 2023 & 2024 for two phases of the project. While gas-fired[96] and cogeneration power is less polluting than coal-fired power, there will still be emissions to air (e.g. GHGs, PM_{10}, $PM_{2.5}$). Coal fired plants in Rayong will continue to be a major source of air pollution for some decades under the BAU scenario. For example, current air pollution from coal-fired power plants operated by BLCP Power Limited and GHECO-One Co Ltd in Rayong's Map Ta Phut Industrial Estate contributed 40 per cent of the annual PM2.5 level in Pattaya and Koh Samet and made up 20 per cent of the annual PM2.5 level in Bangkok.[97]

It is worth noting that the 2019 PDP is targeting increasing percentages of renewable energy generation systems in Thailand's energy mix. However, because of land prices in Rayong, and because of its value as an energy hub and industrial centre, utility scale renewable installations are not likely. There would be possibilities for exploring dual land use options with farmers, i.e. where wind or solar farms are co-located, which can increase overall land productivity combining energy generation and agricultural production.[98]

Industrial areas in Rayong are a growing source of pollution. Under the BAU scenario industry will remain in its current configuration, with a strong emphasis on heavy industries like oil refining and petrochemicals, which emit significant pollution to air, including VOCs, PM_{10}, $PM_{2.5}$, NO_x, and SO_x. While Map Ta Phut was declared a pollution control zone in 2009, emissions of pollutants to air

[96] Gas-fired plants emit 7 percent the nitrogen oxides and 0.2 percent of the sulfur dioxide of coal burners, largely because nitrogen oxides can be more efficiently controlled in a gas plant and sulfur content is very low in natural gas.
[97] The Nation, 2018, Coal-fired power plants partly to blame for Bangkok pollution - https://www.nationthailand.com/national/30338354
[98] See: https://cleantechnica.com/2017/11/24/combining-solar-panels-agriculture-makes-land-productive/

continue to be routinely outside standards. Efforts to address this with legislation such as the 80:20 offset scheme,[99] have not reversed the growth in industrial pollutants. Given the projected slowdown in industrial investments, particularly in heavy industries, under the BAU scenario emissions of VOCs such as benzene, butadiene and 1.2-dichloroethene (which are of particular concern to human health) are not likely to grow significantly in coming years (Figure 13.3).

Figure 13.3: Annual average VOC concentrations at Banplong, near Map Ta Phut industrial zone

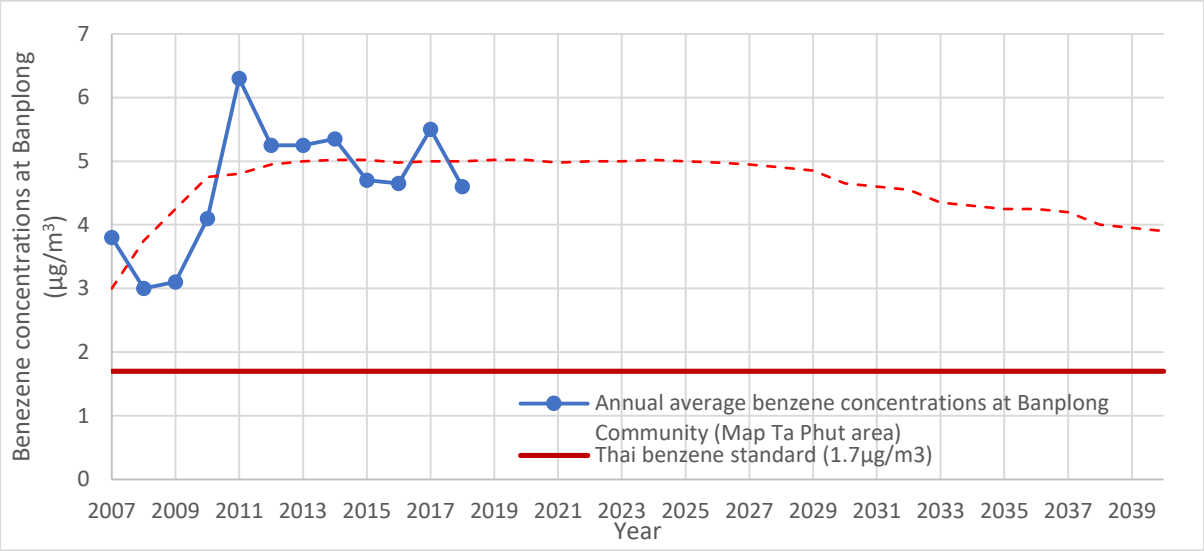


Figure 13.3 provides an example of annual average VOC concentrations in an area near Map Ta Phut industrial zone where most of Rayong's heavy industry, such as petrochemicals is located. The slowing growth in the emission trend line reflects slowing investments in petrochemicals and other heavy industry in Rayong over the same period (see industry impact assessment chapter). VOC emissions under the BAU scenario are stabilising, but at a levels significantly higher than the national standards. The stabilisation of VOCs like benzene is not because of active management, but rather is the result of broader macro-economic influences, such as regional competition in the petrochemicals and oil refining industries as well as the rapidly depleting natural gas deposits in the gulf of Thailand. Other industry related pollutants, such as particulate matter as well as NO_x and SO_x will continue to be emitted in increasing quantities on trend with industrial growth in Rayong. As petrochemical factories and oil refineries are decommissioned, the ambient level of VOCs such as benzene will decline relative to their levels in the early 2020s, but without active management it will be many years before they drop to within Thai national standards.

13.8 Solid and hazardous waste

Drivers of change in solid waste reducing sustainability
▪ Capacity and resources inadequate to manage additional municipal solid waste
▪ Growth in the tourism sector, which already contributes around 9% of Rayong's MSW, will further overload waste management capacities.

[99] The 80:20 offset scheme works when new companies begin operating in an area. For example, if a new project will emit 80 tons/hr of SO_x or NO_x (for example), the owner of the new project has to find a partner (or partners), in the area where the project will be established, who is willing and able to reduce their existing emissions of SO_x or NO_x by 100 tons/hr to offset the emissions of the new project. Thus, adding this new industrial venture should reduce the cumulative industrial emissions in the area by 20 tons/hr.

- Waste that needs to be incinerated must be transported to Ratchaburi Province, on the far side of Bangkok. This increases the risk of accidents on the road, and also makes it more attractive for industry to engage in illegal dumping of their hazardous waste to avoid transport costs

Rayong's capacity to manage solid waste is at its limit. Yet, Rayong is not investing in waste management capacity. Existing facilities, including hazardous waste receiving points, are full. Sectors like tourism which generates around 9% of Rayong's MSW are growing. Despite national programs designed to encourage sustainable forms of tourism, in Rayong eco-friendly models are still in their nascent stages.

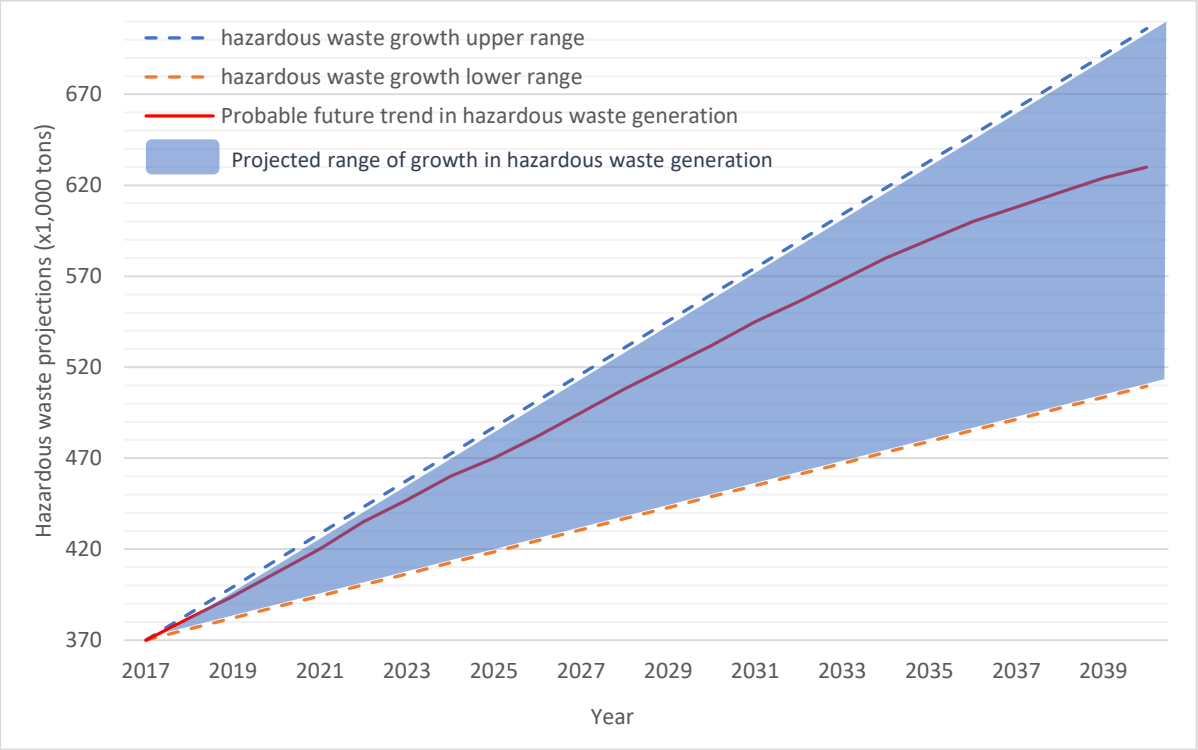
Industrial hazardous waste that requires incineration must be transported to Ratchaburi Province on the far side of Bangkok. Transporting hazardous waste over long distances increases the possibilities for accidents, and continued growth of current forms of industry under the BAU scenario means that hazardous waste as a proportion of overall pollution loadings will continue to grow.

Most hazardous waste comes from Map Ta Phut, but a significant proportion is also generated by the 40% of factories that are located outside industrial estates. Transport of hazardous waste is carried out by the private sector, and some factories seek to reduce costs by illegally dumping.

The possibilities for hazardous waste leaching into surface and groundwater, as well contaminating soils will increase under the BAU scenario as already observed in the Map Ta Phut port area. A significant inherited problem still to be addressed is improper decommissioning of old factories, with hazardous wastes and chemicals often left abandoned in disused sites. These waste products will continue to leach into the groundwater and into surface water bodies, as well as being burnt releasing toxic emissions in accidentally or deliberately lit fires.

It is difficult to quantify and verify past hazardous waste generation rates. However, between 2015 and 2017 generation of hazardous waste grew from about 310,000 tons to about 370,000 tons, a growth rate of 9% per year. This growth rate is a little over the growth rate of investment in industry over the period 2009 – 2017 (i.e. 7% per year), which reflects the growing proportion of hazardous waste within industrial waste stream. The BAU does not include measures to de-couple hazardous waste generation from industrial activity, hazardous waste generation in the province is projected to grow in line with industrial growth projections (Figure 13.4).

Figure 13.4: Hazardous waste projections for Rayong



In Figure 13.4, the upper and lower ranges for waste projection are based on historical industrial growth rates for 2017 – 2019 (lower range) and 2014 – 2019 (upper range). Even the lower range projections show an increase in hazardous waste generation of almost 150,000 tons per year by 2040.

13.9 Full RPDP implementation scenario for Rayong's environmental quality

Many of the goals, objectives and targets included in the early pages of the RPDP support improved environmental quality, including improved domestic and industrial waste management, dealing with air and water pollution issues. Section 13.2 summarises environmental quality related projects included in the RPDP. However the combined impact of those projects will have a negligible contribution in meeting the sustainable development objectives for environmental quality.

While there is over 400 million THB included in the plan for conservation and restoration projects, this is somewhat offset by the transport and drainage/dredging projects which dominate the investment portfolio and which are likely to have significant environmental impacts. The solid waste management project on Koh Samet may be a useful pilot project for broader MSW management in Rayong, particularly as the growing tourism sector in Rayong is already responsible for 9% of Rayong's MSW. The other positive elements of the RPDP is the 70 million THB project to develop a GIS database on economic, social and environmental issues within Rayong. A database of this sort can provide the foundation for an integrated monitoring and reporting system of environmental issues. Yet, the level of funding puts at risk its sustainability.

Despite those highlights, the RPDP does little to address environmental pollution to land, water or air or to rehabilitate and maintain aquatuc and terrestrial natural systems. The most significant gaps in the RPDP are:

(i) The critical governance issues constraining effective environmental management in the province have not been considered;
(ii) There are no mechanisms to improve the much needed monitoring and reporting on environmental pollution, including for industrial and domestic effluent and treatment systems;

(iii) There is nothing in the plan to rectify the poor performance of the municipal wastewater systems;
(iv) Waste management capacity is only being addressed on a very small scale, with hazardous waste not considered;
(v) The importance of environmental flows and rehabilitation of river systems is not considered
(vi) No projects are defined which would enhance forest cover and green space throughout the province, despite ambitious goals and targets.
(vii) The importance of sustainable urban design as Rayong Province's urban population rapidly increases. Filling that gap requires a much improved zoning plan with development controls and safeguards promoting innovating approaches to energy use and GHG emissions (based on transport related uses), water quality and recharge, habitat and ecological quality, energy use and production (based on non-transport related uses), and equity and health.

Because of those gaps in the RPDP and because only very limited funding has been proposed that would address environmental quality issues, the trends undermining sustainability in Rayong with full implementation of the RPDP will be virtually the same as for the BAU scenario.

14 CONCLUSIONS

The rapid expansion of heavy industry in the province, coupled with associated growth in urban population and transport has led to the uncontrolled use of resources in the province and rapidly increasing pollution loads from all sources. This, in turn, has resulted in a decline in environmental quality and liveability particularly in urban areas, and a more general degradation of the natural environment.

Over the last two decades, demand for natural resources in the province has grown dramatically. The issues are particularly acute concerning land and water use in the province in addition to the air as a natural sink for pollutants. Largely uncontrolled land development and inadequate integrated spatial planning has resulted in a range of issues related to the development of an inappropriate mix of land uses in many locations with poorly enforced zoning and a limited framework of standards.

Longitudinal development along transportation corridors is common as is seemingly *ad hoc* conversion of land to residential, commercial and industrial uses. These types of development represent an inefficient use of land, promote urban sprawl, increase the costs of infrastructure and service provision and can lead to issues with traffic congestion and reduced quality of life. Inappropriate mixtures of land use also serve to exasperate pollution issues, for example when industrial development is allowed close to residential areas.

Similarly, growing water demand from industry, commercial and residential sectors have been met by an almost exclusive concentration on the increase of water supply, necessitating development of further reservoirs and supply infrastructure to bring water in from further afield. Given the limited water resources in the province, it is of concern that little or no emphasis has been placed on demand reduction, particularly in industry. More generally, the RPDP fails to address the serious issues posed by the lack of coherent resource management in the province, which in turn poses a long-term threat to the sustainability of socio-economic development.

Pollution in the province from all development sectors and domestic sources is a serious issue not receiving an adequate management and budgetary response. The limited initiatives in the RPDP for pollution control and abatement measures does not reflect the severity of the issue nor the problems it will pose for future development in the province. Poor local air quality in industrial areas remains a key challenge. Water pollution also poses a significant issue for industry and the urban sector. Issues also persist with solid and hazardous waste in the province, and illegal dumping of waste is still relatively common. Water quality and aquatic environments in particular have been seriously degraded, which in turn compounds water supply issues and costs. Monitoring and enforcement provision is weak, legal remedies are inadequate and capacity amongst competent agencies limited. Without significant institutional and legal changes it seems unlikely that the province will be able to get to grips with these issues.

In moving up the value-chain and seeking to develop higher value-added industry in the province, as part of the EEC initiative and more broadly Thailand 4.0, the attractiveness and liveability of urban areas in particular will become critical in providing a location that can attract and retain talent, and build human capital. It is clear that, given the choice, the kind of highly skilled, globally mobile professionals involved in knowledge intensive sectors will not choose to reside in locations where their physical health and well-being may be put at risk by environmental pollution and substandard amenities.

In the last 30 years the population has swelled through in-migration due to the availability of jobs, and the proportion of people living in urban areas has grown rapidly. While agriculture still uses three-quarters of the land in the province it contributes insignificantly to the provincial economy. Some agricultural areas are being converted to urban and industrial areas, and the agricultural workforce is both declining in number and increasing in average age. Yet, the growing urban population, industrial

workforce and significant numbers of tourists visiting Rayong all need food - which would seem to provide good market opportunities for some farmers. Efforts are being made to encourage young agri-entrepreneurs to get involved in more mechanised farming, using modern technology to generate food products with higher quality standards, as well as a greater emphasis on value-adding food processing, and high-value export markets. This may enable individual farmers to make a better living than before, but even so, it is unlikely to alter the relative contributions of industry and agriculture to the provincial economy, and the strong trend of decline in the sector.

Along with the growth of industry has been the growth in demand for water in the industrial sector, which now uses about half the available water supply in Rayong. Although less than 13% of farmland is irrigated, those farmers with access to irrigation are concerned that in any water shortage situation, needs of industry will be prioritised over the needs of agriculture. There are many farmers who would like to see the coverage of the irrigated area expanded, but there are no plans to address this significant unmet demand. Given projected future water demand in all sectors - particularly in the case of EEC-related developments, water supply in Rayong will not be sufficient beyond 2025, without an inter-basin transfer from neighbouring Chanthaburi Province - which under the Water Act 2018, would have to be approved by the National Water Resources Commission. By 2030 it is likely that even this will no longer be sufficient and plans are already being considered to divert water from Cambodia to Rayong. This extreme adherence to meeting demand at all costs, is of great concern from an environmental, social and economic perspective, and runs counter to the self-reliance and efficient resource use strategies embraced in the sufficiency economy philosophy embraced in the RPDP.

Remaining forest cover in Rayong is only 7.8%. Most of this is contained within three protected areas - Khao Laem Ya - Mu KoSamet National Park; Khao Chamao-Khao Wong National Park, and Khao Ang Rue Nai Wildlife Sanctuary. Only the first of these is wholly contained within Rayong, the other two overlap with neighbouring provinces. Most of the National Reserve Forest outside protected areas had already been cleared two decades ago, and only small patches remain, with some of this now being managed as community forests. In recent years, forest loss has plateaued and the RPDP includes ambitious targets for increasing the area but with little planned investment backing or spatial and sector strategy.

Rayong has more terrestrial biodiversity than would normally be expected from its low forest cover. This is largely due to the connectivity between forests of Rayong and the much larger Eastern Forest Complex which covers parts of five provinces. This internationally important forest landscape enables the plants and animals found in Rayong's forests to exist as parts of much larger populations and bigger gene pools, thereby increasing the chances for their continued survival. Maintaining this connectivity is crucial to quality of life in Rayong – and globally for biodiversity conservation. It could be threatened through the widening/improvement of small tertiary roads, especially in the area between Khao Chamao and Khao Ang Rue Nai. Construction of new reservoirs and pipelines for the inter-basin transfer between Chanthaburi and Rayong, while not directly impacted forests in Rayong, may impact other parts of EFC. The footprint of future development in Rayong will certainly have impacts on water and forests extending beyond the provincial boundary.

In summary, the current Rayong Provincial Development Plan has important aspirational goals and targets for improving the social and environmental conditions within the province. It sets out policy positions which address many of the strategic issues of concern identified by SEA stakeholders. Yet, in practice it fails to deliver on those aspirations through projects and budgets. The plan ends up promoting a conventional development portfolio. It fails to address very serious issues of ecological sustainability and environmental quality, of degrading living conditions, and of increasing inequities in the process of economic structural adjustment and losses in local livelihoods and traditional ways of life.

In large part this poor sustainability performance of the Rayong plan is due to the lack of status, authority and expectations given to provincial planning within the Thai system of government.

Provincial authorities are dependent on the good intentions and willing collaboration of national and regional agencies to fulfil development aspirations. In Rayong that collaboration has not always been forthcoming. The Thai system tends to dampen the ambitions of provincial government in what they seek to cover in their development plans. There is a view that PDPs should focus on parochial issues and leave the main development agenda to higher level government bodies. The current RPDP is definitely shifting away from that conventional constraint by setting out broad sustainability objectives, even though it does not follow through on their effective implementation. The movement to give greater weight to provincial plans is to be strongly encouraged so that the next RPDP iteration becomes an essential platform of standards, development controls and investment priorities which all arms of government must respect and adhere to.

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