SEA OF THE RAYONG PROVINCIAL DEVELOPMENT PLAN - SUSTAINABLE DEVELOPMENT PATHWAY 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 - SUSTAINABLE DEVELOPMENT PATHWAY REPORT

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

- Methodology and scoping report
- Baseline assessment report
- Sustainability analysis (impact assessment) report
- **Sustainable development pathway 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.

Prepared by	ICEM Asia
Prepared for	NESDC, Rayong Provincial Governor's Office and ADB
Suggested citation	ICEM. 2019. TA 9204-THA Phase 2: Strategic Environmental Assessment of the Rayong Provincial Development Plan and Revision of the Draft Thai SEA Guidelines. *Sustainable Development Pathway Report*. Prepared for NESDC and ADB. Hanoi.
More information	www.icem.com.au | info@icem.com.au ICEM - International Centre for Environmental Management 6A Lane 49, To Ngoc Van, Tay Ho, Hanoi Viet Nam
Cover image	www.erarayong.com
Project Team	Jeremy Carew-Reid (Team Leader), Allan Sriratana Tabucanon, Bancha Kwanyuen, Daniel Gilfillan, David Annandale, John Sawdon, Kelsey Harpham, Mai Ky Vinh, Richard Cooper, Robert Mather, Saniwan Buaban, Sinee Chuangcham, Sumaitt Putchakarn, Vithet Srinate and Wanpen Wirojanagud

ABBREVIATIONS

3Rs	Reducing, reusing and recycling
ADB	Asian Development Bank
BAU	Business as usual
BCAMP	Biodiversity Conservation and Protected Areas Management
BRT	Bus Rapid Transit
CATSPA	Catalysing Sustainability of Protected Areas
CHP	Combined Heat and Power
CPD	Cooperative Promotion Department
DEDE	Department of Alternative Energy Development and Efficiency
DIW	Department of Industrial Works
DOA	Department of Agriculture
DOAE	Department of Agricultural Extension
EBSA	Ecologically or biologically significant areas
EFCOM	Eastern Forest Complex
EGAT	Electricity Generating Authority of Thailand
EMPs	Environmental management plans
EPPO	Energy Policy and Planning Office
ESDP	Eastern Seaboard Development Programme
EVs	Electric vehicles
GES	Good Environmental Status
GPS	Global Positioning System
GSTC	Global Sustainable Tourism Council
HSR	High speed rail
ICOR	Incremental capital-output ratio
ICZM	Integrated Coastal Zone Management
ICZM	Integrated Coastal Zone Management
IEAT	Industrial Estate Authority of Thailand
ITDP	Institute for Transportation and Development
KARNWS	Khao Ang Rue Nai Wildlife Sanctuary
KCKWNP	Khao Chamao-Khao Wong National Park
LYMKSNP	Laem Ya-Mu Koh Samet National Park
MAF	Mean annual flow
METT	Management Effectiveness Tracking Tool
MPA	Marine protected areas

MSFD	Marine Strategy Framework Directive
MSW	Municipal solid waste
NAP	National Adaptation Plan
NESDC	National Economic and Social Development Council
NG	Net Gain
NNL	No Net Loss
NWRC	National Water Resources Commission
OAE	Office of Agricultural Economics
ONEP	Office of Natural Resources and Environmental Policy and Planning
ONWR	Office of National Water Resources
PACs	Protected Areas Committees
PAO	Provincial administrative organization
PCD	Pollution Control Department
PEA	Provincial Electricity Authority
PEO	Provincial Environment Office
PES	Payment for ecological services
POAC	Provincial Office of Agriculture and Cooperatives
RBCs	River Basin Committees
REO	Regional Environment Office
RID	Royal Irrigation Department
RPAO	Rayong Provincial Administration Organization
RPDP	Rayong Provincial Development Plan
SD	Sustainable development
SEA	Strategic Environmental Assessment
SMART	Spatial Monitoring and Reporting Tool
SPP	Small Power Producer
VSPP	Very Small Power Producer
WARPA	Wild Animal Reservation and Preservation Act

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 Background

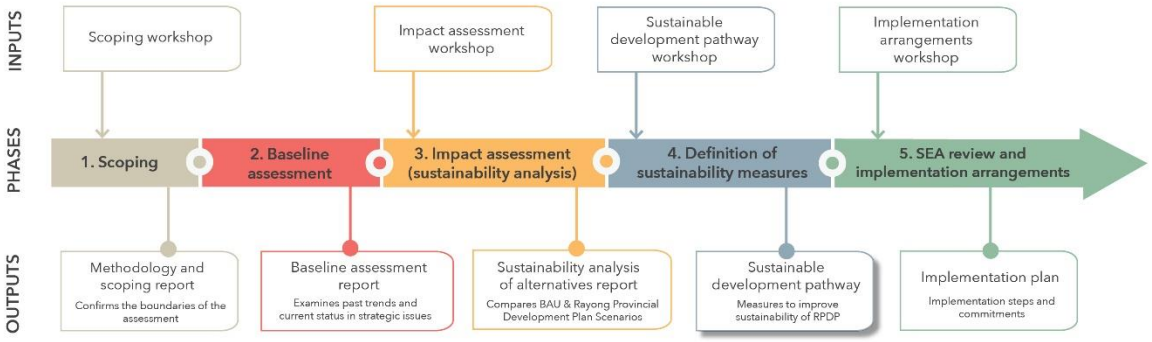
This fourth volume of the pilot Strategic Environmental Assessment (SEA) of the Rayong Provincial Development Plan (RPDP) sets out the Sustainable Development Pathway intended for integration into the current and future iterations of the RPDP. The Pathway outlines the measures to be taken across the thirteen SEA thematic areas to enhance sustainability in the province. This was a pilot SEA, which was initiated to test and guide Thailand's draft national SEA guidelines. Consequently, the pilot SEA has two key objectives:

(i) To test implementation of the draft national SEA guidelines leading to their completion and submission to Cabinet for endorsement; and
(ii) To support Rayong authorities in defining measures for inclusion in the provincial development plan that will help to improve sustainability within the province.

Initiated jointly by the National Economic and Social Development Council (NESDC), the Rayong Provincial Governor's Office, the Office of Natural Resources and Environment (ONEP) and the Department of Water Resources (DRW), the project was funded by the Asian Development Bank (ADB) through an extension of TA 9204-THA. The SEA component of the project was conducted as a rapid strategic assessment over a period of six months with a budget of approximately USD200,000. The SEA was one component of the project which included review and revision of the national SEA guidelines and preparation of training materials in support of guidelines implementation. The full project ran for one year from February 2019.

In order to test the implementation of the draft national guidelines, the pilot SEA followed the steps set out in the draft guidelines: (i) scoping, (ii) baseline assessment, (iii) sustainability analysis (impact assessment), and (iv) the development of recommendations to support a transition to a sustainable development pathway (Figure 1-1). A fifth stage – SEA implementation – is concerned with the consultations, arrangements and oversight for reviewing and implementing the SEA SD pathway and recommendations. Initial steps for stage five are set out in the final chapter of this volume.

Figure 1-1: SEA process diagram



The pilot SEA used a participatory approach with stakeholders from Rayong province and national and regional agencies to: (i) identify 13 strategic thematic areas that influence or are influenced by Rayong's development pathway, (ii) to identify strategic issues of concern for development within each of the 13 themes, (iii) to access local knowledge, opinion and data about Rayong's development, and (iv) to review historical trends, the current situation and project likely future trends as well as drivers of change for the 13 themes and their strategic issues. The open and consultative process moved towards reaching consensus and acceptance among stakeholders of the needed measures to address their concerns and aspirations for Rayong province.

The details of the previous three phases of the SEA (Scoping, Baseline and Sustainability Analysis) are contained in Volumes 1 through 3 of this SEA respectively.

1.2 Scoping phase (Volume I of the SEA)

One of the initial activities for the SEA was the development of a stakeholder consultation and communications plan used to optimize and guide stakeholder engagement for the duration of the SEA. The stakeholder consultation and communications plan helped identify the main agencies, groups and individuals that need to be involved in the entire SEA process. Also, it set out the communication and participatory methods and events targeting the stakeholders.

The scoping workshop was used to define the geographical, temporal and substantive boundaries of the SEA. Stakeholders worked with the SEA team to identify the thematic areas as well as the strategic issues of concern for each theme. While the scoping for the SEA occurred mainly during the initial phases of the SEA, there was a continuing focusing of the assessment throughout the process taking into account new information, views and analysis.

Sustainable development (SD) objectives for each strategic theme and associated indicators were identified during the scoping phase as a sustainability framework for assessing the performance of the current RPDP and alternative development pathways. The SD objectives and their linked indicators also form the basis for future monitoring of implementation of the sustainability measures included in this final volume of the SEA.

1.3 Baseline assessment (Volume II of the SEA)

The 13 SEA thematic areas identified during the scoping phase provided the substantive focus for documentation and analysis during the baseline assessment. The baseline established the historical trends for the strategic issues in each of the thematic areas. Assessing historical trends included a detailed analysis of the factors driving change and the nature and extent of development. The baseline also assessed the current status and forces with potential to influence the strategic issues in future. In the case of climate change, modelled of projections was conducted and a climate change profile to 2050 defined for the province.

The baseline assessment provides the foundation for the SEA. It establishes a comprehensive evidence base for each thematic area in the form of trends, drivers of change and original analysis. In many ways it is the most important phase of the SEA. It lends credibility and authority to the process, allows for agreement on the facts and a deeper understanding of the social, economic and environment situation. The original in-depth analysis provides the solid insights and rationale for later phases of the SEA. The baseline assessment forms Volume II of the SEA report set.

1.4 Sustainability Analysis (Impact Assessment) (Volume III of the SEA)

In the sustainability analysis phase of the SEA, trends for the strategic issues for the 13 thematic areas were projected into the future under two development scenarios. The first was a business as usual (BAU) scenario. In the BAU scenario, the current RPDP and other yet to be implemented national and regional plans likely to have an influence on Rayong's development were not considered. The BAU scenario provided forward projections for the strategic issues of concern for each of the 13 thematic areas based on historical trends and their drivers.

The second development scenario assumed that the current RPDP was implemented in full. The strategic themes and issues were projected forward under an RPDP development framework. The scenario projections were conducted with stakeholders in a two day sustainability analysis workshop. The final stage in this process was to compare and score the results for the two scenarios against the sustainability objectives for each theme taking the indicators into account. For each theme and issue under the two scenarios, stakeholders responded to the question, "is the trend leading Rayong closer to or away from the SD objective?" The assessment was to determine what elements of the RPDP would improve conditions in the province and what could have negative impacts on sustainability.

A third development scenario was defined to enhance promising measures in the RPDP, to add momentum to positive trends, and to respond to the negative impacts identified under the BAU and full RPDP implementation scenarios. The goal of the third scenario is to achieve the SD objectives under all themes. The basis for the third scenario, titled the Sustainable Development Pathway, was prepared in a two day stakeholder workshop in Rayong Province.

1.5 Sustainable Development Pathways (Volume IV of the SEA)

This final volume of the pilot SEA provides measures for inclusion in the current and next RPDP as well as in other plans that influence provincial development.

The measures are guided by the strategic issues of concern to be addressed and the SD objectives for each theme which need to be achieved in Rayong Province. The SD pathway adheres to the overarching goals and principles governing ecologically sustainable development:[1]

The core goals of the SD pathway are:

- to enhance individual and community well-being by following a path of economic development that safeguards the welfare of future generations;
- to provide for equity within and between generations;
- to protect biological diversity and maintain essential ecological processes and life-support systems.

The guiding principles governing implementation of the SD Pathway are:

- decision making processes should effectively integrate long and short-term economic, environmental, social and equity considerations.
- international economic competitiveness needs to be maintained and enhanced while improving environmental quality and ecological sustainability and related environmental management capacities.
- the transboundary dimensions of environmental impacts of actions and policies should be recognised and addressed.
- cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms.
- lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation, especially where there is a threat of serious or irreversible harm.
- decisions and actions should provide for broad community involvement on issues which affect them.
- climate change shapes all strategic issues of concern to development in Rayong Province and needs to be considered in development planning.

These guiding principles are all important and have equal weight. Development in Rayong Province has proceeded without due concern for maintaining, enriching and building on natural systems and services. Consequently, environmental quality, economic sustainability and community quality of life has suffered. The SD Pathway seeks to bring nature back as an essential development strategy for the Province to underpin economic competitiveness, social equity and to reassert the fundamental role that a healthy environment plays in happiness, wellbeing and productivity.

[1] These goals and principles are adapted from the Australian Strategy for Ecologically Sustainable Development accessed in September 2019 from http://www.environment.gov.au/about-us/esd/publications/national-esd-strategy-part1#Principles

1.5.1 Monitoring and evaluation framework

A structured, consistent and well documented monitoring and review process must be put in place to keep track of implementing the SD measures. That framework needs for become an integral part of the overall monitoring and reporting system for the RPDP as a whole. Monitoring and review of the SD measures should be a cyclical process that is used to improve sustainability performance.[2] The SD measures and arrangements for implementation should be refined and updated based on changing circumstances and what is working or not working each implementation cycle.

The monitoring process should determine if the RPDP is helping to achieve progress towards the sustainable development objectives and targets. During this pilot SEA, the TA team, the key stakeholders from Rayong Province, and representatives from NESDC and ONEP developed the sustainable development objectives and indicators for each theme. The objectives and indicators are included in Table 3 in the Methodology and Scoping Volume of this SEA report series, as well as being highlighted again within each chapter of this Sustainable Development Pathways Volume. Together they form the basis of the framework for monitoring implementation of the measures included in this volume and evaluation of their effectiveness.

The Rayong Governor's Office has the main role in managing and coordinating the monitoring and reporting process. Many actors will need to contribute on a regular basis – leading to real time monitoring data and at least annual reporting. There is a special role for national sector agencies in reporting on their activities according to agreed environmental management plans as proposed in this volume. A substantial role falls on the private sector for self-monitoring and reporting much more extensively and openly than in the past. And a stakeholder advisory committee is needed to support the Governor's Office in ensuring monitoring, analysis and reporting is adequate to a full understanding of changing conditions. More guidance is provided on the RPDP sustainability monitoring framework in the concluding chapter on the volume.

1.6 Structure of this volume

This volume is divided into two parts. Part I presents the SD measures for the development sectors – ie those strategic themes concerned with use of natural resources and economic production. Part II presents the SD measure for what has been termed the quality of life themes. The development sector themes are industry, transport, energy, water resources and agriculture as well as tourism, coastal and marine environment and urban development. The social and environmental well-being themes are social equity, forests and terrestrial biodiversity climate change and environmental quality. Each thematic chapter begins with a brief summary of the main points from the baseline and sustainability analysis that relate to the strategic issues for the theme. The SD measures for each theme are presented in two tables, the first detailing actions for inclusion in the RPDP, and the second detailing actions that may be beyond the mandate of the Rayong authorities, but which are nevertheless critical for supporting and enhancing sustainable development in the province.

The final chapter sets out important steps to ensure update and implementation of the SD measures and SEA recommendations. The greater the resources and effort which goes into continuing consultation and definition of responsibilities, the more likely the SD pathway will be implemented successfully as an integral part of the RPDP and other relevant sector and regional plans. Without an emphasis on what is the fifth phase of an SEA process – ie implementation of recommendations – the initiative will fail in its primary intent. This SEA was complex because it covered all development sectors operating within the province – and their influence one on another, and on the quality of life

[2] See e.g. Ozcoasts' review of Australia's National Water Quality Management Strategy, available at: https://ozcoasts.org.au/management/emf_frame/review/

themes. That inclusiveness means that all sectors and levels of government have a role to play and obligations to fulfil in implementing the SD pathway. They all need to progressively modify their development plans, their budgets and allocation of staff and other resources to ensure their responsibilities to sustainability in Rayong are met.

PART I: SUSTAINABLE DEVELOPMENT MEASURES FOR THE DEVELOPMENT SECTORS

The development sectors in Rayong Province are those which contribute to economic expansion and livelihoods. Some primary sectors concerned with extraction of natural materials such as agriculture and fisheries have faded in importance while off shore gas production and provision of water are thriving sectors as the basis for industry and sector maintenance and growth. Secondary industry which consumes water, energy and land and processes raw materials and semi-finished goods is the foundation of the provincial economy. Primary and secondary sectors all impact on natural resources and environmental conditions. They also impact on social welfare. A linked development sector is urban expansion which has its own real estate dynamic and impacts.

The tertiary sector which provides services is expanding, especially tourism, information technologies and finance. Sometimes supply of water and gas is regarded as service industries. Some service sectors such as tourism have substantial natural resource demands and linked impacts on scarcity and environmental quality.

This part of the SD pathways volume sets out measures to improve the sustainability performance of the development sectors. Some measures relate to the conservation and efficiency in use of natural resources, others to enhancing environmental quality, still others are concerned with achieving social equity. Many measures have multiple benefits across all those fields.

The tables of measures indicate the appropriate starting time and duration of implementation. Some adaptation measures need to be put place before others can be implemented. For example, capacities in design of nature based solutions must be enhanced and awareness improved in the use of alternative technologies before they can be rolled out. Other than that, there has been no attempt to identify sharp priorities. That priority setting process needs to be left to the next stage of the SEA which is concerned with arrangements and responsibilities for implementation.

2 INDUSTRY

2.1 Introduction

Industry has driven extensive changes in Rayong over the last three decades, and will continue to be the main influence on sustainability and Rayong's development pathway in coming decades. For this reason, the recommendations in this chapter of the SEA are of paramount importance in ensuring that provincial development follows a trajectory that embraces Thailand's sustainable development goals and ensures that Rayong continues to be a place where people want to live and work.

The purpose of this chapter is to provide measures for the next iteration of the RPDP to enhance sustainability in Rayong's industrial sector. The chapter begins by summarising the industry components of the SEA baseline and impact assessment volumes. The summary outlines (i) the historical and future trends for the three strategic issues of critical concern to industry's sustainable development in Rayong, (ii) the sustainability gaps in the RPDP that relate to industry, and (iii) industry's sustainable development goals that were identified during the scoping and baseline phases of the SEA.

Following the summary, the SD pathway of measures for industry are presented, divided into actions over which Rayong authorities have influence, and broader recommendations for measures which require higher level government decisions and commitments for effective implementation.

SEA stakeholders identified three strategic issues of critical concern for Rayong's sustainable industrial development:

(i) Rapid industrial growth;
(ii) Increased generation of industrial pollution; and,
(iii) Resource use in industry.

The key features of these three issues and reasons why they have been given priority are summarised below.

2.1.1 Rapid industrial growth

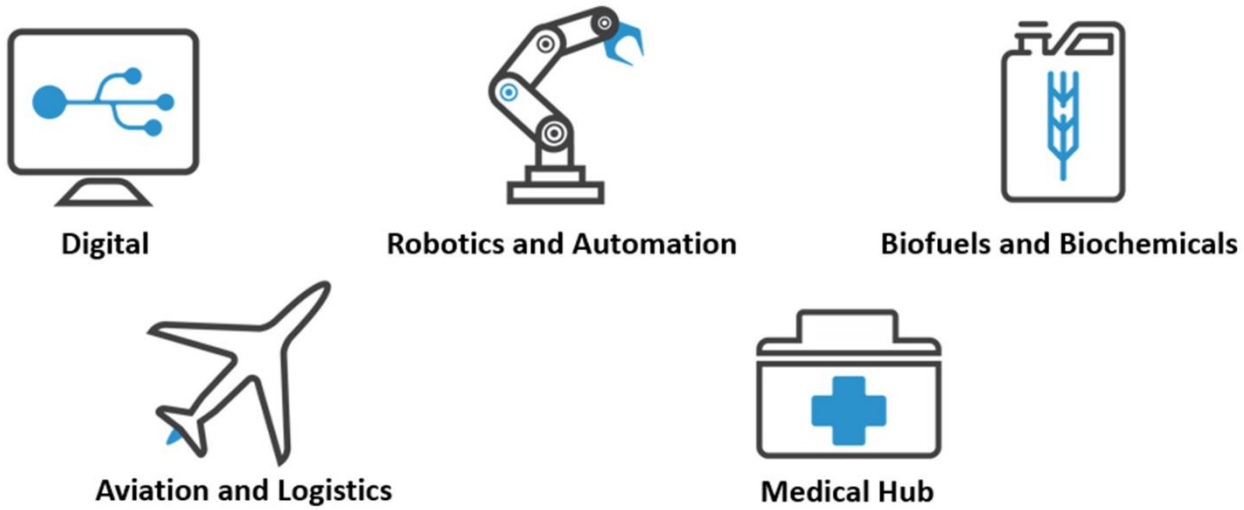
Economic growth in Rayong has largely been driven by the industrial sector, and in particular, following the Eastern Seaboard Development Programme (ESDP),[3] the expansion of heavy industry including petrochemicals, basic materials and car manufacture. Those sub-sectors account for most of the investment and output in the province, as well as for a large share of employment. The bulk of industrial production takes place within the 12 industrial estates in the province, which collectively cover around 8,300 Ha. In addition there are over 2,000 industrial enterprises located outside industrial estates. Since 2017 there has been a marked decrease in the rate of industrial growth.

Under the SEA sustainability analysis, a Business as Usual (BAU) trajectory for industry, without additional government intervention, would likely see limited diversification and growth in the sector slow further in the face of stiff international competition. However, the Eastern Economic Corridor (EEC) plan is set to promote greater diversification into high-tech, high value-added sectors and spur industrial growth (Figure 2-1). Already the EEC is attracting investment, for example, as a component of the Chinese "Belt and Road Initiative"[4] and through collaboration with funding agencies such as the

[3] See e.g. Mieno, F. (2013) The Eastern Seaboard Development Plan and Industrial Cluster in Thailand: A Quantitative Overview, available at: https://doi.org/10.1057/9781137023483_3
[4] https://www.eeco.or.th/en/pr/news/eec-welcomes-chinese-investors-visiting-thailand

Asian Development Bank, which is committed to finance a 2,500 MW combined cycle gas turbine power plant in the Rojana Rayong 2 Industrial Park.[5]

Figure 2-1: New S-curve industries being promoted under Thailand 4.0 and EEC development planning



Source: Asia IOT Business Platform, 2020[6]

Rapid industrial expansion has driven economic growth and structural change in the province. It has been the main driver of urbanisation and demographic change and the knock-on implications for environmental conditions, social quality of life and for growth in other development sectors such as fisheries, tourism and agriculture. Industrial development has brought with it rapid increases in pollution levels and an increased toxicity of the overall pollution loading to the environment. It has significantly degraded environmental quality, amenity and public health, and has increased pressure on Rayong's natural resource base.

2.1.2 Increased generation of industrial pollution

Much of Rayong's industry emits significant pollution to air, water and land. *Air pollution*, particularly around the large industrial estates such as Map Ta Phut, have been a critical problem for more than a decade. Map Ta Phut has been designated a pollution control zone, but excess emissions to air are still detected regularly, with ambient VOC levels generally well above national standards.[7] *Solid and hazardous waste* is produced in significant quantities by the industrial sector. While most is disposed of at designated sites, low treatment capacity in the province remains a problem, particularly for hazardous waste. Low treatment capacity is likely linked to the levels of illegal dumping of industrial waste in Rayong, with this presenting a critical environmental problem for the province because of pollution to surface water, leaching of toxins and pathogens (including carcinogenic VOCs) into ground

[5] https://www.adb.org/news/adb-gulf-pd-sign-deal-build-2500-mw-power-plant-thailand
[6] https://iotbusiness-platform.com/blog/thailand-4-0-opportunities-in-the-s-curve-10-targeted-industries/
[7] The Industrial Estate of Thailand Operation Center integrates information about all industrial estates via seven hubs located across the country. Map Ta Phut and Eastern Seaboard (Rayong) Industrial Estates in Rayong province are the hubs for the eastern region. The IEAT uses a volatile organic compounds (VOCs) monitoring and environmental information management system (VM-EIMS) for Map Ta Phut Industrial Estate set up by the Japanese company – Fujitsu. The monitoring covers 19 kinds of VOCs, 10 odour-causing compounds and ozone. The system includes risk assessment and communications capacities as well as advanced simulations for use in assessing the diffusion of air pollutants. https://www.fujitsu.com/downloads/MAG/vol50-3/paper03.pdf accessed December 2020

water, and contaminating soils. Industrial effluent in Rayong commonly contains pollutants such as organic matter, nitrates, phosphates, and hydrocarbons, as well as more toxic substances including POPs and heavy metals.

Overall pollution load figures for Rayong are not available, but without effective controls or significant outside influence, industrial pollution emissions will continue to grow in line with industrial growth in the province. The industry chapter in SEA's baseline assessment volume provides projections for industrial growth and industrial pollution. The EEC development program will be a strong influence on the level of growth within Rayong, if not necessarily on how well it is managed, which will be determined by relevant line agencies. With the structural changes to industry targeted under this program, the composition and quantity of pollution emissions will change too. In particular, there is likely to be less rapid growth in pollution emissions than was the case under the heavy industry focus of the earlier ESB programme.

Inter-sectoral links: Industrial pollution emissions have significant impacts on environmental quality and human health. Water quality and aquatic and marine ecosystems are particularly affected. Similarly, human health impacts from air pollution have been identified in populations living in proximity to large petrochemicals facilities. In the face of rapidly growing industrial pollution, legislation to control emissions and effluent are inadequate, institutional arrangements are diffuse and unclear and monitoring and enforcement capacity is deficient.

2.1.3 Resource use in industry

The heavy industrial development that has taken place in Rayong has also led to significant demands being placed upon natural resources in the province, particularly on water, land and energy. Industrial land use has risen from less than 1,000 ha in 1989 to around 14,000 Ha in 2019. Already, in 2019, the industrial sector accounts for 50% of water demand, and industrial energy use has grown rapidly. For example, industrial energy demand accounts for more than three quarters of electricity demand growth in Rayong since 2008.

Industrial resource use is growing at a less rapid pace than growth in industrial investments. The SEA sustainability analysis industry chapter, shows that water and energy use is growing at approximately 65% of the rate at which industrial investment is growing. While the EEC programme will spur industrial growth, but aims to increase investment in less resource intensive sectors. EEC developments will increase the rate of industrial growth with commensurate increase in land use, but it is likely to be accompanied by a relative decoupling from trends in energy and water use.

Inter-sectoral links: Intensive resource use by the industrial sector and the high consequent level of industrial demand places pressure upon available resources, particularly water and land which have limited availability in the province. This causes conflict with other resource users and in particular agriculture.

2.2 Gaps in the existing Rayong Provincial Development Plan

The RPDP contains a number of important aspirational statements related to industrial development, including that:

(i) The economy should be balanced between industry, agriculture, tourism and the commercial sector,
(ii) Rayong should pursue knowledge intensive and innovative industrial sub-sectors, and
(iii) Emphasis should be placed on ensuring social and environmental goals are met.

While these statements are broadly in line with national policy, the province does not have the legal authority, capacity or resources to achieve them. To illustrate, industrial pollution control is largely outside the remit of provincial authorities with, for example, PCD and DIW (the agencies tasked with acting on instances of emission or effluent standards being breached) being national level line agencies operating in Rayong but not under the authority of the provincial administration. Further,

despite the RPDP's goals, the plan itself actually contains limited investment to address the critical strategic issues identified for industry within the province.

Investments in the RPDP that target the industrial sector account for THB 737 million or around 4% of total RPDP investment. Of this budget allocation around 38% (THB 280 million) is focused on pollution monitoring and management, and particularly on monitoring and control of air pollution in and around Map Ta Phut industrial area. A further 32% (THB 236 million) is proposed for promotion of cleaner production, and 21% (THB 155 million) is planned for expenditure on human resources development in industry, particularly in support the EEC development program. Despite waste management being recognised as a serious issues for human health, for environmental management, for sustainability, and for the viability of Rayong's future, just 6% of the industry focused part of the RPDP budget (THB 44 million) targets solid and hazardous waste management. The final 3% of the industry portion of the RPDP budget (THB 22 million) is allocated to a variety of sustainability related projects.

Analysis of the RPDP investments highlights a number of important gaps in the RPDP in regards to industrial pollution control and resource use:

- **Resource use (general):** There are no projects targeting more efficient resource use. While resource use decisions are usually made at central level, there is a strong case for the better consideration of resource use in the RPDP for water and land use in particular. There are projects that seek to improve resource supply, but there is very little consideration in Rayong of demand side industrial resource use management;
- **Land use:** Similar to issues explored in the urban development chapter of this volume, lack of coherent and enforceable planning controls have led to ad hoc ribbon development that is challenging and difficult to service, that results in co-location of pollution generating factories and estates and residential areas as well as inefficient use of land. Specifically, the RPDP is reactive instead of pro-active in terms of dealing with the way land is used and developed;
- **Pollution control:** Outside Map Ta Phut's pollution control zone, the RPDP contains only limited measures to address pollution monitoring, limited measures to enforce pollution controls and limited measures to address the lack of capacity and resources in provincial and regional environmental departments.
- **Resource efficiency funding**: The RPDP has inadequate budgetary provision for resource efficiency in industry within the province.

2.3 SD objectives and indicators

The government of Thailand recognizes the importance of industry in the country's future development. For example, the main focus of Thailand 4.0[8] is the development of a value-based economy, to be achieved through renovation and structural change in the industrial sector, and shifting the policy focus from promotion of heavy industry to the promotion of high-tech, high value-added production.

A key component of Thailand 4.0 planning is promotion of green manufacturing industries that generate low carbon and other emissions. These goals are mirrored in Thailand's 12th NESDP (2017-2021),[9] which includes strategies focused on (i) strengthening the competitiveness of the Thai economy, (ii) green growth, stability and sustainability, and (iii) regional, city, and special economic zone development. These ideals are also reflected in EEC program objectives.

[8] A summary of the Thailand 4.0 strategy is available from https://thaiembdc.org/thailand-4-0-2/
[9] Thailand's 12th NESDP is available at:
http://www.nesdb.go.th/nesdb_en/ewt_w3c/ewt_dl_link.php?nid=4345

These national and regional strategies rely on development and application of less environmentally damaging industrial processes. Their importance to Thailand's future economic growth is highlighted by the need for attractive and liveable places that are part of the packages offered to mobile, and highly skilled managers and workers. With these considerations in mind, Table 2-1 sets out the sustainable development objectives defined with SEA stakeholders and initial indicators for monitoring progress in their implementation.

Table 2-1: Strategic issues, sustainability objectives and potential indicators for the industrial sector

Strategic issues of concern	Sustainability objective	Indicators
1. Rapid industrial growth	Structural transformation increasing the capacity of local industry for value-addition, diversification, job creation and production in high-tech sectors	▪ Energy intensity of industrial value-added ▪ Water intensity of industrial value-added
2. Increased generation of industrial pollution	Use of best international practice in environmental technologies and management to prevent the discharge of industrial pollutants to water, air and land	▪ Proportion of waste-water from industry receiving suitable treatment ▪ Hazardous waste streams from industry receiving suitable treatment
3. Resource use in industry	Environmentally sustainable development through the promotion of green industries using cleaner production technologies and resource efficient production	▪ Incremental capital-output ratio (ICOR) for industry ▪ Value-added per industrial worker

2.4 Sustainable development measures for the industry sector

The measures included in this section are designed to improve the sustainability of industry related aspects of the RPDP. These measures were developed so they would align with the broader macro-economic goals detailed in the RPDP, and also align with regional and national planning and other strategic policy instruments. Priority measures for inclusion during the RPDP review process, as well as in future iterations of the RPDP are included in Table 2-2. Because the RPDP has most influence in the operating environment, rather than on industrial growth itself, the focus of the recommendations included here are on monitoring systems and processes relating to industrial pollution, as well as on ways to address industrial resource use issues.

Recognising that sustainability in Rayong also depends on regional and national policies, strategies and programs, details of recommendations that are outside the remit of Rayong authorities are included separately, in Table 2-3.

Table 2-2: Actions for inclusion in next RPDP (2021-2025)

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
Increased generation of Industrial pollution	**2.1 Develop a GIS-based inventory of industrial and other significant polluting establishments in the province, pollution load modelling, ground truthing and pollution hot-spot identification** Systematic assessment of all industrial and other significant polluting establishments, including slaughterhouses, intensive farming activities, large commercial premises and large hotels. This pollution sources assessment should include: (i) Developing criteria for inclusion/exclusion of the pollution assessment. This should be based on readily available data, such as the amount of power an establishment uses; (ii) Conducting a census of all enterprises of concern, including critical operation data including sector, sub-sector, number of employees, initial capital investment, output, location (by GPS positioning), as well as pollution control equipment being used and an assessment on its effectiveness; (iii) Mapping the location of polluting activities in the province using GIS systems; (iv) Development of a model of enterprise pollution emissions and the environmental pollution loading; (v) Calibration of the model through on site measurements; (vi) Identification of pollution hotspots and heavy polluting enterprises; (vii) Establish a wide network of water quality monitoring stations to be the basis of ambient standards pollution control in the medium term future. The aim of the GIS-based inventory should be to provide a regularly updated database (e.g. monthly or quarterly updates depending on capacities) that will be used to identify areas and enterprises of concern, and which can be used to focus monitoring, management and enforcement activities.	Industrial Estate Authority of Thailand (IEAT), Pollution control Department, Department of Industrial works, Rayong.	Next 5 years
	2.2 Conduct a feasibility assessment into establishing a provincial pollution control fund Linked to the need for PCD and DIW to have sufficient funding and budgetary capacity to effectively monitor and enforce pollution control legislation, there should be research into the feasibility of establishing a provincial pollution control fund. Research areas should include: (i) Assessing the effectiveness of existing funds and sources of funding for pollution control in Rayong (ii) Identifying mechanisms for raising the funds required; (iii) Defining strategies for sustainability in funding for both private and public sector enterprises/institutions (iv) Identifying suitable incentives for enterprises to reduce their pollution levels (noting that incentives for public sector enterprises may differ in general from incentives for private sector enterprises);	Pollution control Department, Department of Industrial works, Ministry of Finance, Office of the Comptroller General's Department, Rayong.	Next 5 years

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
	(v) Identifying loan as well as grant mechanisms (e.g. concessional loans for adopting pollution control technologies, for relocation expenses and for factories that wish to transition to new S-curve industries, and grants for conducting pollution audits)		
	2.3 Provide incentives for pollution emissions reductions to air and water With a clearer GIS-based picture of industrial pollution sources and having developed a pathway to establish a pollution control fund, Rayong should act on this information to reduce industrial pollution, with a focus on industrial pollution hot-spots. In order to reduce industrial pollution, a variety of negative and positive incentives for out of standard pollution emissions should be considered: (i) While it will be difficult for the province to significantly influence the size of financial penalties that are applied, Rayong authorities can support the Regional Environment Office and Provincial Environment Office to more strictly apply penalties; (ii) Rayong and relevant line agencies should establish a website to share industrial pollution monitoring data, highlighting the best and worst performers, as well as including descriptions of how out of standard polluters are impacting environmental and public health; (iii) Rayong should build on the publicly accessible database, and actively promote pollution reductions through (i) competitions highlighting the cleanest factories and (ii) factories that have improved their performance the most in the preceding 12 months; (iv) Rayong authorities and relevant line agencies to collaborate in providing tax incentives to factories for reductions they make in pollution loading to the environment; (v) Rayong authorities in collaboration with national bodies should provide transition support in terms of advice, financial support (e.g. no or low interest loans) for existing polluting factories to upgrade machinery and pollution filtering technology, as well as to transition to new S-curve industries in line with Thailand 4.0 and EEC development strategies; **(vi)** The Rayong government should support research into areas where waste products (particularly industrial waste streams) can be used as feedstocks for other industries. This research should be used to encourage co-location of symbiotic industrial processes (See more detail on this in the section on reducing industrial resource usage).	Industrial Estate Authority of Thailand (IEAT), Pollution control Department, Department of Industrial works, Rayong.	Next 5 years
	2.4 Establish a hazardous waste incineration unit in Rayong In order to address risks associated with transporting hazardous waste long distances to Ratchaburi Province, to reduce the quantity of illegally dumped hazardous waste (by making it easy and cheaper to dispose of), and to address the current overburdening of Rayong waste receiving services in terms of hazardous waste, Rayong	PCD, Regional and Provincial Environment	Next 2 – 3 years

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
	should establish a hazardous waste incineration unit in the province (as per Block et al., 2015, emissions to air from state-of-the-art incinerators are not damaging to the health of workers or nearby residents[10]). Actions to achieve this will include: (i) Locating a suitable and acceptable site for the incineration unit; (ii) Research into state of the art hazardous waste incinerators to determine a suitable sized unit, cost, maintenance plans and operating protcols; (iii) Deciding whether the province would run the incinerator directly, or sub-contract to a private contractor. (iv) Monitoring for illegal dumping of hazardous waste (see environmental quality chapter in this volume for more details)[11]	Offices, Rayong Governor's Office	
Resource use in industry	**2.5 Decouple industrial output from water usage** Water usage in Rayong is problematic, with industrial usage accounting for half of all water used. In order satisfy projected demand through the 2020s, Rayong is planning inter-basin transfers from neighbouring provinces, and in the 2030s satisfying projected demand will require transfers from Cambodia. The continuing need to pipe water from further and further away highlights the unsustainability of this way of addressing future water shortages. Therefore Rayong authorities with national government support should focus heavily on demand side management of water usage, through: (i) Promoting and incentivising water recycling in industry. Incentives should include a. tax incentives, b. advice on technology requirements and availability, as well as c. no or low interest loans to support changes in factories.	ONWR East Water, Rayong Governor's Office, RID	Next 5 – 10 years

[10] See https://www.researchgate.net/publication/273705155_Incineration_of_Hazardous_Waste_A_Sustainable_Process

[11] The establishment of industrial hazardous waste incinerator is classified as no.7 under Annex 1 of the Notification of the Ministry of Natural Resources and Environment on proposals Which May Seriously Impact Natural Resources, Environmental Quality, Health, Sanitation, Life Quality of People in a Community that are Required to Provide an Environmental Impact Assessment Report and Rules, Procedure, and Conditions in Providing an Environmental Impact Assessment Report: Link to English version: http://www.onep.go.th/eia/wp-content/uploads/2019/04/lawengEHIA.pdf

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
	(ii) Water for industry should be priced to reflect the status of water as a critical resource in short supply. Revenue generated from increasing the price of water for industry should be used to fund incentives for water recycling within Rayong Province. It should not be absorbed into the much wider RID water fund.		
	2.6 Decouple industrial output from energy usage Industry in Rayong is a major consumer of energy, with factories using grid provided power as well as power from the many small power producers in the province. Producing electricity is associated with emissions to air (particulate matter, SO_x & NO_x). Demand side management of industrial energy usage is an important way of supporting industry while at the same time reducing environmentally damaging consequences. Measures to decouple energy use from industrial output should include: (i) Using tax incentives to encourage factories to conduct energy audits; (ii) Financial incentives (e.g. tax and concessional loan based) for factories to upgrade their machinery; (iii) Financial support (concessional loans and grants) to support factories that which to transition to new S-curve industries that are not as energy intensive).	Rayong Excise Office, Rayong Governor's Office , EEC Office NESDC	Next 5 – 10 years
	2.7 Assess the opportunities for use of waste products as feedstocks for industrial processes While there have been some efforts to improve reuse and recycling of waste products in Rayong, to date these have not been of sufficient scale to have an appreciable impact on sustainability in the province. Given the scale and varied nature of industry in Rayong, there is an opportunity for the provincial government to develop a coordinated and nationally funded research programme to systematically investigate waste reuse and recycling potential in manufacturing, particularly given the likelihood of significant industrial growth under EEC development plans. Any research program developed should examine possibilities for promotion and scaling of re-use and recycling. The study would involve: (i) Conducting a census of industrial establishments that would consider process inputs, processes used, as well as waste streams produced; (ii) Reviewing international best practice in reuse and recycling waste through industrial processes; (iii) Identifying potential synergies between process waste streams and other production process in the province (i.e. for one factories waste to be used as an input for another factory); (iv) Identifying barriers to the use of these waste streams; and	DIW, IEAT	Next 5 years

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
	(v) Recommending initiatives to address barriers identified (e.g. promotion of new technologies, improving coordination between plants, introduction of reuse/recycling obligations etc.)		

In addition to the direct industry-related initiatives included here, some of the recommendations for other sectors that are included in this SEA volume address industry caused environmental issues. For example, comprehensive land use planning for the urban sector would help address pollution issues associated with mixed industrial residential areas - such as those that persist in the pollution control zone around Map Ta Phut.

Table 2-3 provides details of "out of province" actions that are needed as part of addressing the address the strategic issues for industrial sustainability in Rayong. As for Table 2-2, rapid industrial growth is not considered here as it is comprehensively covered by government policy and planning documents.

Table 2-3: Sustainable development measures for industry that will require initiative from national government and line agencies

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
Increased generation of Industrial pollution	**2.8 Review national legislation and institutional arrangements for industrial pollution control** Current arrangements for pollution control are failing Rayong. Responsibilities are fragmented and unclear, capacity is inadequate and sanctions and enforcement for polluters are insufficient. To address this a comprehensive review of legislation as well as institutional arrangements for pollution monitoring, reporting and control is needed. This would include: i) Reviewing international experience in industrial pollution control ii) Establishing appropriate best-practice guidelines for reform: a. In the short term, implement point source monitoring and enforcement of pollution standards; b. Develop a plan for inclusion of ambient standards once there is a clearer provincial understanding of pollution hotspots; iii) Systematically reviewing current legislative and institutional context to establish strengths and weaknesses of the system; iv) Reviewing institutional arrangements for pollution control:	DIW, IEAT, OOG, National Board of Investment, PCD, REO, PEO.	Next 5 years

	a. Ensuring clear mandates for monitoring, reporting and enforcement of pollution control standards; b. Revise the existing penalty system relating to pollution, to reflect the current economic situation and future growth trajectories, so that penalties applied help to incentivise pollution minimisation and control; c. Ensure there are clear communication lines and protocols to improve communication and information sharing between different agencies involved in pollution monitoring and control (e.g. Regional Environment Office, Provincial Environment Office, IEAT, PCD, DIW; Developing an implementation plan to reform pollution control administration.		
	2.9: Develop a national industrial pollution control fund While pollution monitoring and tougher sanctions is one side of controlling pollution, by itself it is insufficient. There is also a need for concessional loans for industry to enable them to implement measures to cut pollution. Provincial level funds may be used for this purpose for SMEs and other small enterprises (see measure 3.2). However, for large, strategic scale industry such as petrochemicals, a national level fund will be necessary. Implementation of a national level industrial pollution control fund should be done in conjunction with the review and reform of the pollution related institutions and legislation described as measure 3.8.	DIW, IEAT, OOG, Board of Investment, Ministry of Finance, PCD.	Next 5 to 10 years
	2.10: Develop an industrial pollution control plan Along-side legislative and institutional reform, and funding support for pollution controls in industry there is need to develop a sequenced master plan for national industrial pollution control. The DPC prepared various plans such as the Municipal Solid Waste Management Master Plan (2016-2021) and National Waste Management and Pollution Control Strategy and Implementation Plan 2016 – 2020, but as yet no plan specifically targeting industry has been prepared. This master plan for industrial pollution control should set the priority goals and priorities in terms of, for example:	EEC Office, Ministry of Environment	Next 3 years

	i) ii) iii)	First, second and third tier industries to be targeted and supported; Timelines for phasing of the pollution control plan; Defining how land use planning will be integrated with pollution control mechanisms.		

2.5 Effect of measures on trends in strategic issues of other themes/sectors

In general terms, the effect of implementing the proposed SD measures for the RPDP and for national and regional plans would positively influence the other thematic areas. For example, pollution reductions, resource use reductions, and more rational and planned use of land resources would significantly improve environmental outcomes in the province.

Improved environmental outcomes would:

(i) Enhance urban liveability;
(ii) Improve public health in communities, in particular those that are close to industrial facilities;
(iii) Help reduce water needs in industry
(iv) Help address water quality issues, including issues of environmental degradation in marine and aquatic environments.

There would be costs involved in implementation as well. For example, while resource efficiency investments would pay for themselves over time, capital investments in pollution control equipment as well as the operational and maintenance related expenses represent a direct cost to industry that would affect its bottom line. This could result in some industries being less able to invest in additional productive capacity, thereby affecting provincial economic growth. While for some industries, their viability in Rayong may be compromised by these pollution control costs, this strategy is in line with the Thailand 4.0 strategy. For Thailand to move into higher value-added production, and escape the middle income trap, it must provide an environment that supports low polluting, high-technology industries. The transition will inevitably mean that some industries will no longer be competitive, however, these will primarily be highly polluting, low value-added heavy industries. While these have been the backbone of Thailand's economic development for the last three decades, they have much less of a place in Thailand's and in Rayong's, future.

2.6 Conclusion

Industrial growth has largely driven the economic development of Rayong province. However, it has come at a cost in terms of high levels of industrial pollution and increasing strain on the availability of natural resources. The RPDP falls well short of what is needed to address the acute pollution and resource use issues that have been identified in the SEA process. This is to some extent a result of broader, national level failings in the administration of pollution control. Nevertheless, given the broader national aspirations of the Thailand 4.0 strategy and the critical role the EEC, and the role that Rayong province will play in the EEC, there is a window of opportunity for adopting a more aggressive approach to pollution control.

Strict industrial pollution control measures should be seen as part of the wider EEC and Thailand 4.0 strategy, and as such should be given high priority. If pollution control and cleaner production are seen as an essential element in Rayong's development strategy, this will encourage development and adoption of technology and approaches that will make Rayong, and Thailand, a best practice leader in the region. This will enable Thailand to become a key provider of pollution control capital goods and services in the future. This will entail some structural change in industry, and is likely to be damaging to the enterprises such as petrochemicals, that have enjoyed a strong competitive advantage in Rayong in the past. For this reason, it may be politically challenging to implement the necessary changes.

Wider ambitions aside, the main priority actions that should be undertaken in the next RPDP to start addressing industrial pollution issues are (i) the development of a GIS-based inventory of industrial pollution loads in the province; (ii) capacity development for the PCD and DIW; and, (iii) an institutional review of pollution control activities in the province.

3 WATER RESOURCES

3.1 Introduction

The purpose of this chapter is to outline measures to enhance the sustainability of water resources management in Rayong Province. The availability of adequate water will define what can be achieved in Rayong province in all development sectors. It is the critical constraint on economic development. It is also the essential resource for sustaining a diversity of livelihoods, heritage and well-being of Rayong's residents and communities. Inevitably, in the decades to come it will be the focus of increasing tension between competing uses and a potential source of social unrest. A key strategic issue for the province will be the extent to which extreme efforts are made to maintain an open ended expansion of supply as opposed to a much greater emphasis on demand side management. Industry is the main consumer by far, but this strategic issue needs to be confronted in all sectors. Another strategic issue is the rapidly reducing quality of water with relatively limited progress in addressing the main sources of contamination. That issue will affect the cost of water in all sectors – and its availability for economic, domestic and environmental purposes.

The sustainability development measures set out here are for inclusion in the RPDP and other relevant strategies and plans. The measures take into account linkages and influences across sectors, as well as hierarchical effects. For example, water is a critically important resource for industry and agriculture, and the measures included here seek ways to balance the demands from those sectors considering linked social and cultural values, while greatly improving supply for environmental flows and water quality for domestic usage.

Stakeholders in the SEA process identified two strategic issues of concern for water resources in Rayong. These concerns are (i) water supply and demand, and (ii) water quality. The past trends and drivers of change influencing those two critical issues were examined in the SEA baseline assessment. In the SEA impact assessment phase, the effect on these issues of a business as usual scenario and fully implementing the RPDP was assessed. The measures included in this chapter are defined in response to the examination of historical trends and drivers, and the forward projections of the BAU and full RPDP implementation scenarios and their impacts.

A brief summary of the findings for each of the critical sustainability issues is provided here.

3.1.1 Water supply and demand

Thirty years ago the agricultural sector was the main water user, however, in the past five years industrial water usage has outstripped agricultural usage in Rayong. Water demand in the future is likely to increase from all sectors, particularly if the EEC development plans are fully implemented. For example, under EEC planning, East Water will transfer additional quantities of water to clients in Chonburi Province, as well as satisfying industry demands in Rayong. The gap between available water supply and meeting demand will continue to narrow. By 2026 meeting demand will require inter-basin transfers from Chantaburi Province, and possibly transfers from neighboring Cambodia also being considered. Those estimates do not take climate change and drier conditions into account or the urgent need to increased environmental flows and for protecting rivers and natural drainage corridors throughout the Eastern Seaboard. Rivers, their watershed, sediments, nutrients and natural patterns of flow provide essential ecosystem services from their source to coastal areas which have been progressively lost in Rayong. Strong evidence-based environmental flow regimes are needed to restore and maintain those services and trade-offs in meeting immediate development demands for water will be required. During this SEA, it has been disturbing to hear from some senior water managers that water reaching the sea unused for development is wasted.

Inter-sectoral links: Expansion of industry and changes in agricultural practices have two way linkages with water supply and demand. Industrial growth requires additional water supply, and there is pressure from the agricultural sector to expand Rayong's irrigated area and reorient to water intensive

crops. The agricultural sector is also seeking to sell to international quality markets, and is demanding contaminant free water supply. In addition, population growth and increasing tourism in Rayong are both contribute to an escalating demand for water.

3.1.2 Water quality

Industry, agriculture and domestic effluent are all polluting Rayong's waterways with raw wastes and increasing toxicity of effluents. Population growth and mounting untreated municipal wastewater is a major concern not being systematically or convincingly addressed by national, regional or provincial authorities – one of the most puzzling findings of the SEA given the great wealth being generated in the province. Rayong's three waste water treatment plants have a combined capacity of 48,000 cubic meters/day, but operating at 6.8% of capacity (PCD, 2017). The Regional Environment Office reports the condition of Rayong's main river – the Khlong Yai – as critical. Agricultural runoff remains unchecked by management innovations and lost natural filters so that soil, pesticides and fertilizers are entering surface and ground water affecting all users. Most serious for public health is the rapidly increasing pollution loadings from industry and their inconsistent management and enforcement of regulations.

Polluted rivers and canals, and ground water is flowing into the sea is impacting the coastal environment, as well as fishing and aquaculture livelihoods. New factories and intensive commercial development areas have been established in the upper watersheds of reservoirs reflecting ineffective zoning and enforcement – and a serious mismanagement of land use by authorities. The waste from these factories has potential to pollute reservoirs, which Rayong and neighbouring provinces rely on for water supply.

Inter-sectoral links: Declining water quality affects all sectors and public health as more people are exposed to unclean water with resulting increases in the costs of treatment and management. Tourists are less attracted to polluted areas. Fish from Rayong's coastal waters have been shown to be contaminated by heavy metals, pathogens, plastics and complex chemicals at levels above national standards.

3.2 Gaps in the existing Rayong Provincial Development Plan

In the RPDP, the water sector is not recognized as a key focus of the plan or a core development issue for the province. There are, no specific development objectives for the sector. Important water-related targets and indicators under other headings are included in the plan, for example: *"Amount of waste water produced/day is reduced 12% against present baseline"* (page 150), an indicator listed under Provincial Development Goals, and *"86% of irrigated areas manage water efficiently"* (page 157), an indicator listed under Agriculture.

Nevertheless, of the 176 projects identified in the Rayong Development Plan, 76 or 40% are water-related, most concerned with the provision of hard water engineering infrastructure with a combined cost of 2.733 billion THB or 15% of the RPDP budget. The main water projects are for water supply, diversion, and transmission, reflecting Rayong's commitment to satisfy growing demand. Another group of water projects relate to dredging. There are 29 dredging projects spread across four development objectives concerned with *"water course restoration and rehabilitation"*. The dredging projects will severely harm freshwater ecosystems and aquatic species.

Overall, the plan treats water as a commodity available freely or cheaply, managed directly by the Royal Irrigation Department and the East Water Resources Development and Management Public Company Limited or East Water. That approach to water management means that the RPDP has numerous critical sustainability related gaps in the sector. The plan lacks:

- Measures to promote demand management of water resources
- Measures to effectively offset the impacts that planned industrial development and urban expansion will have on water supply and quality;

- Ecosystems based approaches to water management including reference to environmental flows and nature-based solutions;
- Recognition of the importance of watershed management and effective zoning, safeguards and enforcement
- Avoidance and control of pollution from agricultural sources
- Resilience building responses to climate change especially as a key consideration in siting, design and operation of the predominantly hard infrastructure investments;
- Watershed management interventions.

The plan needs to support the introduction of water-efficiency methods and technologies for all sectors. In agriculture, drip irrigation and sub-surface irrigation where appropriate should be promoted, as well as other farming practices that conserve water, along with on-farm water storage. Farmers with properties adjacent to water courses should be supported in restoring and protecting riparian vegetation to help stabilize river banks, prevent excessive sedimentation, and reduce chemical run-off. In industry, water efficiency can reduce water consumption by 20-50% (Table 4).[12] Targets need to be set with regulations to make them mandatory for various industry subsectors and for agriculture, domestic and tourism sectors. Feasibility and cost-effectiveness studies of water recycling for industry, and desalination are needed. Additional support should be provided to foster appropriate use of ground water.

Table 3-1: Water saving potential in industry

Efficiency measures	Potential savings (%)
Closed loop reuse	~ 90%
Closed loop recycling with treatment	~ 60%
Automatic shut-off valves	~ 15%
Counter-current rinsing	~ 40%
High-pressure, low-volume upgrades	~ 20%
Reuse of wash water	~ 50%

Source: Afedonline 2019

None of those important fields for sustainability in water resource use and management are dealt with at all or adequately in the RPDP.

3.3 Sustainable Development Objectives and Indicators

Thailand's national government is committed to intergrated river-basin management for protecting ecosystems and watersheds and to address drought, flood and other water related issues.[13] Similarly, the 12th National Social and Economic Development Plan (12th NESDP) targets increases in water resource management efficiency and green growth that will help reduce water pollution.[14]

[12] http://www.afedonline.org/water%20efficiency%20manual/PDF/4Chapter%203_Industry.pdf
[13] Reliefweb, 2018. PM emphasizes Government's progresses and plans for national water management https://reliefweb.int/report/thailand/pm-emphasizes-govt-s-progresses-and-plans-national-water-management
[14] NESDB, 2017, The Twelfth National Economic and Social Development Plan (2017-2021), Office of Prime Minister, Thailand, https://www.nesdb.go.th/nesdb_en/ewt_dl_link.php?nid=4345

During the scoping phase of the SEA, stakeholders identified water availability and quality issues as high priority strategic concerns for development in the province. They helped define water resource sustainable development objectives and their linked indicators. The sustainable development objectives provide the long term management vision for Rayong's water resources, and the indicators are to be used to track progress in their implementation as part of the RPDP's monitoring framework. The issues of strategic concern, the sustainable development objectives and the indicators for tracking progress towards sustainable water resource management identified for the SEA are set out in Table 3-2. There are many potential indicators which could be added to this initial monitoring framework for the SD objectives. The key will be in ensuring the demands of using an indicator do not go beyond the capacity of the provincial government to deliver. At this stage the indicators proposed are kept to a relatively simple set which can be added to over time.

Table 3-2: Strategic issues, sustainability objectives and indicators for water resources management

Strategic issue	Sustainability objective	Indicators
4. Water supply and demand	▪ 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.	▪ Funding for public water resource and river basin management authorities/groups ▪ Number of water shortage complaints ▪ Total water consumption divided by provincial GPP
5. Water quality (surface and ground water)	▪ Rehabilitate and manage river basins and water resources for ecological sustainability and environmental quality.	▪ Biological Oxygen Demand

3.4 Governance: policy and institutional framework to drive sustainability

3.4.1 The Water Act 2018

The Water Act (2018) established the National Water Resources Committee (NWRC), which was responsible for developing the overall National Water Resources Master Plan 2018-2037, approved in June 2019, with six main strategies: management of water usage; water production security; flood control; water quality conservation; afforestation in watershed areas; and prevention of soil damage. River Basin Committees (RBCs) are to be established for each legally approved mapped river basin. These RBCs will develop Master Plans for each basin, which will be reviewed and approved by the NWRC. There are a number of specific aspects of the law that can help drive sustainability in the water sector:

- Setting water use fees to enable the establishment of a PES-like scheme (Section 49)
- Establishing protected areas in the Prasae watershed, as well as any remaining wetlands in Rayong Province (Section 73)
- Establishing requirements for riparian buffer zones and limiting the use of agricultural chemicals in areas around reservoirs (Section 74)
- Controlling use of chemicals in farming close to streams, rivers and wetlands, fostering sustainable dredging practices, and reducing dredging activities (Section 77).

3.4.2 Eastern Special Development Zone Act (2018)

The Eastern Special Development Zone Act (2018) establishes the Eastern Special Development Zone Policy Committee, chaired by the Prime Minister. While the overall aim is to provide a framework to support and facilitate investment in industry to drive economic growth, it does provide a framework for assessing likely future impacts of that economic development on the water sector and water-related ecosystems, and putting in place measures to address those concerns. This can provide the

basis for many of the specific actions required for sustainability in the water sector in Rayong, set out in this chapter.

3.4.3 Climate Change Master Plan

Thailand's Climate Change Master Plan (2014-2050) includes a number of water-related priorities for adaptation in the agriculture sector that could be applied in Rayong, including: increasing the proportion of irrigated areas, improving water resource management in non-irrigated areas, and increasing use of soil and water conservation practices in climate change hot-spots.

3.5 Measures for Water Sector Sustainability in Rayong

Box 1 sets out key principles and linked actions which need to drive sustainability in the water sector in Rayong. The broad principles or goals to work towards are subsidiarity, ecological integrity, equity, efficiency and resilience. Those principles are embraced in various ways within the Thai Master Plan for Water Resource Management (2018-2037) approved in 2019 and the Master Plan for Integrated Biodiversity Management B.E. 2558 – 2564 (2015-2021).[15]

Subsidiarity implies that water management and service delivery should take place at the lowest appropriate governance level. It means that governance and decision making can reflect watershed boundaries that cross normal administrative jurisdictions and promote local community and stakeholder engagement. Thailand has embraced that principle in its renewed emphasis on the roles and authority of river basin committees under the Water Resource Act. Yet, successful decentralization is heavily dependent on dedicated financial resources and human resource capacity, both of which are lacking in Rayong Province for water management.

The maintenance of *ecological integrity* is a high priority in the Water Resources Management Strategy Plan which identifies Strategy V as "Rehabilitation of forest watersheds and degraded areas" including preventing soil erosion and developing forest watershed conservation plans linked to important river systems. *Equity* is a dominant theme throughout Thai strategies and plans starting with the Twelfth National Economic and Social Development Plan. In the case of water resources management the principle requires fair access and distribution of water resources between areas, sectors and communities. *Efficiency* in use is called for in the Water Resources Master Plan under Strategy II.

Resilience is not well covered in water related policy and plans and sustainable water management not treated comprehensively in Thailand's National Climate Change Master Plan (2015-2050). The linkage between the climate change and the water sectors is weak in policy and practice.

Box 1: Principles driving the SD pathway for water and priority measures.

1.	**Subsidiarity:** The National Water Resources Commission (NWRC) should devolve decision making about each individual River-basin or sub-basin to its River Basin Committee (RBC), which should be given a clear mandate, authority to implement that mandate, and the necessary budget to do their work effectively. The RBC in turn should allow water-user groups to make their own decision on some aspects of water management, and allow them to provide inputs into the development of the Master Plan for the river basin, as key stakeholders.
2.	**Ecological Integrity**: River basin Management Planning, and all related decisions, should be made based on a sound understanding of the meteorology, hydrology and natural ecology of the river systems. When

[15] ONEP, 2015, Master Plan for Integrated Biodiversity Management B.E. 2558 – 2564 (2015-2021), Office of Natural Resources and Environmental Policy and Planning Ministry of Natural Resources and Environment, Thailand.
National Office of Water Resources, 2018, Water resource management strategic plan: the cabinet approved water resource management strategy (2015-2026), NOWR, National Water Resource Commission, Thailand

	provincial or sectoral development plans create threats of serious or irreversible damage to watersheds, wetlands riparian areas and estuaries, mitigation hierarchies should be applied.[16] Development alternatives that would cause no, or less, damage should be given priority based on a precautionary approach, meaning that where there are threats of serious or irreversible damage to the environment, lack of full scientific certainty should not be used as a reason for avoiding or postponing measures to prevent environmental degradation. Environmental management plans should be put in place to ensure damage is minimized and any unavoidable damage is subsequently restored. In the worst case scenario where damage is unavoidable and cannot be restored at the site, then offsets should be considered as a last resort.
3.	**Equity:** Water allocations to different sectors, areas and communities should be equitably distributed based on an impartial negotiation processes. It should provide for the fair, orderly and efficient allocation of water resources to meet the community's needs once environmental flows have been set aside. The first priority in water allocation should be for environmental flows to provide a regime that is adequate in terms of quantity, quality and timing for sustaining the health of the rivers and other aquatic ecosystems.
4.	**Efficiency:** Water efficiency means doing more with less water. Water efficiency differs from water conservation in that it focuses on reducing waste, not restricting use. Incentives and support should be provided for more efficient use of water and water conservation in all sectors. Cost effective and flexible policy instruments should be adopted to drive efficiency and conservation, such as improved pricing of raw water, payment for ecological services (PES), and other incentive mechanisms. Targets should be set requiring industry to progressively use increased amounts of recycled water.
5.	**Resilience:** A safe and secure supply of water requires investment and maintenance of the infrastructure network and linked ecosystem assets, building in resilience from natural hazards and the impacts of climate change applying nature based measures in combination with engineering. That requires climate change to be well integrated into provincial and sector plans and into regulations which determine water allocation, use and conservation.

Despite most of those sustainability principles for water management having references in Thai national water strategies and master plans, the overriding emphasis is on the construction of engineering infrastructure such as dams and reservoirs, canals, river training and confinement, pipelines, river diversions and increasing supply at all costs. That dominance of hard engineering fixes is reflected in the RPDP and RID and East Water plans shaping development in the province. The broad wording is moving in sustainable directions but the detailed actions are effectively more of the same unbridled manipulation of nature heading for serious unsustainable ecological and social consequences.

Those principles are consistent with the SDG goals which Thailand has formally endorsed and is actively promoting especially SDG 6 – "Ensure availability and sustainable management of water and sanitation for all" which includes the following fast approaching targets:

- 6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
- 6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reduce the number of people suffering from water scarcity

[16] The mitigation hierarchy is a tool that guides users towards limiting the negative impacts on biodiversity from development projects. It emphasizes best-practice of avoiding and minimizing any negative impacts, and then restoring sites no longer used by a project, before finally considering offsetting residual impacts on biodiversity. Offsets are measures taken to compensate for any residual, adverse impacts after full implementation of the other three steps of the mitigation hierarchy.

- 6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate
- 6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

Table 3-3: Actions for the next RPDP (2021 - 2025)

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
Water demand and supply	**3.1 Strengthen the River Sub-basin Management Committees (RBCs) and Water User Groups for Khlong Yai and Prasae river basins** In order to more effectively manage water resources, authority for decision-making for river basin water management should be devolved to the river basin committees and water user groups: ▪ River basin committees should be delivered a clear mandate outlining their authority and role as spelt out in the Water Act 2018; ▪ The RBCs should outline the roles and responsibilities of water user groups in managing the river basin for all ▪ The RBCs require substantially greater technical and budget capacity to function adequately. Decentralised RBC technical secretariats should be established on a pilot basis to provide the committed expert staff needed to fulfil RBC functions, especially the preparation, implementation and monitoring of basin management plans. ▪ The RBCs must have as their primary function the restoration and maintenance of river ecology - that requires the RBCs have the capacity to adopt a sophisticated approach to recognizing environmental water needs and the importance of aquatic ecosystem functioning in providing goods and services	Rayong Governor's Office, Eastern Coast River Basin Committee, RID	Next 2 - 3 years
	3.2 Prepare sub-basin master plans for Khlong-Yai and Prasae river basins The Khlong-Yai and Prasae river basins should be actively managed for healthy ecosystem functioning in providing goods and services. ▪ That requires basin management plans be prepared involving: (i) Conducting a situation assessment (ii) Formulating a vision and objectives which reflect an ecological foundation to management of uses (iii) Developing basin strategies and outcomes related to protection, use, disaster management and institutional development, designed to achieve the vision. (iv) Defining actions that give effect to the basin strategies and should ultimately achieve the vision and objectives.17	Office of National Water Resources (ONWR), Eastern Coast River Basin Committee, Rayong Governor's Office, East Water	Next 2 – 3 years

[17] G. Pegram, Y. Li, T. Le. Quesne, R. Speed, J. Li, and F. Shen. 2013. River basin planning: Principles, procedures and approaches for strategic basin planning. Paris, UNESCO.

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
	▪ Different characteristics or uses across the basin should be recognised with higher levels of protection in some parts of the basin (e.g. key ecological zones, or sources of drinking water supply), allowing other areas to be more heavily developed. The process should be consultative with plans made publicly accessible via web sites and other media		
	3.3 Develop and issue regulation on pricing for different water usage types	RID, NESDC, ONWR, River Sub-basin Committees for Khlong Yai and Prasae, Rayong Governor's Office, East Water	Next 2 – 3 years
	▪ Water demand growing, and with local availability insufficient to meet demand, ▪ Water prices should reflect the reality of water as a scarce resource and the need for environmental flows to ensure sustainable ecosystem and riverine health. ▪ Pricing of water should also take into account the economic situation for different sectors, including industry, agriculture, commercial, tourism and domestic. ▪ Currently, East Water does not pay an adequate price for Rayong's water and RID does not link that revenue stream to the protection and maintenance of source reservoirs and watersheds within the Province. ▪ The regulation should require direct and transparent links between the revenue stream, protection of the sources and implementation of the river basin plans.		
	3.4: Pilot an improved environmental flow regime - Allocate 20% MAF to environmental flows	ONWR, RID, River Sub-basin Committees for Khlong Yai and Prasae, Rayong Governor's Office,	Next 2 – 3 years
	▪ The current environmental flow regime is inadequate and making environmental quality and ecological conditions progressively worse with long term and irreversible consequences for Rayong's rivers. ▪ As a carefully monitored pilot, the minimum release of environmental water from Rayong's reservoirs should be maintain at least 20% of the average (mean) annual flow rates – that regime should be introduced and monitoring while a long study is conducted. ▪ Conduct a 2 year study to provide an ecological evidence base for managing environmental flows: (i) Using historical records, determine natural average (mean) annual flow (MAF) of Rayong's rivers (i.e. assuming all water flows to the sea); (ii) Under this regime, observe and document the ecological functionality of the rivers, their aquatic biodiversity as well as their mechanical ability to withstand salt water intrusion in lower reaches; (iii) Use this observational data and its analysis in comparison with studies of riverine ecological functionality to make evidence-based policy on environmental flows.		
	3.5 Incentivise more water efficient technologies and processes		

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
	▪ The agricultural and industrial sectors can both use water more efficiently ▪ Water supply can benefit from improved efficiency. The following measures should be implemented for the **agricultural sector**: (i) Incentivising more water efficient irrigation, such as sub-surface irrigation, drip irrigation and installation of soil water monitors to optimise water levels in the soil by crop type; (ii) Promotion of less water intensive crops. (iii) Provide incentives and technical support for better on site management of water through nature based solutions The following measures should be implemented for the **industrial sector**: ▪ Use of financial incentives (e.g. tax concessions, grants and loans) and regulations to require (i) water usage audits for all existing and planned plants and estates (ii) Implementation of measures recommended through the audit process including those covered in Table 4.1 and the cited reference. (iii) updating machinery (iv) water recycling with technical advice about technology and its availability The following measures should be implemented for **water supply**: ▪ Irrigation canals converted to pipes to reduce water losses (middle basin)	IEAT, DIW, Rayong Governor's Office	Next 5 – 10 years
	3.6 Conduct a ground water assessment and prepare a management plan A provincial ground water assessment is needed to determine: ▪ Sources of water entering aquifers ▪ Volume of water available in Rayong's aquifer(s) ▪ The quality of ground water ▪ Current consumption patterns ▪ How aquifer recharge can be enhanced On the basis of the assessment prepare a ground water management plan for Rayong to: ▪ Provide background on the groundwater levels and quality; current and future management practices and responsibilities; responses to potential negative impacts; monitoring programs; arrangements in cases where users exceed defined groundwater extraction levels; and requirements on reporting and review.	Groundwater Department, Regional and Provincial Environment Offices, East Water	Next 2 – 3 years

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
	▪ The plan should include objectives of renewability (replenishment, recharge) of the resources, and sustainable exploitation and consumption standards and arrangements.		
Water quality (surface and ground water)	**3.7 Reduce pollution entering Rayong's waterways** Surface water quality in Rayong is poor and is declining over time. This is a critical issue that needs to be addressed: ▪ Existing wetlands should be assessed and restored; ▪ Riparian zones should be revegetated; ▪ Artificial wetlands should be created to support water treatment from small communities; ▪ Require industry and households to connect to centralised wastewater treatment systems (where they are available); ▪ Ensure that existing and planned wastewater treatment systems are used to their full capacity.	Regional and Provincial Environment Offices, Provincial Forestry Office	Next 2 – 5 years
	3.8 Assess the quality of groundwater and define management responses to avoid contamination (as a component of measure 5.6) ▪ Current industrial processes are degrading groundwater quality in Rayong. ▪ Limited monitoring means that the level and extent of contamination and its sources are not known. ▪ A groundwater quality assessment is required to: • Determine the severity and extent of groundwater contamination; • The root causes of pollutants, including the sources, and how the pollutants enter and disperse in groundwater; • Define measures to reduce groundwater contamination at source and more widely through management, engineering and nature based solutions	Groundwater department	Next 2 – 5 years
	3.9 Conduct an assessment of reservoir condition and threats, and implement management plans to protect them from pollution and encroachment ▪ Agriculture and industry located in the vicinity of Rayong's reservoirs are undermining water quality because of chemical runoff and industrial effluent. ▪ The reservoir buffers are being encroached leading to erosion, pollution and sedimentation in reservoirs ▪ Threat assessments and management plans are needed to: • Refresh land zoning and safeguard frameworks to prohibit industrial and other forms of development in the catchments of reservoirs;	RID, Town and country planning, Agriculture department, Regional and Provincial Environment Offices,	Next 2 – 5 years

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
	• Promote organic farming practices for farms within reservoir catchments; • Rehabilitate forests and ecosystem services in reservoir catchments; • Removal of illegal structures (e.g. houses, sheds and stables) and eliminate land uses that encroach on reservoir buffers ▪ Ensure stricter enforcement of catchment zones and standards, and reservoir buffer requirements is essential for water quality and supply from Rayong's reservoirs and for replenishment of the resource; ▪ Conduct awareness raising and educational programs about the importance of watersheds and watershed management.		
	3.10 Strengthen and expand the water quality monitoring system ▪ Establish a more extensive network of water quality monitoring stations as the basis for enforcement of ambient pollution standards and control strategies; ▪ Expand the point source standards and monitoring and enforcement arrangements ▪ Use the network monitoring as the basis for providing residents with early warnings of extreme water pollution events; ▪ Make the water quality monitoring data and its analysis available in real-time through a publicly accessible web-site. ▪ Increase the staffing and budget resources and capacities within the Provincial and Regional Environment Offices to ensure more effective monitoring and reporting on water quality	Provincial and Regional Environment Offices, PCD	Next 2 – 3 years

Table 3-4: Other actions required to address critical sustainability issues for water resources

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
Water Demand and Supply, Water Quality	**3.11 Assess options for an effective and transparent Water Fund for ecological sustainability in Rayong and the EEC** ▪ RID operates a water fund which receives payments from East Water and other sources – but is not Rayong or EEC specific ▪ RID has full authority in managing and allocating that fund ▪ The RID fund is allocated mainly for engineering projects for storage and distribution.	RID, NESDC, MONRE, Ministry of Finance, EEC Committee	Next 2 - 3 years

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
	▪ A comprehensive review is required to assess institutional options for receiving revenues from water sale and other sources and for ensuring it is used to support implementation of river basin plans, ecological sustainability and watershed protection in addition to grey infrastructure. The following activities could be supported by a new or reformed water fund: • Matching demand and supply through demand side management and targeted investments in supply; • Ensuring continuous improvement in water quality • Payments to communities to restore and help manage watersheds • Support to farmers in areas above reservoirs to shift to organic farming to prevent chemical run-off • Support to farmers with land adjacent to water courses to maintain or restore natural buffers between their farmed land and the stream channel to reduce chemical contamination, soil erosion, bank collapse and sedimentation • Compensation to farmers if their irrigation water is reduced in order to supply enough water to meet the needs of industry, in times of limited water availability ▪ Pilot a payment for ecosystem services (PES) scheme. While Thailand does not have a strong legal framework for implementing PES schemes, Article 49 of the Water Law (2018) provides an avenue to support a PES scheme in Rayong without the need for developing new legal instruments.		
	3.12: Assess alternative water source schemes	ONWR, ONEP, NESDC, IEAT, EEC Committee	Next 5 – 10 years
	▪ Because of projected increasing demand for water in Rayong and the constraints on supply, a priority needs to be given to demand side management. ▪ However, there are also several supply side methods that need to be piloted to increase the quantity of water available. Conduct an assessment of alternative water sources and if feasible pilot, for example: • A desalination plant for industries located in Map Ta Phut; • A waste water purification to drinking water or industrial use (possibly through a PPP arrangement) scheme ▪ Assess the effectiveness of cloud seeding for artificial rain-making – and extend if supported by a science evidence base.		
	3.13 Introduce and strengthen national standards and regulations to control dredging, protect riparian buffer zones and increase punitive measures for pollution	Ministry of the Interior, MONRE	Next 3 – 5 years
	While Table 3-2 included measures that can be taken at the provincial level to address poor water quality, these should be supported by national level measures and regulations. As a priority:		

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
	▪ Develop and issue dredging operation standards that focus on maintaining aquatic biodiversity and protecting wetlands; ▪ Develop and issue regulations for riparian buffer zones, including measures for determining the extent of zones based on vegetation types, geomorphology and surrounding land usage, as well as measures for determining suitable vegetation coverage and types; ▪ Strengthen punitive provisions for agricultural and industrial chemical discharges into the environment		

3.6 Effect of measures on trends in strategic issues of other themes/sectors

The effects on the water sustainability measures on other sectors are largely positive. Improvements in water quantity and quality will benefit all sectors using water, including the agriculture, industrial, residential, and tourism sectors. Improved flood management will benefit the transport and urban development sectors, and improved quality of water flowing into the sea will benefit the coastal environment and the fisheries sector. Restoration of watersheds will also enhance forest cover and biodiversity with the other amenity benefits they provide.

The negative impacts may include increased costs associated, for example, with water efficiency and conservation measures, alternative water source strategies, enhanced water quality, and watershed management. Farmers may be required to cede a portion of their land to develop riparian buffers and artificial wetlands; and their yields may be reduced with restrictions on use of agricultural chemicals in watershed areas. Additional "costs" for farmers may be compensated by payments or other support provided under a PES or similar program in the river basins. The industrial sector will likely bear additional costs associated with purchases of more expensive raw water. Additional costs may be incurred related to more effective wastewater treatment; creating on-site water harvesting and storage; and in the longer term, desalinated or water purification schemes. Industry may be able to pass on some of these costs to consumers of their goods and services.

3.7 Conclusion

While the rapid development of Rayong Province poses significant challenges for the water sector, a robust legal, policy and institutional framework for managing these challenges is now in place. The present iteration of the Rayong Development Plan proposes numerous water-related projects, mostly consisting of water infrastructure aimed at increasing supply; and dredging activities. Many additional interventions are required to achieve sustainability in the sector. The sustainable development pathway set out here requires significant investment in ecosystem-based approaches to river basin management, including restoration of watersheds, riparian buffers and wetlands. Demand side management strategies and greater water-use efficiencies in all water consuming sectors are very high priorities for action. Integrated use of surface water and ground water and effective treatment of a much higher proportion of waste water are also essential ingredients of the SD pathway.

A program of communications, education, and public-awareness raising is required to support the transition to a more sustainable pathway. Design principles for this program include: the finite supply and value of water; the shared need and responsibility for sustainable water use; and the innovations necessary to ensure sustainability.

The SD measures will require significant additional resources, which may not be readily available. It will require adjustments to investment priorities. And given the importance the government attaches to the EEC as a driver of economic development and the importance of water supply underpinning this development, allocating needed resources for implementation for SD pathway measures should be a priority. Exploration of options for an EEC Water Fund (as part of the overall EEC Fund) is recommended as a potential support for implementation of the water sector sustainable development pathway specifically in Rayong but with significant benefits more generally for the EEC.

4 AGRICULTURE

4.1 Introduction

The purpose of the chapter is to set out measures for sustainable agriculture to be integrated into the next iteration of the Rayong Provincial Development Plan (RPDP), and into other plans which are shaping development within the province. Thailand has a very strong framework of sustainability policies and proposed actions running through its national and sector strategies and plans for agriculture, many developed and demonstrated over the past 20 years. Those policy commitments are often linked to pilot projects but have tended to hit obstacles at local level where farmers are under pressure to commercialize through contract farming and large-scale agribusiness.[18] Therefore they are not being applied systematically in provincial plans and budgeted measures.

The Provincial Office of Agriculture and Cooperatives (POAC) in its Agriculture Plan for Rayong for 2017-2021, identifies five main challenges:

- Land availability and quality (some agricultural land is degraded and no new land is available)
- Agricultural labour (limited supply and dependence on migrant labour)
- Research and development(there is a need for increased investment in innovation in the sector)
- Irrigation (the area covered is limited to about 12% of available farmland)
- Commodity prices (low prices for produce and dependency on global markets)

Thailand's agricultural exports account for about 17% of total exports and are valued at about 1.3 trillion baht/year. Food and agriculture produce constitute about 85% of that amount, with products for agro-industry making up the other 15%. Rubber accounts for 216 billion baht and fruits for 142 billion baht (including durian- 22 billion baht). Between 2016 and 2017, the value of agricultural exports increased by 11%, led by strong growth in demand for rubber from the expanding automobile industry in China and elsewhere, as well as rising demand for Thai fruits, especially durian, in China. At the same time, cassava exports declined, due largely to competition from Vietnam. Agriculture only accounts for a small part of the economy in Rayong, and is dominated by rubber, cassava and fruit, which are all highly dependent on the export market to East Asia, especially China.

SEA stakeholders identified the reduction in the area farmed, the supply of agricultural labour, and the availability of water for agricultural production as the main strategic issues of concern to development in the agricultural sector in Rayong. These were synthesised into two key strategic issues:

(i) Transformation of the agricultural sector – including issues of availability of agricultural land and agricultural labour
(ii) The availability of water for agricultural production

These issues are closely related to industrial development and urban growth in Rayong, both of which compete with agriculture for water supply and land. Industry offers regular employment that provides better wages, and is drawing labour away from the agriculture sector – especially younger people. On the positive side, growing urban and industrial areas offer growing markets for agricultural produce.

[18] Thanwa Jitsanguan, 2001, Sustainable Agricultural Systems for Small-Scale Farmers in Thailand: Implications for the Environment, Department of Agricultural and Resource Economics, Faculty of Economics, Kasetsart University, Bangkok, http://www.fftc.agnet.org/library.php?func=view&id=20110718190247

4.2 Gaps in the existing Rayong Provincial Development Plan (RPDP)

The POAC has planned a number of interventions to combat these challenges – not all have been integrated into the RPDP. The RPDP supports innovation and technological development in farming, as well as the provision of some skills training, which will benefit sustainability in the agriculture sector. Support for new market places, as well as marketing promotion and agro-tourism promotion are also beneficial actions included in the RPDP. The planned water infrastructure developments could be more beneficial for agriculture if a proportion of the additional storage created was allocated for agricultural use. The main gaps in the plan for the agriculture sector are:

- Failure to address climate change issues or promote climate-smart and sustainable farming systems
- Lack of skills development for agricultural labour or support for young agri-entrepreneurs
- No consideration of water-efficient forms of irrigation (drip irrigation and sub-surface irrigation)
- No promotion of on-farm water storage or efficient use of ground-water
- Lack of incentive to reduce use and runoff of agricultural chemicals or restore riparian vegetation
- Lack of crop insurance schemes (particularly important in the face of growing climate uncertainties)

Urban expansion with both industrial and residential development will continue to take some land away from agriculture. The availability of jobs in Rayong and the significant improvements in planned transport infrastructure will continue to attract migrants looking for work and tourists to the province. Water demand in the residential, tourism, and hospitality sectors will increase and compete with the agriculture sector. On the other hand, the increasing size of Rayong's population, and the increasing number of visitors will both provide additional local markets for agricultural produce.

4.3 Sustainable Development Objectives and Indicators

The sustainable development objectives for the agriculture sector defined with stakeholders, and potential indicators which can be used to keep track in their achievement are shown in Table 4-1.

Table 4-1: Strategic issues, sustainability objectives and potential indicators for the Agriculture sector

Strategic issues	Sustainability objectives	Indicators
Transformation of the agriculture sector, including land-use change and shortage of agricultural labour	1. The agriculture sector is modernized to meet international standards through sustainable production models for small - holders and commercial agriculture. 2. Farmers adopt sustainable land management practices, enhance biodiversity, reduce environmental pollution and build climate resilience	• #/proportion of SMART farmers • #/proportion of farmers collaborating in "Megafarms" • #/proportion of farmers with organic farming certification • #/proportion of farms with on farm water supply/water storage; and using water and soil conservation techniques
Securing water supply for crop production	3.RID ensures adequate irrigation water supply for farmers	• Farmer satisfaction with irrigation water supply/# of complaints received/ month

4.4 National policy framework driving sustainability in agriculture

Thailand's national development plans prepared by NESDC have long promoted sustainability in agriculture. For example, the 8th Plan defined the "aim to revive the rural community using sustainable farming by reaching 25 million rai for sustainable agriculture and 20% of national arable land targeting

8 million farmers". The NESDC and linked national plans advocate five main strategies for achieving ecological sustainability in Thailand's agriculture:[19]

1. **Integrated Farming System** used when two or more different agriculture activities are in the same field. This lowers costs for farmers and utilizes limited spaces to their maximum potential.
2. **Organic Farming** limits the quantities of herbicides, pesticides and fertilizers used in farming. By using less harmful chemicals, the soil and land are protected.
3. **Natural Farming** includes farming with no tillage, no application of chemicals and complete preservation of the ecosystem with little damage from farming.
4. **Agroforestry** enabling cash crops and cattle to coexist with trees and forestry land thus improving the ability to use the land for sustainable agriculture while promoting reforestation.
5. **New Theory Farming** tailored to farmers with limited field allotments and a shortage of water resources, and promoted self-sufficiency by dividing the available land into four parts and utilizing each for fish ponds/raising, fields for crops and vegetables, a rice paddy for self-consumption and space for living and livestock raising.

The National Strategic Plan 2018-2037 - "Thailand 4.0" - sets out a number of other key sustainability strategies. The three most relevant to agriculture are:

- "Competitive Advantage" - increase yield per area through technology and innovation; geographic identification and niche marketing; and take advantage of growing interest in food safety through organic agriculture
- "Human Resource Development" - train workforce to develop new skills and approaches
- "Opportunity and Inequality" – increase overall well-being and "leave no one behind"

One challenge will be implementing "opportunity and equality", as smaller and poorer farmers may not be in a position to take advantage of the new technology unless it can be made cheaply available or subsidised. The Ministry of Agriculture and Cooperatives is focused on increasing the standard of living, increasing local pride in agricultural occupations and profession, increasing income, reducing debt and climbing out of the middle-income trap.[20]

The Agriculture Development Plan under the 12th National Economic and Social Development Plan (2017-2021) includes within its first strategy the promotion of sustainable agriculture and then as its fourth strategy "Balanced and sustainable management of agriculture resources and the environment" with five guidelines to:

1. Rehabilitate and conserve agriculture resources
2. Promote environmentally friendly agriculture
3. Manage water resources efficiently and sustainably
4. Manage agriculture land sustainably

[19] Ladawan Kumpa, 2015, Sustainable Agriculture and Food Security in Thailand: National Government Perspectives and Policies, Deputy Director General, NESDB, Thailand. https://www.slideshare.net/SIANIAgri/nesdb-ms-ladawan

[20] The middle income trap is a situation in which, following a period of successful development, a country fails to advance further. It has lost its competitive edge in the export of manufactured goods because of rising wages and a lack of skills and innovation. It suffers from low investment, slow growth in the secondary industry, limited industrial diversification and poor labour market conditions. See for example - http://siteresources.worldbank.org/DEC/Resources/84797-1154354760266/2807421-1382041458393/9369443-1382041470701/Middle-Income_Traps.pdf

5. Build immunity in agriculture against climate change

Thailand's Climate Change Master Plan (2014-2050) includes a number of priorities for adaptation in the agriculture sector, which need to be implemented more widely in Rayong. They are picked up in the Climate Change in the Agriculture Sector Strategic Plan (2017-2021) which gives priority to increasing adaptive capacity in climate change for farmers/farmer organisations and related business by integrating local community into water management, increasing water usage effectiveness, adopting risk maps to guide adaptation and apply precision farming where appropriate.

4.4.1 Promoting Transformation in the Agricultural Sector

Several organisations are central to facilitating implementation of comprehensive framework established through the national strategies and plans, including the Office of Agricultural Economics (OAE), the Department of Agricultural Extension (DOAE), Cooperative Promotion Department (CPD), the Cooperative Development Fund (CDF), and the Royal Irrigation Department (RID). Those agencies responsibilities are spelt out here against some of the important sustainability issues which they are addressing.

Mechanisation and modernisation to meet international standards: OAE is the lead agency in developing and formulating Thailand's agricultural strategy. The general national objectives for agricultural mechanization policies are to produce high quality and labour-saving agricultural machinery at prices affordable to farmers (Thepnet, 2015; Win, 2016a). New technology will increase productivity and lead to higher yields and higher income, making farming a more attractive occupation. Yet, this may lead to greater inequality in the sector because poor farmers may not be able to afford new technology or have the relevant capacity to use it, and this may lead to greater inequalities in the sector. Cooperatives may provide an opportunity to make new technology available to poorer and small-scale farmers. The Department of Agriculture (DOA) plays a role in transferring agricultural technology to concerned government officials, farmers and the private sector. The Ministry of Agriculture and Cooperatives is emphasizing two significant projects - Mega Farm Promotion and Smart Farmers. It is unclear to what extent these two approaches will be rolled-out in Rayong, but both hold promise for enhanced sustainability in the sector.

Improved Marketing of farm produce and increasing farm incomes through cooperatives: The Cooperative Act was enacted in 1968 and enabled the establishment of the Cooperative League of Thailand as the apex organization of the cooperative movement. The increasing number of cooperatives also led to establishment of the "cooperative Bank" in 1974. In 1999 a new "Cooperative Act was issued. Cooperatives in Thailand are officially categorized into seven types, of which "Agricultural Cooperative" is one. The Cooperative Development Fund (CDF) was set up for the purpose of loaning working capital up to 25 million baht to cooperatives and farmer groups.

Khao Kitchakood Agriculture Cooperative (KAC) in Chantaburi Province, adjacent to Rayong is a very successful model of a fruit farmers' cooperative, from which cooperatives in Rayong could learn. Key lessons relating to the prerequisites to success include: surveying the demand of major fruit markets, collaborating with private companies and the government sector to encourage production of quality fruits for export, educating consumers on the benefits of fruits, encouraging new techniques of production and post-harvest, and collective marketing to enable selling to Thai supermarkets and exporting to China and Vietnam. The success of KAC is considered to be a result of strong and trustworthy leadership; outstanding business networking, professional running of the operations; regular communication; and involvement of members in developing excellent plans.

The Cooperative Promotion Department (CPD), which is responsible for promoting and disseminating the cooperative approach, should focus efforts in Rayong on fruit producer cooperatives, particularly durian and should support exchange and learning between cooperatives in Rayong and other successful cooperatives like KAC.

Young agri-entrepreneurs in the Thai farming sector: To counter the trend of lower participation of young people in the Thai farming sector, several public and private organizations in Thailand are supporting new young farmers. The Department of Agricultural Extension (DOAE) is tasked with increasing agricultural production and processing capacity, while increasing the value of agricultural goods, controlling product quality, and transferring agricultural technology to farmers through vocational training and agricultural services. Given the current context of agriculture in Rayong, and the overall economic development trajectory of the province, DOAE should focus on supporting young innovative farmers.

Migrant labour: The role of migrant workers in the Thai economy is huge. Their importance in the agriculture sector in Rayong is growing as younger Thais leave farming to take up more regular and better paid jobs in the industrial and services sector, and the remaining Thai farming population continues to age. Overall, Thais have a positive outlook toward immigrants and their role in the economy (Chalamwong 2018). It would appear certain that the role of immigrants from other provinces in Thailand and other countries will continue to expand in Rayong's agriculture sector. Strategies for ensuring that labour resource leads to positive outcomes for local farmers and for sustainability are needed.

Securing Adequate Irrigation Water Supply: The Goals of the Royal Irrigation Department (RID) are to increase the amount of reserved water and irrigation area, to supply that water to all sectors thoroughly and equitably; and to ensure that consumers are satisfied with water management. Issues related to irrigation in Rayong are explored fully in the Strategic Development Pathway for Water chapter of this volume.

4.5 Measures for sustainable agricultural development in Rayong

Priority sustainability measures identified, cover those for inclusion in the RPDP, as well as actions in higher level plans and by national and regional bodies where needed to support and drive progress towards sustainability in Rayong Province. Many of the basic principles of sustainable agriculture are well reflected in Thailand's national development strategies and plans which provide a strong policy directions for uptake and replication in the RPDP.

Achieving agricultural sustainability is complex with many facets. It includes economic imperatives - sustainable farms should provide for local livelihoods and be profitable businesses that contribute to a robust economy. Social needs must be met – cultural and heritage values require safeguards and workers should be treated well and have a mutually beneficial relationship with the surrounding community. Environmental quality and ecological imperatives need to be the foundation of the sector – farming should not degrade the natural capital and ecological functions of the landscape that provides the ecosystem services on which it depends.

Sustainability in agriculture depends on good stewardship of the natural systems and resources that farms rely on for their long term productivity. Key sustainability measures needed for farms in Rayong include building and maintaining healthy soil, managing water efficiently, minimizing pollution, and promoting biodiversity across the farm landscape. Farming in Rayong needs to be "climate smart" to ensure resilience in a changing climate which is leading to drier conditions overall and more intense rainfall and storms during the wet season. Sustainable agricultural practices listed in Box 2 have been demonstrated elsewhere in Thailand and need to be applied more extensively in Rayong.

Box 2: Sustainable agricultural practices demonstrated in Thailand for wider replication in Rayong

- rotating crops, intercropping and alley cropping to enhance diversity and improve soil health and pest control;
- planting cover crops in the off-season to prevent soil erosion, keeping weeds in check and replenishing nutrients;
- reducing tillage to reduce erosion and improve soil condition;
- applying integrated pest management to minimize use of chemicals;

- integrating livestock and crops to feed animals and provide organic manure more efficiently;
- managing the whole farm landscape with a strong emphasis on diversity and nature based solutions; and
- raising cash crops and livestock integrated with forestry

Table 4-2 picks up on those ideas and practices and on the suggestions from SEA stakeholders for SD pathway measures for agriculture. The Table provides a summary of the actions that can be integrated into the next iteration of the RPDP (2021-2025) and included in subsequent RDMPs, together with the key agencies involved and an appropriate timeframe. These are all focused on best practices, innovation and new technologies and techniques. Many reflect existing commitments by agencies such as the Provincial Office of Agriculture and Cooperatives and Department of Agriculture and Department of Agricultural Extension, but need to be promoted more systematically and provided more substantial resources for effective implementation.

Table 4-3 sets out actions needed to address the strategic issues that are likely to be outside the remit of the RPDP and Rayong provincial authorities. These are largely national level decisions concerned with budget allocation and roll-out of large national programmes in Rayong.

Table 4-2: Actions for inclusion in next RPDP (2021-2025)

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
Farming System Transformation	**4.1: Roll-out of farming cooperative approaches in Rayong** (i) Facilitate cooperation amongst neighbouring farmers with large plots of land to manage their farms and take decisions collectively about what to grow and where to market it, with support from the government and the private sector. (ii) Coordinate with private enterprises to develop agreements to help to buy products, provide marketing information to farmers, and organize training on modern agricultural methods to create added value to farmers' products. (iii) Establish benefit sharing arrangements between private enterprises and farmers in line with the Agricultural Extension and Development System Act, 2017, through facilitation of dialogue and negotiation processes	Provincial Office of Agriculture and Cooperatives, Department of Agriculture and Department of Agricultural Extension	Next 2 years for pilot phase, up to 10 years for expansion phase
	4.2: Roll-out of "smart-farms" projects in Rayong (i) Support establishment of Smart Farmers (Smart Agricultural Groups) and their focus on agricultural products with quality standards that meet the needs of the market (Smart Agricultural Products) through workshops, focus group discussions and formation of groups of like-minded farmers (ii) Support smart farmers decision making to cultivate products in areas with appropriate potential for those products, through development and dissemination of land-suitability maps (Smart Area Agriculture). (iii) Strengthen "smart farmers' institutions" through provision of training and farmer to farmer extension programmes (iv) Raise product standards in line with market demand – train farmers on how to meet the required standards (v) Increase competitiveness with use of technology and innovation – introduce farmers to appropriate new technology (vi) Develop government management systems: developing personnel and researchers to become "Smart Officers" and "Smart Researchers" to link and integrate the work, through an internal capacity-building programme	Provincial Office of Agriculture and Cooperatives, Department of Agriculture and Department of Agricultural Extension	Next 2 years for pilot phase, up to 10 years for expansion phase
	4.3: Improve Marketing of farm produce and increasing farm incomes through cooperatives (i) Prioritise efforts on strengthening existing high value fruit producing cooperatives (ii) Build capacity for improved marketing through exchange sharing and learning visits to successful cooperatives in neighbouring provinces	Cooperatives Promotion Department,	Next 2 years for pilot phase, up to 10 years for expansion phase

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
	4.4: Support development of different models for young agri-entrepreneurs[21] Models promoting young agri-entrepreneurs which have been tested and demonstrated in Thailand should be supported in Rayong through development of case studies, provision of training, and developing a programme of farmer to farmer extension and business to business exchange and learning visits. The models with special promise which have been identified by Thai agricultural specialists include: (i) **Farm improvement** in which young farmers are supported in playing a key role in providing and developing farming techniques, such as smart farming applications and farm machinery for their parents' farms (ii) **Market-driven approaches** in which **:** young entrepreneurs are trained to take responsibility mainly or solely in the marketing aspect of their parents' farms (iii) **Processing** in which young entrepreneurs focus mainly, or solely, on processing businesses, while their parents keep running their farming businesses (iv) **Service-driven approaches** in which young entrepreneurs are given technical and financial support in starting or expanding their business (or their parents' businesses) into service sectors (for example, relying on agro-tourism in Rayong) (v) **Farm diversification** in which young agri-entrepreneurs are provided technical and financial support for the acquisition of farm businesses, to change and diversify farming systems and production structures in line with natural based approaches (vi) **Co-operatives** in which special training and technical support is provided to young agri-entrepreneurs to actively participate in co-operatives and/or community-based enterprises	Provincial Office of Agriculture and Cooperatives, Department of Agriculture and Department of Agricultural Extension.	Next 2 years for pilot phase, up to 10 years for expansion phase
	4.5: Improve support for migrant farm labourers and their families (i) Develop an integrated strategy to manage and provide support for migrant farm labourers and their families	Department of Labour, Department of Public	Next 2 years

[21] These models are being practiced in various provinces in Thailand and are summarised here from Decharut Sukkumnoed, 2018, Youth and Agri-Entrepreneurship on Thailand, Faculty of Economics, Kasetsart Univesrity, FFTC Agricultural Policy Articles, FFTC Agricultural Policy Plaform (FFTC-AP), Food and Fertilizer Technology Centre for Asian and Pacific Region. http://ap.fftc.agnet.org/ap_db.php?id=924

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
		Health, Department of Basic Education, Department of Non-Formal Education. Can be integrated into updated RDMP	for pilot phase, up to 10 years for expansion phase
	4.6: Improve sustainability of farming systems - enhancing biodiversity, reducing pollution and building climate resilience (i) Increase number of "natural" and organic farms in Rayong through farmer to farmer extension programmes and training. (ii) Improve water use efficiency and availability, increasing the number of farm ponds and wells in non-irrigated areas through extension services (iii) Increase use of soil and water conservation practices (especially in climate change hot-spots) through extension services, and training (iv) Reduce open burning of agricultural residue, through provision of training on the benefits of alternative uses for agricultural residues (v) Increase farms applying agro-forestry practices and area under complementary cropping and forestry regimes (vi) Increase the number of farmers with crop insurance through promotion of the availability of insurance services	Provincial Office of Department of Agriculture Extension and Land Development Department; Ground Water Department	Next 2 years for pilot phase, up to 10 years for expansion phase
Securing Adequate Water Supply	4.7: Expand the area of arable land with access to irrigated water (i) Conduct a comprehensive survey of farmers concerning the sources and availability of water (surface and ground water), water adequacy, need for irrigation water in terms of area and quantity, and implications for the agricultural sector of expanding access to irrigated water. (ii) Increase amount of water supply available for irrigation, at the same time emphasising water use efficient technologies such as drip irrigation and decentralised rain water storage. (iii) Increase size of the irrigated area by identifying new areas where the existing system can be extended, developing district water management plans and budgets (iv) Supply water to each sector through a transparent and equitable process including public meetings and negotiations	Royal Irrigation Department, RBOs	Continuous over the next 10 years

Table 4-3. Other actions needed to address the strategic issues

Strategic issue of concern	Level	Action and description	Responsible Agency	Time horizon
Farming System Transition	National government agencies	**4.8: Identify Rayong as a pilot and demonstration province for implementing farming cooperative approaches** (i) Ministry of Agriculture and Cooperatives to identify Rayong as a priority province for piloting and demonstration of the farming cooperatives approach and to provide policy commitment and funding for the roll out in addition to special technical support services in collaboration with DOAE	▪ Ministry of Agriculture and Cooperatives ▪ Department of Agricultural Extension (DOAE)	Next 2 years
		4.9: Identify Rayong as a pilot and demonstration province for implementing the Smart Farms strategy Ministry of Agriculture and Cooperatives to identify Rayong as a priority province for piloting and demonstration of SMART farmers projects and to provide policy commitment and funding for the roll out in addition to special technical support services in collaboration with DOAE	▪ Ministry of Agriculture and CooperativesDepartment of Agricultural Extension (DOAE)	Next 2 years
	Banking Sector	**4.10: Increase financial and technical support to farmers in Rayong Province as a priority structural adjustment policy** (i) Identify Rayong province as a priority for economic structural adjustment with special support provided to the agricultural sector. (ii) Allocate a significant proportion of the $22 billion available nationally to support farming sector SMEs to smart farmers and young agri-entrepreneurs in Rayong (iii) Focus loans from the Cooperatives Development Fund/Cooperatives Bank on high value fruit producing cooperatives in Rayong	▪ NESDC ▪ Bank of Agriculture and Agricultural Cooperatives ▪ Cooperatives Development Fund/Cooperatives Bank ▪ SME Bank	Ongoing over 10 years

4.6 Effect of measures on trends in strategic issues of other themes/sectors

The effects of agricultural sustainability measures on other sectors are largely neutral, and in some cases positive. Improvement of food quality and safety, increasing diversity of food products and more organically produced foods should have positive impacts for the public health sector. Any negative impacts may be seen in terms of increased costs as the agriculture sector adjusts and adapts to the new economic, social and environmental conditions. The prices of higher quality and organic food may be higher than current food prices.

4.7 Conclusion

Under the present RPDP, support for agriculture mostly emphasises the economic aspects of sustainability, while the social and environmental aspects of agricultural sustainability are not so evident. A number of additional necessary actions have been identified that would enhance overall sustainability of the agricultural sector in Rayong. These sustainability measures address the identified issues of agricultural land (quantity and quality), and agricultural labour (workforce and skill level), as well as agricultural water supply in non-irrigated areas. Irrigation is dealt with under the sustainable development pathway for the water sector. Many of the required actions can be integrated into a revised version of the current RPDP, or into the next and other subsequent RDMPs. Many of them would also require decision-making and commitments at the national level about roll-out of national programmes in Rayong and associated budget allocations.

5 ENERGY

5.1 Introduction[22]

The energy sector in Thailand is managed at the national level. The National Energy Council and Ministry of Energy (MOE) oversee the sector, and approve the power development plan which is developed by the Energy Policy and Planning Office (also under MOE). Regulation is conducted by the Energy Regulatory Commission (ERC). Most generation capacity is owned by the state-owned Electricity Generating Authority of Thailand (EGAT) which also operates Thailand's transmission system and acts as single-buyer for Thailand's electricity market. Most new investments in generation capacity are being undertaken by the private sector (excepting the case of PPT which is state-owned), as a consequence EGAT's share of installed capacity is declining. Outside Bangkok metropolitan area is owned and managed by the Provincial Electricity Authority (PEA) is responsible for (some) generation, procurement, distribution, and sale of electricity. The Department of Alternative Energy Development and Efficiency (DEDE) is responsible for energy efficiency and conservation policy and regulation, and new technology dissemination.

The role of the provincial government in energy and power sector planning is limited and the Rayong Provincial Development Plan (RPDP) does not address energy. However, Rayong Province is the most important energy hub in the country and the provincial authorities should have a key role in shaping the environmental safeguards governing the sector development in the province. For example, there are opportunities for Rayong authorities to support national level goals around reductions in emissions of greenhouse gases and other pollutants to air and water. This chapter sets out measures that should be integrated into the next iteration of the RPDP (2021-2025), as well as into national level power related strategies and plans that impact on Rayong's energy sector and development.

SEA stakeholders identified three strategic issues of concern for development in the province relating to the energy sector: (i) continued growth of decentralized power generation, (ii) Rayong as a strategic energy hub for Thailand, and (iii) environmental consequences of energy sector development. The past trends and future projections for those issues were examined in detail in the SEA baseline and impact assessment volumes. The main SEA findings for each strategic issue of concern for energy sector development in Rayong are summarized here as background and justification for the SD pathway measures set out in Table 5-2.

Continued growth in decentralized power generation – Rayong has experienced rapid expansion of distributed power generation due to the Small Power Producer (SPP) legislation which has enabled and encouraged relatively small Combined Heat and Power (CHP) plants, coupled with access to natural gas in the region, and the concentration of energy-intensive heavy industry for whom CHP plants represent a viable and cost-effective approach for meeting energy needs. Around 22% of Thailand's SPP plants are located in the province.

There has been relatively little development of renewables in Rayong. Further installation of SPPs in the province is to be expected as well as wider expansion of small-scale renewables, which will be supported under the VSPP legislation and by the falling costs of solar and other renewable technologies. Growth in decentralized power generation is closely related to the growth of local industrial demand and has consequences for pollution from the sector to air and water.

[22] This chapter is concerned with the energy supply side, including energy transport and transformation. Issues related to energy use in transport and industrial sectors in particular, such as transport emissions and energy efficiency in industry are addressed in those chapters.

Rayong as a strategic energy hub for Thailand – As Thailand's main landing point for its gas fields in the Gulf of Thailand, Rayong has developed as a national hub for energy transport and transformation. Rayong hosts more than half of Thailand's oil refineries and a quarter of national electricity generating capacity, as well as most of the country's petrochemicals industries. Rayong also hosts most of Thailand's gas processing and distribution facilities, as well as the country's only LPG import facility.

Rayong is expected to remain Thailand's most important energy hub and a critical location for meeting Thailand's growing energy needs, although emphasis is expected to shift towards a significant increase in energy imports, and the expected decline in domestic gas production. Rayong's rapid industrial expansion is closely related to its energy role and assets, this linkage is expected to remain important in the future.

Environmental consequences of energy sector development – Pollution issues related to the energy sector in Rayong are significant. Air pollution from power generation is a growing concern, with two large coal plants and numerous smaller gas fired plants in the province with a new 2,500-megawatt (MW) combined cycle gas turbine power plant to be built in the Rojana Rayong 2 Industrial Park, pollutants such as PM10, PM2.5, NOx and SOx are evident.

In this regard GHG emissions are a particular concern. Gas-fired generation and the development of efficient CHP plants minimize GHG emissions relative to other fossil fuel sources. Nevertheless, fugitive emissions from gas extraction and processing are important sources of GHGs. GHG emissions from the coal plants are also a cause for concern. Reducing GHG emissions from the energy sector in the province will be challenging but is likely to be an increasing concern as the unfolding climate crisis moves up the policy agenda.

Water use and pollution is also a significant issue, with water used widely for cooling plants. This is particularly the case for the coal plants that use sea-water for cooling and discharge contaminated water into the marine environment. The disposal of fly-ash and bottom ash from the coal plants, as well as various detergents, lubricants and oils used at plants also poses the risk of pollution to water bodies and land. Finally, the potential for oil spills from tankers and pipelines also poses a significant threat to the marine environment.

Environmental pressures caused by the energy sector are likely to grow with the expansion of the sector. Although the introduction of better regulation and wider adoption of energy efficiency and renewable technologies may mitigate pollution risks somewhat.

Pollution from the energy sector affects all other development sectors and the quality of life themes in this SEA. It is linked to water resources management, with climate change, and with environmental management of air, water and land contamination. The marine and coastal environment is also at risk from leaks and spills, discharge of cooling water from power stations, and leaching of pollutants from waste products like fly ash.

5.2 Gaps in the existing Rayong Provincial Development Plan

The RPDP does not address energy issues. There are no dedicated energy projects although a number of projects concerned with developing more sustainable human capacity and awareness raising with regard to environmental issues could arguably affect the energy demand side.

Energy supply is outside the scope of the RPDP. Provinces are rarely consulted up front on the strategic decisions for power development and location of major facilities. Investments in the sector are undertaken by the private sector and planned in collaboration with central government. Planning in the sector is conducted by EPPO, regulation by ERC. The Department of Alternative Energy Development and Efficiency (DAEDE) is responsible for energy efficiency and conservation policy and regulation, and new technology dissemination. Working linkages between those agencies and the Rayong authorities is tenuous and ad hoc.

The 2018 – 2037 PDP includes significant new commitments to investment in renewables. Despite high levels of power demand in Rayong it is unlikely that greater utility scale renewable energy deployment can play anything other than an ancillary role. There may be opportunities for the greater deployment of wind and solar at the household and business level, but utility scale deployment is likely to be limited by the availability and price of land in the province. The exception may be the potential for floating solar panels on the surface of reservoirs – although this would likely fall under the remit of RID rather than energy authorities.

The deployment of small-scale renewables will be dependent on national rather than provincial policy, and in particular the ability of renewables to compete with grid tariff levels. Waste-to-energy plants are a major exception, with 10 plants totalling 58 MW of installed capacity in the province. Most of these are on-site captive plants that can provide excess power generated to the national grid. There is at least one anerobic digester- biogas plant with a capacity of 70 t of organic waste per day, although this plant has been plagued by difficulties relating to the technology and the availability of suitable feedstocks. It is currently only operating at 29% of its capacity. Like other renewables the viability of waste-to-energy plants is heavily dependent on national policy and available preferential tariffs rates. Waste-to-energy however, requires close collaboration with provincial and municipal level authorities both in licensing and management, and should be better addressed in the RPDP.

Despite the highly centralised approach to energy planning and development in Thailand, the RPDP has an important function in establishing the sustainability framework influencing how that development takes shape, its obligations to the province and the special safeguards and controls which need to be applied. Also, there are a number of areas where the RPDP should be used to support national energy sector goals, and in so doing, enhance overall sustainability in Rayong, these are:

- Encouraging household and commercial businesses to install renewable energy generation facilities;
- Establishing a provincial level pollution emissions point source inventory for the energy sector;
- Establishing a broad network of ambient and point source air quality monitoring stations in the province; and,
- Auditing and improving energy efficiency in municipal and industrial buildings and equipment.

5.3 SD objectives, targets and indicators

Issues related to energy do not feature in the RPDP, aside from general energy efficiency awareness raising as part of wider sustainability education projects. Nevertheless, energy and emissions objectives are a significant feature of national level policy and planning. The 12th NESDP 2017-2021, in strategy 4 emphasises sustainability and the more efficient use of resources, with the objective of reducing GHG emission by 7-20% of BAU projections by 2020. Strategy 7 focussing on infrastructure and logistics development has a stated goals of reducing energy intensity from 8.22 to 7.70 ktoe/billion baht and increasing the share of renewable energy by 17.34% between 2017 and 2021.[23]

In addition, Thailand's national Climate Change Master Plan, Nationally Appropriate Mitigation Action Plan, and Nationally Determined Contributions all commit to significant reductions in energy intensity and GHG emissions over the coming years. Those aspirations and targets are reflected in the Thailand 4.0 strategy, with its focus on the development of a less energy intensive economy. Drawing from experience in Rayong Province, SEA stakeholders identified the strategic issues of concern to the energy sector and development in the province, and linked sustainability objectives and indicators for

[23] NESDB, 2016, The Twelfth National Economic and Social Development Plan (2017-2021), Office of the Prime Minister, Bangkok, Thailand. (see section 9)

keeping track of their implementation as set out in Table 5-1. The indicators were defined as an initial set for the energy sector which would be part of the overall monitoring framework for the RPDP.

Table 5-1: Strategic issues, sustainability objectives and indicators for the energy sector

Strategic issue of concern to development in Rayong	Sustainability objective	Indicators
Continued growth of decentralized power generation	Promotion of renewables and energy efficient generation technologies	• Share of RE in generation mix • Fleet efficiency of power plants • Share of electricity generated by prosumers
Rayong as a strategic energy hub for Thailand	Affordability of energy supply to residents and businesses in the province	• Share of average household income used for electricity
Environmental consequences of energy sector development	Reduce pollution emissions from energy supply to meet ambient and point source air quality standards and GHG emissions reductions targets	• PM 2.5 emissions from power generation in the province • GHG emissions from power generation in the province • Water use by power sector in province • Water emissions by power sector in province

5.4 Action plan for the sector/theme

The limited remit provincial authorities have for the development of the energy sector in Thailand and the national importance of energy related developments in Rayong, constrains the scope for provincial level interventions. Table 5-2 sets out potential actions in the sector with a focus on areas within the RPDP remit - i.e. local supply-side interventions, and demand-side projects that lie within the scope of provincial government authority/influence. Table 5-3 defines SD measures requiring the initiative and involvement of national government and line agencies in conjunction with Rayong authorities.

Table 5-2: Actions for inclusion in next RPDP (2021-2025)

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
Continued growth of decentralized power generation	**5.1 Prepare a provincial plan for decentralised RE energy generation and promotion of local "smart-grid" network** Following on from other initiatives in Bangkok, the province should explore the possibility for greater decentralised power generation. Utilizing distributed generation (such as rooftop solar), battery storage, smart grid technologies and payment schemes. Planning should pay special attention to potential linkages with private sector investments in the manufacture of renewables capital stock and possible developments in high-tech sectors. This should include: (i) Assessment of renewables potential in the province – paying special attention to roof-top solar, waste-to-energy and solar thermal; (ii) Assess the potential for integrating battery (or other energy storage technologies) into grid operations; (iii) Develop plans for operationalisation of smart-grid technologies in the province; and, (iv) Investigate potential linkages with private sector investments in the manufacture of renewables capital stock possible developments in high-tech sectors.	Provincial Department of Energy; Provincial Energy Authority	Next 5 years
Environmental consequences of energy sector development	**5.2 Establish a system for tracking environmental performance of Rayong's energy sector** Because Rayong is an energy hub for Thailand, producing around 20% of the country's electricity, environmental management of sector is a high priority. Tracking the environmental performance of energy facilities is extremely important for ensuring management effectiveness. Priorities for this tracking are to: (i) Develop and maintain a provincial level point source and ambient emissions inventory for energy. Sub-inventories should include: a. Greenhouse gas emissions; b. Particulate matter emissions (e.g. sulphur and nitrogen oxides); c. Emissions resulting from energy sector accidents (e.g. leaks from gas pipelines); d. Water emissions from power plants (both quantity and quality). (ii) Build provincial level capacity for monitoring of greenhouse gases and other emissions; (iii) Build public awareness about energy sector emissions; (iv) Identify and implement suitable mitigation activities to reduce / manage energy sector emissions. Regulate for provincial access to industrial estates and set in place data sharing arrangements with line agencies and the public	Provincial Department of Energy	Next 5 years
	5.3 Develop a comprehensive air quality monitoring system for Rayong province		

	Given the size of Rayong's heavy polluting industrial base including the expanding energy sector coal and gas assets and transmission, a comprehensive understanding of the province's air quality is a critical issue. An air quality monitoring system in Rayong should include the following elements: (i) A widespread network of ambient air quality monitors, with regular (i.e. hourly) updates onto a publicly accessible website; (ii) Priority monitoring sites should include in and around industrial estates and zones and along main transport corridors; (iii) Identification of air quality hot spots; (iv) Point source monitoring for industries identified as high risk polluters, and as appropriate in hot spot air quality zones; (v) Build provincial capacity for point source and ambient air quality monitoring (recruitment and training of personnel, provision of funding and equipment)	Department of Public Works, Rayong.	Next 5years.
	5.4 Municipal renewables and energy efficiency measures To reduce energy use and promote renewables in municipally owned and managed buildings, the following measures should be introduced: (i) Annual energy audits of municipal buildings and industrial facilities and equipment; (ii) Installation of solar systems (photovoltaic and/or thermal) on municipal building rooftops and in other under-utlized spaces (e.g. car parking areas); (iii) Upgrading of municipal buildings based on energy audit results. E.g.: a. Replacing old/inefficient air conditioners; b. Improving thermal insulation of buildings; c. Replacing street lighting with newer energy efficient lighting systems; d. Energy efficiency measures for municipal wastewater treatment plants; e. Introducing measures at solid waste disposal sites to enhance waste-to-energy opportunities;	Department of Public Works, Rayong.	Next 5years.

Table 5-3: Other actions needed to address the strategic issues

Strategic issue of concern	Level	Action and description	Responsible Agency	Time horizon
Continued growth of decentralized power generation	National Government	**5.5 Conduct a strategic review of incentive and licencing policies for renewables** Thailand's power development plan envisages the development of a significant decentralised renewables capacity. However, it is not clear that current incentive and licencing polices support the PDPs ambitious targets. To address this a review should be undertaken including the following: (i) Review existing incentives and licencing frameworks for renewable (particularly small scale) generation systems; (ii) Develop a range of policy incentives to encourage more renewables based energy generation across Thailand; (iii) Examine up-front licencing fees for small scale renewables; (iv) Consider all scales of renewable energy from utility-scale facilities to community and household scale.	Energy Policy and Planning Office; Electricity Generating Authority of Thailand; Ministry of Energy	Next 5 years
		5.6 Conduct a review of emerging technology for energy provision Technological change in the energy sector is moving rapidly. If Thailand wishes to achieve the environmental goals of the new PDP as well as economic and productivity goals of the Thailand 4.0 strategy the country will need to Conduct a detailed review of emerging technologies to assess their relevance for Thailand, including the potential for their domestic adoption, as well as potential for their production within Thailand. This will include the consideration of: (i) Support the development of industries involved in the development of green technologies: and (ii) Support their implementation domestically. E.g.For smart grids and battery storage.	Energy Policy and Planning Office; Electricity Generating Authority of Thailand; Ministry of Energy	Next 5 years
		5.7 Review and strengthen air pollution control legislation and institutions Review national air pollution control legislation and institutional arrangements with a view to: (i) Strengthening provisions for sub-national level monitoring and enforcement; (ii) Strengthening sanctions against polluters; and (iii) Comprehensively implementing the "polluter pays" principle.	PCD; Energy Policy and Planning Office; Electricity Generating Authority of Thailand; Ministry of Energy; Ministry or Transport.	Next 5 years

5.5 Effect of measures on trends in strategic issues of other themes/sectors

Developments in the energy sector are closely linked to industrial, transportation and urban development. Improved energy efficiency is an extremely important objective in consumptive sectors. These issues are addressed in greater detail in the transport and industrial sector chapters. Measures taken in the RPDP on the energy supply side will have little influence on the sector. Given the limited current remit of the province in energy related issues, in the short-to-medium term the measures suggested in Table 5-2 and Table 5-3, while important, are likely to have limited direct impact on the strategic environmental issues identified by SEA stakeholders.

5.6 Conclusion

Rayong will continue to be a critical hub for the nation's energy infrastructure. Environmental problems and pollution concerns from the power sector will remain an important strategic issue for the province. Despite the concentration of energy sector infrastructure in the province, Rayong authorities have little say in sector planning, and little influence on the monitoring and enforcement of pollution control legislation. Without reforms to national pollution control legislation and improvements to enforcement mechanisms it is difficult to see how the energy sector issues can be addressed effectively. Keeping track of performance and enforcement of standards needs to be decentralized. Ensuring the energy sector is transparent and accountable to local communities and government for the environmental impact of its activities in the province is critical.

To the extent that pollution from the sector compromises the livability of the province, this is likely to pose a risk to the province in achieving the goals of the EEC project and wider Thailand 4.0 strategy. Without a significantly improved living and working environment the region will fail to attract and retain the human capital necessary for a move to high-tech higher-value added production. That broader economic and industrial strategy affords the opportunity for Thailand to develop synergies between the energy sector and high-tech industry, which Rayong province should seek to exploit.

6 TRANSPORT

6.1 Introduction

The purpose of this chapter is to outline measures for inclusion in the next iteration of the Rayong Provincial Development Plan (RPDP) for improving sustainability within Rayong's transport sector. To that end, the chapter builds on the SEA transport baseline assessment and analysis of the influence of the RPDP on sustainability in transport in Rayong. The focus areas for sustainable transport development are three key issues of concern for the transport sector identified by SEA stakeholders during the scoping phase: i) expansion of transport infrastructure; ii) increasing transport-related resource use; and, iii) increasing transport-related pollution.

As a brief introduction to the three key transport issues of concern, drawn from the SEA transport baseline assessment and sustainability analysis, is provided in this introduction.

Expansion of transport infrastructure – Since the national Thai government began its program of industrialisation on the Eastern Seaboard in the 1980s, provision of transportation infrastructure has been a critical component of Rayong's development. This steady expansion of the transport facilities has included upgrading existing and building new road networks, developing energy, industry and freight transportation infrastructure, notably shipping and access roads linked to the Map Ta Phut port complex and industrial estates.

Rayong has significant commitments in place to continue expanding its transportation infrastructure, as part of the EEC regional development. Plans includes the construction of a high speed rail (HSR) link to Bangkok, expansion of U-Tapao airport and port facilities at Map Ta Phut and further expansion of the road network through the completion of the Pattaya-Map Ta Phut motorway link and upgrade of the highway between Rayong and Chonburi. In addition, the RPDP includes substantial road upgrading and extension projects for provincial roads, many of which support the EEC development and link local roads to the new motorways.

Trends in growth of transportation infrastructure are linked to urban development, with urban sprawl following the main transport corridors, to tourism by facilitating easier access to Rayong along highways, to agriculture providing better access to markets, and through conversion of agricultural land into roads, and to industry for bringing raw materials in and products to market. Unless carefully planned and managed, the expanding assets in the sector have potential to change run-off patterns and exacerbate flooding. Also, inevitably the development will lead to increased vehicle stock, use and emissions. .

The expansion of transport infrastructure, particularly the widening and upgrading of minor roads in some parts of the province also has implications for forest connectivity and biodiversity. This is particularly important in the area between Khao Chamao Khao-Wong National Park, and Khao Ang Rue Nai Wildlife Sanctuary in the northern part of Khao Wong District. Road 4060 is critical in this regard

Increasing transport-related resource use – The transport sector is a significant and growing consumer of energy in the province. Rayong has seen increased transportation energy demand as populations have grown, incomes have risen and infrastructure improved. Expansion of the tourism sector in the province has added to increased transport demand. Growth in goods transported in bulk by truck, train, ship and aircraft has been closely linked to industrial expansion. Personal transportation has seen a modal shift from motorcycles to cars and light-trucks. Transportation investments in the RPDP will facilitate greater use of personal transport. These changes have added to energy use in the sector. Those trends will continue and likely accelerate with overall development of the EEC.

Increasing transport-related pollution. Pollution from the transport sector is an important contributor to reduction in air and water quality and increased land contamination in the province. Transport sector pollution stems from combustion, dust from tyre wear and brake-disks, and oil from accidental leakages and engine servicing. Pollution from shipping is a growing concern, including significant emissions to air from the use of fuel oil, cleaning of tanks and bilges, and accidental spills. As with energy use in the sector, pollution has grown in line with greater transportation volumes driven by growth in population, economic activity and incomes.

This trend will continue in response to increased transportation demand in the province. New national emissions regulations should curb engine emissions from motor vehicles if enforced. The development of the HSR may shift some traffic to rail, and lead to a reduction in emissions due to long distance traffic than would otherwise have been the case, but those innovations will have limited impact on the air pollution loadings in urban areas. Increasing emissions to air and water will further degrade environmental quality, impact on people's health and well-being, and will have a negative effects on the riverine, coastal and marine environment.

6.2 Gaps in the existing Rayong Provincial Development Plan

Around two thirds of expenditure in the RPDP is on transportation projects. Leaving aside the Map Ta Phut by-pass project which accounts for around a third of the Plan's budget, the main expenditure proposed in the RPDP is still for transportation infrastructure. Without the Map Ta Phut bypass, 37% of remaining investment funds allocated to transport is for EEC related projects, 33% for road renovation, 29% for road upgrading and 1% for traffic management. There are other transport projects mentioned in the RPDP for which funding is not allocated, such as construction of two stations linked to the HSR project.

The RPDP includes some measures to improve the efficiency of the transportation network, for example, the Map Ta Phut By-pass and traffic management measures. However, when considered from the perspective of stated RPDP goals to enhance environmental outcomes and promote technological upgrading, the RPDP has a number of areas relating to transport that it should address more effectively:

- Reducing transportation demand and facilitating modal switching to more environmentally benign transport modes;
- Diffusing environmental technologies throughout the transport sector; and,
- Improving enforcement of transport related environmental standards.

Those three areas constitute a significant opportunity for the next iteration of the RPDP to address transport related sustainability. An efficient, environmentally sustainable transportation system in the province will be critical to enabling the development of high value-added industries, the continued development of the tourism sector and the promotion of liveable urban environments in the province.

6.3 SD objectives and indicators

National planning policies in Thailand's 12th NESDP[24] targeting improved environmental outcomes, increased energy efficiency and liveability in urban areas are directly relevant to transport development in Rayong, in particular:

- Increasing the proportion of freight moved by rail and waterways;

[24] NESDB, 2016, The Twelfth National Economic and Social Development Plan (2017-2021), Office of the Prime Minister, Bangkok, Thailand.

- Increased public transportation use;
- Improving environmental quality, reducing pollution and minimizing impacts on public health; and,
- Developing and strengthening existing competitive industries towards more high-technology based industries including in the manufacture of electric vehicles and vehicle parts and benign automotive technologies.

Thailand has also made a national commitment to reduce transport emissions by 22% relative to a BAU scenario by 2030.[25] As with other sectors considered in the SEA, the Thailand 4.0 strategy supports these national sustainability related objectives. Shifting to electric vehicles, autonomous vehicles and shared mobility services are likely to result in very significant changes in the road transport sector and its environmental performance. This change is reflected in Thailand's ambitious plans to have 1.2 million passenger electric vehicles by 2036.[26] Widespread use of autonomous vehicles could either increase or cut harmful emissions and greenhouse gases depending on enforcement of accompanying regulations for fuel efficiency and emission reduction technologies.

SEA stakeholders identified sustainability objectives and indicators linked to the strategic issues of concern in the transport sector (Table 6-1). The objectives provide a vision stakeholders would like to see adopted in the sector to improve sustainability performance. The indicators are to be part of the RPDP monitoring framework to keep track of implementation to pursuit of the objectives.

Table 6-1: Strategic issues, sustainability objectives and indicators for the transport sector

Strategic issue	Sustainability objective	Indicators
Expansion of transport infrastructure	• Promote an equitable and safe transportation system, offering a choice of transport modes, and a geographical balance of development.	• Share of transport demand served by public transport • Proportion of province population served by public transport • Proportion of freight moved by rail
Increasing air pollution due to increased transportation & **Increasing transport-related resource use**	• Reduce transportation related emissions and resource use	• GHG emissions from transport • PM 2.5 emissions from transport

6.4 Action plan for the sector/theme

There are a number of significant actions that could be undertaken to better address the transport related sustainability issues identified during the SEA. Table 6-2 provides details of measures for adoption in the next RPDP. Those interventions are restricted to actions that are within the remit of the RPDP and Rayong provincial authorities. Many of the interventions outlined in Table 6-2 need to be closely linked to effective, transit-based spatial planning and land use.

[25] Office of Transport and Traffic Planning and Policy, 2018, Nationally Determined Contribution in Transport Sector (presentation). Retrieved from https://www.transportandclimatechange.org/wp-content/uploads/2018/03/OTP_TCC_ThailandNDCWorkshop_NDCITS_Mankhong_FEB2018.pdf
[26] Frost & Sullivan, 2018, The Future of Electric Vehicles in South East Asia: Thailand.

Table 6.3 includes those actions needed to address the strategic issues of concern that are likely to fall outside the mandate of the RPDP and Rayong provincial authorities. They will require concerted action and commitment from national government and line agencies working with provincial authorities.

Table 6-2: Actions for inclusion in next RPDP

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
Expansion of transport infrastructure	**6.1: Prepare and implement a plan to expand options for non-motorised (non-internal combusting motor driven) transport in Rayong** Rayong authorities should develop plans to expand alternative transport options (transport options that do not use internal combustion engines) in Rayong. The plan should cover: i) Improvement and expansion of sidewalk/footpath networks; ii) Increasing numbers of pedestrian crossings and pedestrian signals at traffic lights; iii) Planning for footbridges and cycle bridges over busy roads; iv) Spatial and road planning should be conducted to prioritise non-vehicular traffic (pedestrians and cyclists); v) Developing a network of charging stations for electric motorbikes and electric cars; vi) Developing and expanding the network of cycle paths and walkways in Rayong, including in urban areas	Town and Country Planning; Department of Highways;	Next 3 – 5 years
Increasing transport-related resource use	**6.2: Design and implement a program to incentivise alternative transport options and modes** Rayong residents should be encouraged not to use private motor-vehicles. Methods to encourage alternative transport modes should include: i) A plan for a comprehensive public transport network (bus and rail) within 10 years, that is accessible to 90% of Rayong's residents (i.e. 90% of Rayong's residents live within 1km of a bus stop of railway station) and defines: a. options including Bus Rapid Transit (BRT), privatised public transport, government owned and operated public transport; b. measures for low emissions public transport (e.g. electric buses) ii) Implement pay for parking and no car zones in urban centres; iii) Increases registration fees for internal combustion engine vehicles; iv) Provide incentives for people to use alternative transport options (e.g. free bicycle servicing, encourage employers to put showers in the workplace for those who ride to work, free re-charges for electric vehicles, priority parking for electric vehicles; 5 years free registration for electric vehicles; subsidised public transport prices) v) Campaign to promote and incentivise cycling, walking and public transport: a. Public health information materials and advertising; b. Subsidising purchase of bicycles (and battery assisted bicycles);	Rayong Governor's Office;	Next 3 – 5 years

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
	c. Cycling competitions; d. Designating a "ride to work" day each month, with employers rewarded for increase in the number of employees who ride or catch public transport to work.		
Increasing transport-related pollution	**6.3: Monitor and enforce pollution emissions from shipping** To address pollution related impacts from shipping, the following measures should be introduced: i) Ambient air quality monitoring systems should be established inside port areas; ii) Regular (random) monitoring of point source air emissions from ships, to confirm they comply with the most recent revision of the MARPOL Annex VI guidelines; iii) Impose fines for ships that do not comply iv) Impose fines for ships caught flushing their bilges within 5km of Rayong's coastline v) Regular monitoring of ambient water quality in the vicinity of Map Ta Phut and IDRC ports; **Note:** *While recycling and waste management is important for addressing transport related pollution (i.e. used tires, used engine oil and other lubricants and detergents), these are considered in the urban development and industry chapters within the framework of waste management.*	Department of Transport; Map Ta Phut Port Authority; IDRC Port Authority; PCD	Next 5 years

Table 6-3: Other actions needed to address the strategic issues

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
Expansion of transport infrastructure Increasing transport-related resource use Increasing transport-related pollution	**6.4: Introduce fiscal mechanisms to support the transition from fossil fuel powered to electric powered vehicles** Review of vehicle and fuel taxation legislation with a view to better aligning policy to meet environmental goals. The review is particularly important and urgent as large structural and technological changes are likely to disrupt the personal transport sector over the next decade. The revision should encompass all forms of transport and related taxation: i) Fuel taxes (e.g. increasing taxes to make electric vehicles more desirable); ii) Mechanisms to replace petrol and diesel taxes in order to pay for transport infrastructure (e.g. tolls on roads, excise added to electricity sold through vehicle charging stations); iii) Prepare a plan defining when and how to phase in new transport funding mechanisms	NESDB, MoE, MoT, MoF, Office of the PM, Ministry of Justice	5 years
	6.5: Introduce regulations to support the transition from fossil fuel powered to electric powered vehicles In addition to financial incentives and dealing with changes to transport services funding streams, there are other areas where regulations are needed to ensure a smooth transition from fossil fuel based transport to electric vehicles. For example: i) Support to small and medium vehicle services enterprises (e.g. mechanics and petrol stations) to transition from fossil fuel based services to services for electric vehicles; ii) Management of used batteries from electric vehicles (i.e. how they can be disposed of, incentives for using them as low intensity power storage facilities); iii) Establishment of electric vehicle charging stations (e.g. requiring municipal parking areas to provide a number of chargers proportional to parking spaces, tax incentives for shopping centres to install charging units in their parking areas)	NESDB, MoE, MoT, MoF, Office of the PM, Ministry of Justice	5 years

6.5 Effect of measures on trends in strategic issues of other themes/sectors

The transport sector is closely related to a number of other themes considered in the SEA, including urban development, industry, tourism and energy. There are especially important urban spatial planning measures that are needed to promote sustainable transportation. These are explored in the urban development chapter of this volume. Measures which have cross sector implications include for example:

(i) Increasing the proportion of footpaths and cycle-ways in Rayong's urban areas will change the way cities develop and change the ways that people transit.
(ii) Improved public transport facilities and spaces in conjunction with higher taxes on private motor-vehicles will alter the number of vehicles being used to commute;
(iii) Closing certain roads or part of municipal areas permanently or regularly will changes the numbers of commuting vehicles and reduce the energy demand from the transport sector;
(iv) Encouraging a shift to EVs will change the rate at which energy demand shifts from fossil fuel energy to electrical energy

6.6 Conclusion

The environmental issues posed by the growth of transportation sector linked to rapid infrastructure expansion, and increased resource use and pollution need to be addressed particularly in urban areas. These challenges will become more acute as population and economic activity in the province continue to grow. The RPDP does little to address these issues, with an almost exclusive focus on the development of road infrastructure. More effort needs to be placed on the supply-side of the sector, encouraging better integrated planning, promoting a shift to public transport, and non-motorized transport where possible, promoting walkable cities and cycle lanes and promoting the adoption of EVs. Efforts also need to be made in monitoring pollution and enforcing pollution controls for all fossil fuel driven vehicles, particularly for shipping.

7 URBAN DEVELOPMENT

7.1 Introduction

This chapter seeks to promote sustainable urban design and management in Rayong's rapidly growing urban areas. The aim is to create a living environment which enhances the quality of life of residents and their sense of well-being, it brings nature back to reduce the effects of climate change and heat, conserves water and energy and greatly expands green space for public health and amenity. Sustainable design also leads to economic savings and efficiencies and supports effective pollution control and waste management. It seeks a better balance between private vehicles, public transport and pedestrian ways and cycling in what is termed transit oriented development.

The main purpose of the chapter is to set out measures to be integrated into the next iteration of the Rayong Provincial Development Plan, and into other plans which are shaping development within the province.

SEA stakeholders identified three strategic issues of concern to development in Rayong Province for the urban theme. They are (i) urban expansion, (ii) municipal solid waste, and (iii) municipal wastewater. Those issues of concern, their past trends and drivers, were explored in the baseline assessment. They were then assessed against two development scenarios – the BAU and full RPDP implementation.

(i) **Urban expansion** - Lack of effective planning controls coupled with expansionary pressure from increased population and economic activity have led to unchecked urban sprawl, driven by expansion of residential, commercial and industrial development. This type of urbanisation is characterized by mixed use, low density and ribbon development or longitudinal settlement along transportation routes and rapid losses in green space. It makes the provision of urban infrastructure and services more difficult and expensive. In Rayong, expansion along roads has added to congestion and accidents, mixed residential and industrial use has led to serious pollution and public health issues, and more generally, low density development has included inefficient and haphazard use of land resources. There are important quality of life and heritage benefits from some forms of controlled and well managed mixed use – for example integrating commercial servicing enterprise with residential areas can provide for entertainment and recreation, such as restaurants, supermarkets and shopping centres (Figure 7-1). Currently, in Rayong, the costs of mixed uses are outweighing the benefits due to poor planning and development controls.

Figure 7-1: The right mix matters in urban planning

Source: Institute for Transportation and Development (ITDP), 2019[27]

In future under BAU and the RPDP, the urban area will continue to be driven by rapid expansion of the urban population, and of commercial and industrial activities. The area of urban land is expected to expand in a relatively uncoordinated manner in line with past trends. There are no measures within the current RPDP which would offset or address the established trends for this issue.

Inter-sectoral links: Trends in urban expansion are linked to agriculture through issues related to the conversion of agricultural land and rural to urban migration, to tourism development as an important driver of urban expansion in some areas, and to industrial development as a key driver in urban population growth and environmental quality. Uncontrolled urban expansion leads to reduced services and quality of life. It is likely to increase the heat island effect and the capacity to adapt to climate changes.

(ii) **Municipal solid waste** – the trend of growth in municipal solid waste generation reflects changes in consumption patterns leading to greater per capita solid waste, and increasing population in Rayong with consequent increases in total volume of waste generated. Municipal disposal facilities have a capacity of around 1,000 tons/day and waste-to-energy projects in the province around 100 tons/day. Waste generation is already exceeding this capacity. Measures to reduce the amount of waste, recycling and source separation of solid waste have yet to make much headway. Future projections of current trends envisage significant increases in waste generation

[27] https://www.itdp.org/our-work/sustainable-urban-development/

with continuing inadequate treatment facilities. The increasing volume of hazardous waste as a proportion of the total load is a special concern. While some solid waste management projects are included in the RPDP they will not have a significant impact on solid waste generation or disposal.

Inter-sectoral links: Future trends in municipal solid waste management under the BAU and RPDP scenarios will exacerbate environmental quality, cause localized flooding and water contamination, and place added stress on already over stretched health facilities and services. Expanding industries and associated in-migrants seeking work will tend to increase MSW. Also, continued tourism growth will be an important contributory driver to solid waste generation.

(iii) **Municipal wastewater** – municipal wastewater generation is estimated to be around 90,000 m^3 per day for the province. Wastewater generation has grown as a consequence of increasing population and increased household water use enabled by better water supply and higher incomes. Currently, only a small portion of municipal wastewater is treated, with installed capacity unused. If fully utilized the current treatment capacity would not be sufficient to cope with all wastewater generated in the province. The trend of increased wastewater generation will continue with population growth. Under the BAU scenario, full use of rehabilitated plants would not even accommodate anticipated increases in volume. The RPDP will not have any significant impact on wastewater generation or treatment.

Inter-sectoral links: Municipal wastewater management issues are linked to projected growth in tourism as an important source of wastewater as are commercial activities such as restaurants and hotels. Untreated wastewater discharges are a growing concern for public health, fisheries and aquatic and marine ecosystems, as well as posing challenges for tourism, industry and agriculture sectors as water users.

7.2 Gaps in the existing Rayong Provincial Development Plan

Overall the RPDP provides limited guidance and minimal investment addressing the three issues of concern to SEA stakeholders relating to urban development.

The RPDP contains a number of objectives relating to the preservation of natural environments and green space in urban areas. That strategic framework includes references to municipal solid waste and municipal wastewater management as well as pollution reduction more generally, which tie closely to the plan's environmental and public health improvement objectives.

Despite those goals, waste and wastewater management projects are limited to 1.5% of the RPDP budget, out of a total of 9% of the budget allocated for urban development related projects. There are three solid waste management projects, totaling THB 137.8 million (0.76% of RPDP budget), as well as one water management project (including wastewater management) on Koh Samet with a proposed investment of THB 130 million (0.71% of the RPDP budget).

Analysing the RPDP from the perspective of the urban development strategic issues of concern highlights a number of critical sustainability related gaps:

- Urban expansion: there are no actions to address the issue of urban sprawl and ad hoc patterns of land use. In particular, the RPDP does not include measures to improve land use planning, or to improve the implementation of development controls;
- Municipal solid waste: the RPDP has insignificant investment in solid waste management. There are no provincial level programs to reduce waste, no programs to promote source separation of waste and no investments to address the serious capacity short-falls at provincial waste management and transfer sites;
- Municipal wastewater: The RPDP does not include measures to address municipal wastewater management or treatment. Also, there are no measures to address the lack of septic tanks at

older properties of for improving monitoring of septic tanks, especially at larger commercial establishments.

While the RPDP does make some attempt to address the critical issue of managing urban waste streams, investment projects fall short of the stated planning objectives, particularly for wastewater. The lack of clear measures in the RPDP to address land use planning and urban expansion issues is a critical failing. If Rayong is to improve, or even maintain its current levels of liveability, the three strategic issues of critical concern for urban development in Rayong will need to be comprehensively addressed. Lacking a coherent plan, appropriate institutional and policy framework and investment portfolio to ensure that Rayong has an attractive and healthy urban environment will undermine the achievement of the broader RPDP goals and objectives. More broadly, it will fail to support implementation of regional (EEC) and national (Thailand 4.0) strategies and plans.

7.3 SD objectives and indicators

National planning objectives in Thailand include promotion of ecologically sustainable urban development as a core strategy. For example, the 12th NESDP (2017-2012) includes the following focus areas for regional and urban development:[28]

- Developing provincial city centres into "liveable cities for all";
- Developing and reviving key economic areas in ecological ways, including improving community living standards; and,
- Developing new economic areas in ways that will enhance competitiveness and maintain sustainability.

More broadly, the Thailand 4.0 puts sustainable urban development at the heart of the national development strategy, as part of a value-based economy that focuses on innovative industries and services. The strategy emphasises the critical importance of "greening" cities, and the role this will play in developing and ensuring future competitiveness.[29]

During the scoping phase, SEA stakeholders supported the definition of sustainability objectives and linked indictors as a first step in addressing the strategic issues of concern and then to guide the priority setting and monitoring of specific measures. Those are set out in Table 7-1. They form part of the monitoring framework for the sustainability measures set out in this volume.

Table 7-1: Strategic issues, sustainability objectives and indicators for the urban sector

Strategic issue	Sustainability objective	Indicators
6. Urban expansion	Urban areas are planned for energy and water conservation, transit-oriented design and equity, emphasizing green space and infrastructure and nature-based approaches.	▪ Average travel times and road ratio ▪ Urban transport energy use ▪ Area of sidewalks, cycle lanes, pedestrian areas ▪ Area of designated green space in urban areas ▪ Density of urban areas

[28] NESDB, 2016, Twelfth National Economic and Social Development Plan (2017-2021), Office of the Prime Minister, Bangkok, Thailand. (see section 9)

[29] There is a growing literature linking the competitiveness of urban economies with urban livability. This is of particular importance as countries try and avoid the middle-income trap. 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

Strategic issue	Sustainability objective	Indicators
7. Municipal waste water management **8. Solid waste management**	Pollution and waste streams in urban areas are effectively managed, creating a pollution free environment.	▪ Share of municipal wastewater being treated to an acceptable standard ▪ Share of households/commercial establishments connected to municipal sewage system ▪ Share of solid waste being collected ▪ Share of solid waste reused or recycled ▪ Share of solid waste going to landfill

In a broader perspective, Thailand is seeking to implement SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable. That Goal includes the following targets for 2030:

- Ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums
- Provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons
- Strengthen efforts to protect and safeguard the world's cultural and natural heritage
- Reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
- Provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

The target for 2020 is passed but was not met for Rayong province:

- Adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels.

7.4 Measures for sustainable urban development in Rayong

Thailand is committed to applying the United Nations' Sustainable Development Goals in all aspects of national development. SD Goal 11 is to "Make cities inclusive, safe, resilient and sustainable." Key ingredients in support of that goal are set out in Figure 7-2. SDG 11 emphasises the importance of achieving each of those components through inclusive planning and development processes. This section seeks to define measures to improve living conditions, efficiency and equity in Rayong's urban areas.

Figure 7-2: Components of sustainable urban development

Source: City of Yarra 2019[30]

Priority measures cover those for inclusion in the RPDP, as well as actions in higher level plans and by national and regional bodies where needed to support and drive progress towards sustainability in Rayong Province. Table 7-2 provides details of measures for integration into the next iteration of the

[30] City of Yarra, 2019, Ten sustainable urban design principles, https://www.yarracity.vic.gov.au/services/planning-and-development/planning-applications/environmentally-sustainable-design-in-planning/the-10-key-sustainable-building-categories

RPDP (2021-2025). Actions build on current approaches to land use planning and municipal waste management in the province, and include some pilot activities.

While there is a need for concrete investments in solid and liquid waste management in particular, a key success factor will be the development of an integrated, province-wide strategy, which includes institutional development, policy and procedural components as well as infrastructure investment. The installation of new waste management facilities, for example, will not address the underlying causes, and would at best be a stop-gap solution. The interventions included in Table 7-2 emphasise those actions that fall within the remit and influence of the RPDP and of the Rayong provincial authorities. That includes projects which may be funded through national line agencies but which are critical to achieving sustainability in Rayong. Also, it is important that the plan set out the framework of sustainability policies and approaches to which all sectors and agencies with development activity in Rayong must adhere.

Table 7-2: Actions for inclusion in next RPDP (2021-2025)

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
Urban expansion	**7.1 Institutional review and revision of urban planning procedures and development controls and enforcement**	Town and Country Planning Department Rayong, Department of Public Works and Town & Country Planning, Ministry of Interior and NESDC.	Next 2 years
	(iv) Review and revision of policy, procedures guidelines, and institutional arrangements for urban planning, development controls and zoning scheme in Rayong province as the basis for improved zoning safeguards, development controls and enforcement. (v) Conduct a capacity needs assessment to determine what additional skills and staffing may be needed at provincial level for effective urban spatial planning, development controls and enforcement. (vi) Conduct a program of training for Rayong and regional staff in urban spatial planning and development control		
	7.2 A project to prepare an urban environment plan and zoning scheme with safeguards for Rayong province, with a focus on Map Ta Phut and Rayong city municipalities	Rayong Town and Country Planning Department and Rayong Environment Offcie.	Next 2 years
	(vii) Prepare a municipal environment plan, building on but not restricted by current comprehensive spatial plans, (viii) Focus on integration of transportation, the reduction of flooding, controlling pollution issues, provision of green space and corridors, and the application of TOD principles (Figures 1 and 2), creating public transportation corridors, pedestrian and cycling networks and the development of high-density areas for residential and commercial purposes. (ix) The environment plan would identify areas for potential land readjustment (land pooling) initiatives (see table note below). (x) This activity implemented in conjunction with activity 8.10.		
	7.3 Assessment of sites and design of land adjustment pilots	Town and Country Planning Department Rayong.	Next 3years.
	(iii) Identify three predominantly residential locations in the city to redevelop using land pooling/land readjustment, applying methodologies practiced elsewhere in Thailand. (iv) The site redevelopment design should be guided by sustainability and green urban development principles to provide a pilot best practice demonstration for developers in the province.		
	7.4 A project to implement the municipal environment plan and three land pooling/adjustment pilots	Town and Country Planning Department Rayong.	Next 10 years
	(vii) With budget and technical support from MONRE and the Department of Public Works and Town & Country Planning, Ministry of Interior, implement the plan over three years accompanied by parallel independent monitoring and evaluation of effectiveness		

	(viii) Three land pooling pilots would consolidate a selected group of land parcels and then design, service and subdivide them into a layout of streets, green spaces, landscaping, natural drainage corridors, and serviced building plots following green design principles, with the sale of some of the plots for cost recovery	Regional and Rayong Environment Offices	
Municipal solid waste management	**7.5 Development of a solid waste management plan for the province** Development of a detailed integrated investment plan for solid- waste management in the province. Including plans for: (i) Public education focussing on the three Rs; (ii) Source separation of waste (paying attention to the activities of informal waste collectors in the province); (iii) Waste collection arrangements and collection fees; (iv) Siting and management of collection centres; (v) Assessment of land fill capacity needed and identification of additional sites and management arrangements; (vi) Potential for recycling (particularly using municipal waste as a feed-stock for industrial processes in the province), and (vii) Application of waste-to-energy technologies (paying attention to lessons learned from the previous experience in the province). (viii) This project to be implemented with support from action 8.12	Rayong Department of Public Works	Next 3 years
	7.6 Project to implement the Rayong municipal solid waste management plan Implement the Rayong municipal solid waste management plan emphasising: (i) *Waste reduction* - An outreach program and supporting regulations to promote and require waste reduction (ii) *Reuse and recycling* - Two recycling centres established as private-public partnerships and linked to industry use – including a research and demonstration function. (iii) A *municipal waste to energy* plant established as a complementary technology for the recovery of energy from remaining non-recyclable MSW fractions. It should not compete with waste reduction, reuse and material recycling measures. Appropriate tariffs to be introduced to cover investments and staff training program (iv) *Two land fill sites* identified and managed to international standards as pilots for demonstration and training – as a transitional measure to effective implementation of the 3Rs (v) Implemented in conjunction with action 8.12	Rayong Department of Public Works	Next 10 years

Municipal wastewater management	**7.7 Development of a wastewater management and investment plan for the province** Development of detailed wastewater investment and management plan for the province including (i) Assessment of wastewater treatment needs out to 2040; (ii) Assessment of water treatment capacity needs, need for plant upgrading/refurbishment, potential siting of new plants; (iii) Plans for expansion of sewer network and residential connection; (iv) Clear determination of institutional responsibilities for O&M of the system (prior to installation), (v) A financial management plan, particularly focusing on operation and maintenance; (vi) Plan for public engagement on the need for reduction of water use, residential sewer connections and proper management of waste from septic tanks.	▪ Rayong Department of Public Works ▪ East Water ▪ Wastewater Management Authority, MONRE	Next 5 years
	7.8 Wastewater investment and management plan implementation project A project to implement the emphasising: (i) Existing wastewater treatment plant upgrading and refurbishment funded under the Environment Fund (ii) Pilot introduction of a tariff system to require payment for wastewater services to cover operations and maintenance based on strict application of the polluter pays principle. (iii) A pilot and demonstration requirement for DIR and East Water to combine collection and billing of charges for water supply and the wastewater services in Rayong province (iv) Expansion of the sewer network and residential connections by 15% (v) An awareness raising program and pricing system aimed to reduce water use (vi) A program of training for staff of the wastewater treatment plants in plant management and relevant technical staff in wider wastewater management and enforcement	Rayong Department of Public Works, RID and East Water.	Next 5 years

Note to Action 8.2: Land pooling/readjustment (LP/R) is a technique for managing the planned development of urban-fringe lands, whereby a government agency consolidates a selected group of land parcels and then designs, services and subdivides them into a layout of streets, open spaces and serviced building plots, with the sale of some of the plots for cost recovery and the distribution of the remaining plots back to the landowners to develop or to sell for development[31]

[31] Archer, R.W. 1992. Introducing the urban land pooling/readjustment technique into Thailand to improve urban development and land supply. Public Administration and Development. Volume 12, Issue 2.155-174.

Table 7-3 details the actions needed to address those strategic issues that are likely to be outside the capacity of the Rayong provincial authorities to address in a financial and technical sense. For that reason, they are less likely to be picked up in the RPDP. The Thai authorities have a well-established limited expectation of the role and content of provincial development plans. The assumption has been that they would mainly cover parochial matters and some specific local concerns. That constraining assumption is changing – as continued challenges with environmental management and pollution control require local responses. There is a fundamental role for the PDPs to set the framework for ecological sustainable development within their provincial boundaries.

Yet, in a transitional period funds, technical capacities and authority will come from the centre. Table 7-3 identified actions required at central level to support activities proposed for inclusion in the RPDP. These are concerned with larger budget projects, with projects that have regional or national significance as well as with issues related to national or regional legislation, policy or planning.

Table 7-3: Other actions needed to address the strategic issues

Strategic issue of concern	Level	Action and description	Responsible Agency	Time horizon
Urban expansion	National government NESDC	**7.9 Review and demonstrate implementation of SDG 11 with special reference to urban spatial planning and development controls** The Provincial Comprehensive Spatial Plan for Rayong and the City Plan are being revised to integrate the EEC spatial planning framework. This is a transitional stage with the plans to be finalised during 2020. Urban sprawl is Rayong has led to pollution, consumption of resources and energy and various types of dumping grounds (i) Review progress in SDG11 implementation in Rayong as a case study (ii) Pilot application of SDG11 in Rayong to create sustainable green urban areas (iii) Define principles and standards for application of SDG11 – eg ○ increase urban forest canopy cover to 40 per cent by 2040. Increasing forest diversity with no more than 5% of one tree species, no more than 10% of one genus and no more than 20 per cent of any one family.[32]	▪ Department of Public Works and Town & Country Planning, Ministry of Interior ▪ Ministry of Social Development and Human Security ▪ NESDC	Next 2 years – review and standards Next 5 years - implementation

[32] See, for example, the Urban Forest Strategy for Melbourne, Australia - https://www.melbourne.vic.gov.au/community/greening-the-city/urban-forest/Pages/urban-forest-strategy.aspx

Strategic issue of concern	Level	Action and description	Responsible Agency	Time horizon
		○ Rehabilitate natural drainage corridors in urban areas setting vegetated buffer zone standards (the current buffer standards and inadequate). Mimic natural drainage corridors and wetlands linked to canals ○ Increasing urban green space in Rayong to 20m^2/capita – Bangkok is 3.3m^2/capita, Singapore is 66m^2/capita - The World Health Organization recommends the availability of a minimum of 9 m^2 of green space per individual with an ideal UGS value of 50 m^2 per capita.[33] (iv) Monitor and report on progress and lessons to guide national replication		
		7.10 Complete the land and building tax act with innovations for sustainable urban development (i) The Government is restructuring land tax by replacing the Building and Land Tax Act 1932 and Local Maintenance Tax Act 1965 with the draft Land and Building Tax Act in order to empower local governments to collect taxes to have sufficient resource to run local projects. The draft Act aims to stimulate efficient land use, encourage land tenure distribution, and reduce disparity in land ownership. (ii) This project would aim to supplement that reform with proposals to introduce smart land taxation measures to incentivise more sustainable urban development and address land speculation issues (for example, a graduated land value tax, more effective regulation on development gain, including through mechanisms such as a capital gains tax).	▪ Ministry of Interior ▪ Ministry of Social Development and Human Security ▪ Ministry of Finance ▪ NESDC	Next 2 years
	Nati ona l	**7.11 Review and test collaborative arrangements for preparing regional and provincial environmental plans**	▪ MONRE	Next 2 years

[33] World Health Organization. Health Indicators of Sustainable Cities in the Context of the Rio+20 UN Conference on Sustainable Development. WHO; Geneva, Switzerland: 2012.

Strategic issue of concern	Level	Action and description	Responsible Agency	Time horizon
		(i) Review reasons for lack of uptake of EEC region environment plan by the RPDP and local authorities (ii) Prepare an environmental management plan for Rayong province with involvement of relevant MONRE Departments, the Regional Environmental Office and the Rayong Provincial Environmental Office (iii) Define approaches and arrangements for integration of the environment plan with the provincial and town comprehensive spatial plans and special area plans (iv) Set out zone environmental safeguards and development controls, especially for the provincial and municipal comprehensive spatial plans (v) Integrate the environmental plan into the RPDP (vi) Oversee and support implementation of the Rayong Environmental Plan	▪ DPW ▪ Regional Environment Office ▪ NESDC	
	Regional agencies	**7.12 Set up inter-provincial collaborative body for ecological sustainable development** (i) Establish an independent collaborative body led and run by the three EEC provinces bringing them together for collective action and decision making on shared development challenges and transboundary issues (ii) The budget for this pilot interprovincial body to come direct from NESDC (iii) Priority actions to be undertaken by the Easter Corridor interprovincial body include: ○ Preparing and implementing river basin management plans for the Khlong Yai and Prasae rivers in collaboration with the two River Basin Committees and Office of National Water Resources ○ Establishing collaborative arrangements for solid waste management ○ Establishing common approaches to pollution monitoring, sharing of information and reporting with the MONRE REO. ○ Establishing common approaches and standards for ecological sustainable development of new towns and urban areas ○ Collective arrangements for working with the EEC	▪ NESDC ▪ Chonburi, Rayong, and Chachoengsao Provinces ▪ EEC	Next 3 years
Municipal	National	**7.13 Implement a Rayong Province municipal solid waste management plan as a national pilot and demonstration**	▪ MONRE	Next 2 – 5 years

Strategic issue of concern	Level	Action and description	Responsible Agency	Time horizon
		Late in 2018, new national plans and a policy framework was put in place to solve the MSW problem by using the framework of regional waste management, which gives the leading role to the provincial governor and provincial administrative organization(PAO) of the local governments. Capacities need to be strengthened to implement this strategy. This project aims to build that capacity in Rayong and to pilot implementation of the decentralisation strategy to be implemented in support of actions 8.4 and 8.5. (i) Introduce regulations, standards and economic incentives to *reduce* solid waste generation including: ▪ Eliminate use of plastic bags ▪ Require reusable containers ▪ Provide incentives for composting ▪ Establish reuse markets in collaboration with industry ▪ Provide economic incentives for enterprise and community effort to repair rather than discard ▪ Eliminate all single use disposable packaging and containers ▪ Provide incentives for manufacture and consumption of recycled products (ii) Expand application of technologies to reuse and recycle MSWs (iii) Provide upfront budget and a strategy for ongoing financing of a hazardous waste incinerator in Rayong. (iv) Eliminate open dumping sites and replace improper treatments by sanitary landfills and incineration (as required under the National Master Plan for Waste Management 2016-2021) (v) Rehabilitate key open dumping sites as a transitional measures (vi) Ensure the plan has adequate technical and financial supports for the provincial government and training of staff for operations and management.	▪ Department of Public Works ▪ ONEP	
Municipal wastewater	National line agencies	**7.14 Review of building and planning regulations for commercial and residential properties with regards to wastewater** (i) Review wastewater treatment requirements for residences and commercial establishments in Rayong.	▪ Department of Public Works ▪ MONRE ▪ Rayong Town and Country	Next 2 years

Strategic issue of concern	Level	Action and description	Responsible Agency	Time horizon
		(ii) Close loop-holes for avoiding treatment obligations (e.g. there is a current loopholes that allows large hotels with multiple receptions to avoid their wastewater treatment obligations). (iii) For domestic wastewater, introduce retrospective regulation that require all households to have adequate wastewater treatment. (iv) In new urban areas, require all commercial and residential premises to be connected to a municipal sewage network or to a dedicated treatment plant.	Planning Department	
		7.15 Rehabilitate Rayong's wastewater treatment plants and pilot a system of treatment fees (i) Upgrade the Mueang Sukhothai and Mueang Map Ta Phut facilities (ii) Pilot a system of wastewater treatment fees at Bt3 per cubic metre of wastewater as recommended by the WMA (iii) Provide training to local technical staff for management and collection of wastewater fees (iv) Provide training of relevant technical staff in plant management and operations (v) This action to be conducted with action 8.6	▪ Wastewater Management Authority, MONRE ▪ Department of Public Works ▪ ONEP	Next 5 years

7.5 Effect of measures on trends in strategic issues of other themes/sectors

7.5.1 Urban expansion

Measures to reduce urban sprawl and concentrate urban development would

- Reduce the conversion of agricultural land and reduce conflicts resulting from mixed land use (such as those resulting from residences close to polluting establishments).
- Result in higher density urban areas, allowing cheaper more effective public infrastructure provision, including water supply, sanitation, power and public transportation. Higher densities and urban renewal would need to be accompanied by equitable provision of green space and other public amenities.
- Curb ribbon development, which would support improved safety and effectiveness of transportation and facilitate efficient provision of public services.
- Help to reduce land speculation, which would further reduce land conversion trends, and incentivise investment in more productive assets. To support reduced land speculation, a policy and planning environment is needed that captures the value of public goods and services provided, and includes these in land values.

7.5.2 Municipal wastewater and solid waste

Measures to reduce solid waste and municipal wastewater would:

i) Have a positive impact on environmental quality and would
ii) Improve public health outcomes.

Improved solid waste disposal would

i) Reduce pollution in waterways including reducing persistent pollutants such as plastics
ii) Improve the environmental quality of inland waterways, lakes and reservoirs and coastal areas, which would also improve public health outcomes
iii) Reduce the risk of the blockage of drainage systems and associated pluvial flooding issues

Waste-to-energy plants would:

i) Reduce net GHG emissions
ii) Improve the resource efficiency of the provincial economy
iii) Assist with meeting local energy needs

7.6 Conclusion

The issues of unchecked urban expansion and the rapid increase in the generation of municipal waste streams is at a critical stage in Rayong province. This situation will become more acute as the province continues to develop. The economic boost that the EEC will provide significantly magnifies the need to deal with these issues using an integrated approach. In particular, the apparent lack of spatial development controls for private development and the failure to provide adequate wastewater treatment pose immediate and growing risks for the environment as well as for the provincial economy and the social well-being of the population.

If these issues are not addressed, Rayong is unlikely to benefit from the economic concentration of increasing urbanization; to be able to effectively play its role in the EEC development strategies; and to contribute significantly to realising the national Thailand 4.0 aspirations.

The current RPDP could much more effectively address these issues. There are measures which could be adopted at the provincial level that could start to address these difficulties. These would include a concerted effort to build a coordinated and integrated approach to spatial planning and the control of land use in the province, and to prioritise the management of municipal waste streams.

At the same time, these provincial measures could (and should) be supported by national land reform, in order to address issues that are already beginning to pose constraints to national development, as Thailand seeks to escape the middle-income trap.

8 TOURISM

8.1 Introduction

This chapter presents a sustainable development (SD) pathway for tourism development in Rayong province. The main purpose of the chapter is to highlight pathways so that tourism will have a positive influence on local communities, as well as protecting and sustaining the natural environment. This SD pathway ensures sustainability of Rayong's cultural and natural riches, while increasing future income from tourism to support local livelihoods.

This chapter proposes measures for inclusion in the next Rayong Provincial Development Plan (RPDP). Also, it includes measures that should be adopted at regional and national levels in order to support provincial tourism related sustainability. With regard to tourism, SEA stakeholders identified three strategic issues of concern to development in the province: (i) growth in tourism numbers and facilities, (ii) environmental impact of tourism facilities and (iii) marine and coastal debris and pollution, especially plastics and petroleum products that threaten tourism. The current status, trends and drivers of change as well as the impact of the current RPDP, which were considered in the baseline and impact assessment volumes, are summarized here.

Growth in tourism numbers, facilities and revenue has been steady over the past decade. The latest available figures show that in 2017 Rayong hosted 7.3 million visitors. Over the last decade, domestic tourists have constituted the bulk of visitors, accounting for around 92% of all visitors to the province.[34] Beaches and other natural areas are the main tourism destinations, and more recently, agricultural tourism (e.g. fruit orchards), as an alternative form of tourism, is being highly promoted and has increased in popularity, although remaining a small proportion of tourism activity.

Government-led campaigns and plans including the RPDP, are further stimulating tourism growth and increasing the number of new tourism sites. At the national level, promotional efforts have been focusing on high-end, medical and wellness tourism. In addition, eco-tourism is increasing in prominence, although there have been instances of "greenwashing", and more effort is required to manage standards in this sub-sector. Agricultural tourism, due to extensive promotion, including by the RPDP, is expected to increase further in the future.

Growth in tourism increases energy, transport and water demands. Alternative forms of tourism can aid in decreasing socio-economic inequalities and help distribute the benefits of tourism growth more equally. For example, tourism can positively affect the agricultural sector by economically supporting farming communities.

Negative environmental and social impacts of tourism are evident in Rayong, including increasing demands by tourists on available services and the direct impact of tourism on pollution, traffic congestion and on ecosystems, such as coral reefs. Solid waste generation is of particular concern, with tourism generating around 9% of Rayong's solid waste output. Wastewater in general is poorly managed, with only 2.5% currently treated. Generation of both solid waste and wastewater is expected to grow significantly with continued promotion of the tourism sector. Increased awareness of waste related issues, as well as national level planning, will help improve solid waste management, especially on Koh Samet. Even so, solid waste and wastewater generation will continue to increase, with the tourism sector continuing to be a significant contributor to this growth in the coming years.

The negative environmental impact of tourism will affect the coastal and marine environment which in turn affects fisheries through the associated degradation of natural habitats. Additionally, littering

[34] 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

and tourism activities in general affect terrestrial biodiversity negatively, but ecotourism projects supported by additional funds may have a positive influence.

Marine debris and pollution may result from activities related to industry, fisheries, and marine traffic, as well as coming from municipal waste. Litter in the ocean degrades coral ecosystems, which are of high value to the tourist sector. Pollution, including plastic litter as well as oil from spills and from ships flushing their bilges undermine beach quality which negatively affects Rayong's attractiveness as a tourism destination. For instance, the 2013 oil spill caused a significant reduction in tourists visiting the major beach area of Ao Prao on Koh Samet. Waste and pollution such as oil spills are expected to remain important issues in the future. However, industry, municipalities and other sectoral areas are aiming to reduce waste generation and improve waste management. Depending on the outcome of environmental management activities in these related sectors, Rayong's attractiveness as a tourism destination may be enhanced.

8.2 Gaps in the existing Rayong Provincial Development Plan

Solid waste management linked to tourism is clearly recognised as an issue in Rayong, and while supported in the RPDP, the only concrete action identified is for improving solid waste management capacity on Koh Samet. There is an additional noticeable gap when it comes to wastewater management, with no inclusion of tourism-related wastewater projects in the RPDP.

There is a lack of inclusion of ecotourism ideals and principles in the RPDP, although many of the projects are described as being, or supporting, ecotourism. For example a number of projects include environmental awareness-raising including educational activities, and there are a number of ecosystem restoration projects included in the plan. However, it remains unclear how effective new or existing ecotourism initiatives will be at minimizing environmental impacts because of the "greenwashing".

There is a clear gap in the RPDP when it comes to community development, with none of the tourism-related projects included in the plan explicitly targeting community involvement.

8.3 SD objectives and indicators

Three main objectives are the focus of this SD pathway to increased sustainability of the tourism sector (Table 8-1). These objectives are in line with those at national level in the Twelfth National Economic and Social Development Plan[35] that are aimed at encouraging strong and self-reliant communities and strengthening the grassroots economy as well as preserving and restoring natural resources and environmental quality to support green growth.

The objectives respond to the strategic issues of concern to sustainable development of tourism in Rayong. The indicators are to form part of the overall monitoring of RPDP implementation. They can be added to as the capacity of local agencies to monitor and report on them is enhanced.

Table 8-1: Strategic issues, sustainability objectives and indicators for the tourism sector

Strategic issue	Sustainability objective	Indicators
9. Growth in tourism numbers and facilities **10. Environmental impact of tourism facilities**	▪ Promotion of ecological, community and agricultural tourism	▪ Proportion of tourism enterprises that are eco- , community- or agriculture-based

[35] 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

Strategic issue	Sustainability objective	Indicators
	▪ Reducing consumption of water, energy and other resources	▪ Water and energy consumption per tourist head
11. Marine and coastal debris and pollution, especially plastics and petroleum products, threaten tourism	▪ Ensuring that solid waste generated from the tourist sector is treated properly	▪ Proportion of tourism-generated solid waste that is treated properly

8.4 Measures for sustainable tourism in Rayong

Sustainable development of the tourism industry takes two distinct forms: (i) managing the sustainable use of destination, and (ii) sustainability of tourism industry services (e.g. accommodation providers and tour operators).

Tourism destinations are often located on public land and are therefore can be managed directly by local government organizations. Tourism industry services are provided primarily by private companies, and therefore a variety of economic and regulatory incentives need to be applied to create an environment that enables and encourages good performance.

Table 8-2 provides details of measures for integration into the next iteration of the RPDP (2021-2025). Identified measures cover the main actions needed to manage the strategic issues and address sustainable development objectives.

Waste management is a cross-sectoral issue, needing coordinated effort and support from national and Rayong provincial authorities. Large planned investments in tourism will come from the private sector, with related infrastructure investment from national agencies. Most are outside the capacity of provincial authorities to assess, shape and control. Those investments need to be conducted within the framework of SD measures set out in Table 8-2. Table 8-3 sets out some of the higher-level actions needed to ensure that sustainable development objectives for tourism are addressed appropriately.

Table 8-2: Actions for inclusion into the next RPDP (2021-2025)

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
Growth in tourism numbers and facilities	**8.1 Establish and implement a coordinated program for community tourism and SME activities, including increased co-management opportunities** (i) The program should require all tourism projects to support the objectives of community tourism. It should include elements that maximize the opportunities for community involvement including:[36] a. Participatory processes, preferably in the planning stage and in co- management arrangements b. Transparent dissemination of planned tourism developments with opportunities for community input. c. Improved mechanisms for profit distribution and benefit sharing (ii) Provide subsidies, training and technical support for SME enterprises that promote local and sustainable products (iii) Actively promote the inclusion of artisans, farmers and SME's into the tourism value chain (iv) Incentives to encourage tourism enterprises to buy locally and sustainably.	Rayong Governor's Office; District governments; Provincial Tourism Authority; DNP Agricultural department; Village councils	2-5 years
Environmental impact of tourism facilities	**8.2: Introduce zoning and safeguards within all tourism destinations** (i) Review the adequacy of current zoning in all destinations. Zoning for ecotourism should be integrated into the general zoning and management of natural areas. [37] (ii) Prepare zoning plans for all areas used by tourists, including special controls in areas of high conservation value and separating conflicting uses, e.g. snorkeling and waterskiing (iii) Compensate local communities if any restrictions on usage rights are required	Town and country planning; EEC Office; Department of National Parks Wildlife and Plant Conservation;	2-5 years

[36] Community based tourism is tourism in which local residents (often rural, poor and economically marginalised) 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. https://www.responsibletravel.com/copy/what-is-community-based-tourism. And Dangi, Tek, and Tazim Jamal. "An Integrated Approach to 'Sustainable Community-Based Tourism.'" Sustainability 8, no. 5 (May 13, 2016): 475. https://doi.org/10.3390/su8050475.

[37] https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/archive/management/pdfs/Day8_ZONING_MANUAL.pdf

	(iv) Develop communications and interpretative materials for each destination, such as use of maps and signage, and setting out rules and regulations for each zone.		
	8.3 Prepare responsible tourism guidelines and provide training in their implementation (i) Develop guidelines to minimize impacts of tourists including: ▪ ways of reducing waste, including solid waste rules and regulation ▪ respecting local cultures ▪ reducing consumption of water, energy and plastics ▪ minimizing impacts on natural ecosystems (ii) Prepare communications and training materials to support guidelines implementation (iii) Conduct a program of training for tourist operators	Provincial Tourism Authority;	5 years
	8.4 Establish the tourist carrying capacity of existing and new destinations (i) Conduct assessments of tourist carrying capacity in each destination including:[38] ▪ The main tourist attractions, associated behaviour and activities ▪ Important ecological processes, sensitive areas and events e.g. the presence of migratory birds ▪ The main problems and threats, including bottlenecks and constraints. ▪ Define desirable conditions of the ecosystem in each zone which need to be maintained ▪ Identify maximum number of visitors for each season and visitor density. (ii) Include carrying capacity prescriptions in overall management plan. (iii) Assess the impact of tourism on existing destinations and develop responses to avoid and mitigate.	Provincial Environment Office; Regional Environment Office; EEC Office;	2-5 years
Marine and coa	**8.5 Regulate adequate wastewater treatment and solid waste management by operators and accommodation providers**	Provincial Tourism authority;	2 -3 years

[38] https://ec.europa.eu/environment/iczm/pdf/tcca_en.pdf

	(i) Require each tourist facility to conduct internal waste stream audits to better understand environmental and natural resource issues and to identify solutions.[39] (ii) Prepare a communications package and train accommodation and tour operators, in addressing needed solutions for waste reduction by identifying minimal packaging options for procurement of materials and ingredients, reduced water, power and plastics use, and encouraging wastewater reuse such as irrigation of gardens and golf courses with grey water effluent (iii) Promote waste separation and arrangements for reuse and recycling (iv) Define operational procedures for hotels and resorts including innovations such as onsite grease traps, non-chemical treatment methods such as UV of water, nature-based approaches for wastewater[40] and organic waste management[41] (v) Provide financial and technical support to SMEs to establish onsite treatment, stabilization ponds, constructed wetlands for wastewater treatment[42] (vi) Define and apply economic incentives such as tax reductions and fines for increased wastewater treatment and reduction (vii) Increase monitoring and reporting of hotel effluents – applying a media wide "name and shame" approach as a disincentive to poor performance.	Town and Country Planning;	
	8.6: Ensure there is adequate solid waste management in popular tourism destinations Applying the concepts of "waste hierarchy"[43] and "zero waste" from the Thai national 3Rs policy, sustainable waste management should: (i) Adapt the waste hierarchy to the local context and embed it into management plans. (ii) Increase funding and economic incentives for recycling and composting, waste transportation and environmental sound collection and landfill and combustion facilities. [44]	Provincial Tourism Authority; Department of National Parks Wildlife and Plant Conservation;	2-5 years

39 UNEP (2003) A Manual for Water and Waste Management: What the Tourism Industry Can Do to Improve Its Performance. United Nations Environment Programme. URL: http://www.unep.fr/shared/publications/pdf/WEBx0015xPA-WaterWaste.pdf

[40] https://hoteltechreport.com/news/hotel-wastewater-treatment-system-principal-considerations

[41] 2019, Suma, Waste Composition Evaluation for Solid Waste Management Guideline in Highland Rural Tourist Area in Thailand

[42] Environmental Research Institute of Chilalongkorn University, and Bumi Kita Foundation. Sustainable Tourism Management in Thailand: A Good Practices Guide for SMEs, 2007.

[43] The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste in ways that help prevent emissions of greenhouse gases, reduce pollutants, saves energy, conserves resources, create jobs and stimulates the development of green technologies

[44] https://www.thebalancesmb.com/integrated-solid-waste-management-iswm-an-overview-2878106

	(iii) Regulate to reduce single-use plastics especially in the most visited or ecologically sensitive destinations (iv) Plastics controls to include: • Bans on single-use plastics with proper enforcement including instant fines by destination managers (e.g. similar to the Koh Samet ban) • Increased taxes on single-use plastics, styrofoam containers, and other products with limited use but a high end-of life impact. • Effective integrated with the municipal solid waste management system. (v) Prepare and apply a multi-media awareness-raising campaign on the need to reduce use of plastic bags and other plastic products. **Error! Bookmark not defined.**	Municipal Authorities;	
All Strategic issues	**8.7: Conduct a sustainability performance audit on major tour operators and hotels** Establish a monitoring and reporting system to measure status and assess progress in sustainable tourism development and operations: (i) Implement a tourist operators and facilities sustainability certification scheme, such as LEED certification for solid waste management, ISO 21401 for sustainable accommodation establishment[45,46] and ISO 21416:2019 for recreational diving.[47] (ii) Develop indicators to identify what constitutes 'community' tourism and 'ecotourism' including: • local employment, active support to and cooperation with local initiatives, respectful inclusion of cultural heritage, fair wages and safety on the job. • environmental purchasing policy, measurement of water and energy consumption, suitable waste (water) disposal or treatment, the avoidance and eradication of invasive species, and a ban on direct interactions with wildlife. • those based on international recommendations such as the Global Sustainable Tourism Council (GSTC) Criteria.[48] (i) Analyse performance against these indicators for major accommodation service providers and tourism operators. (ii) Make performance listings publicly available to encourage sustainable tourism (i.e. develop a green and black list).	Provincial Tourism Authority; Alternative tourism board;	Establishment of audit mechanism: 2-3 years; Audit: every 2 years

[45] https://www.iso.org/obp/ui/#iso:std:iso:21401:ed-1:v1:en
[46] https://www.iso.org/news/ref2409.html
[47] https://www.iso.org/obp/ui/#iso:std:70875:en
[48] https://www.gstcouncil.org/about/about-us/

Table 8-3: Other actions needed to address the strategic issues of concern to sustainable tourism in Rayong

Strategic issue of concern	Level	Action and description	Responsible Agency	Time horizon
Marine and coastal debris and pollution, especially plastics and petroleum products, threaten tourism	National government	**8.8 Increase budget allocations for wastewater plants, sewerage treatment, operation and maintenance, and for monitoring and evaluation** (i) There is a need for a concerted and very substantial increase in funding for establishment and operation of waste treatment facilities, for training, for monitoring, reporting and enforcement to ensure all private and commercial enterprises pay for treatment and fully comply with sewerage treatment standards and guidance, across all sectors.	Pollution Control Department, Ministry of Natural Resources and Environment Waterworks authorities EEC (Ministry of Public Health, Ministry of industry, Ministry of Interior)	2-5 years

8.5 Effect of measures on trends in strategic issues of other themes/sectors

8.5.1 Growth in tourism numbers and facilities

The program for sustainable tourism aims at decreasing socio-economic inequalities, thereby positively influencing the macro-economy's distribution of benefits; and reducing migration from rural areas by providing other livelihood opportunities, thereby positively supporting local agricultural communities.

8.5.2 Environmental impact of tourism facilities

Clear zoning and ecosystem carrying capacity assessment and tourism guidelines development would reduce pressures from tourism by improving the management of tourist numbers and influencing their behaviour, thereby reducing degradation and positively influencing marine environment and terrestrial ecosystem sustainability (e.g. coral loss due to scuba diving); and increase adaptation to climate change via ecosystem-based adaptation mechanisms, for example by reducing the impacts of floods via protecting mangroves and coral reefs.

8.5.3 Marine and coastal debris and pollution, especially plastics and petroleum products, threaten tourism

Optimal waste management systems in the tourism sector, including plastic bag bans, would increase the effectiveness of measures aimed at urban development and industry waste management via cooperation and exchange. Also, it would increase environmental quality, reduce pollution of coastal environment and water resources, thereby positively influencing marine environment and terrestrial ecosystem sustainability, and decrease biodiversity loss via plastic ingestion and coral loss via plastic-related damage. As a result, improvements in public health outcomes could be expected.

8.6 Conclusions

A clear consideration and program of sustainable tourism, which focuses on maximizing the ability of communities to regulate tourism development, is essential for filling the gap in the RPDP. Additionally, consideration of the impacts on and carrying capacity of ecosystems is needed for any new destinations developed in Rayong province, and especially in less disturbed areas. There needs to be an assessment of the status and development of destinations, accommodation and tourism providers with regard to their performance on different sustainable tourism indicators (e.g. related to community tourism or ecotourism). This assessment is crucial to guide Rayong's path to a sustainable tourism sector. Some location-specific zoning activities, guideline development and raising of awareness can aid in reducing the impact of tourism on communities at different destinations.

The problem of solid waste needs to be addressed urgently, through public awareness campaigns and stronger regulations where necessary. Additionally, regulations need to be communicated clearly and enforced adequately. Finally, some support to SME and larger accommodation providers is required for improving wastewater management, and these efforts should be integrated into broader initiatives in treating wastewater in Rayong province, particularly from the urban development sector.

9 COASTAL AND MARINE ENVIRONMENT INCLUDING FISHERIES AND AQUACULTURE

9.1 Introduction

Because a healthy coastal and marine environment is essential to the sustainability of fisheries and aquaculture in Rayong, the issues of ecological health and fisheries productivity are considered together in this chapter. The purpose of the chapter is to build on the SEA baseline and impact assessments of the coastal and marine environment theme, and to present proposed actions for inclusion in the Rayong Provincial Development Plan (RPDP) to better support sustainability.

This theme relates to management of the coastal zone – a region extending from the coastal hinterlands and lowlands to the coastal waters. The coastal zone is usually taken to include that part of the land affected by the sea, and the part of the sea affected by the land – ie where land-based activities have a measurable influence on coastal and marine ecology. From a practical management perspective it is often defined as a relatively narrow strip of land and adjoining coastal waters, even though the activities of entire watersheds have a significant effect on coastal ecology. In Rayong much of the narrow coastal strip is intensively developed with patches of remaining mangrove forest. It is important for boundaries of the zone to be identified and for a management plan to be prepared with all stakeholders. That plan would include zoning and safeguard frameworks covering the land and coastal waters.

Under the 2015 Marine and Coastal Resources Management Act, the Department of Marine and Coastal Resources (DMCR) can designate Mangrove Conservation Areas and Marine and Coastal Resources Protected Areas in order to protect important coastal and marine resources. The law encourages the participation of communities and local governments in sustainable management by forming multi-stakeholder platforms that can propose management plans for marine and coastal resources. That law and the Rayong comprehensive spatial plan would provide a strong framework for preparing and implementing a coastal zone management plan. Already, mangrove conservation areas and a course zoning of coastal waters have been established. A more comprehensive zoning and management regime is needed.

SEA stakeholders identified three strategic issues of concern to Rayong's development relating to the coastal and marine environment: (i) unsustainable fisheries sector; (ii) poor management of solid wastes and effluent discharges; and (iii) limited environmental monitoring and reporting to support effective evidence-based coastal management. A summary of the SEA findings from the baseline and sustainability assessments is provided in this section as the basis and justification for the SD measures defined later in the chapter.

9.1.1 Unsustainable fisheries sector and practices

Over the last decade, downward trends in marine and inland fisheries capture have been experienced, and disease poses an ongoing risk to coastal aquaculture production. Fisheries yield is expected to decline further and conflict over development of the coastal zone and its natural resources is likely to increase. The RPDP could contribute positively to the sustainability of fisheries by investing in greater protection of ecosystems, heritage, cultural and traditional livelihoods subsidies in the fisheries sector, and structural adjustment support, but there is a strong likelihood that capture fisheries, traditional aquaculture and related cultural associations will continue to decline in the province without concerted action.

Pollution and degradation of the coastal zone due to activities from other sectors will reduce natural fishery stocks due to poor water quality and sediment contamination and damage to coral reefs, sea grasses, mangroves and other coastal ecosystems. Encroachment and destruction of coastal and estuarine habitats including refuges and nursery and feeding areas suppressing spawning and

productivity in marine life. The fisheries sector itself has been part of the problem. Aquaculture contributes to coastal pollution, and destructive fishing practices have damaged coral reefs and other ecosystems on which they rely including over exploitation of commercial species.

Climate change is expected to decrease yields through a number of impacts. Greater storm intensity damages coral reefs and sea-grass beds and covers them with silt. Warming water temperatures and increasing acidity leads to coral bleaching and inhibits development and growth of most fish and cephalopods such as octopus and squid. Warming water temperatures will also affect important migratory fish stocks such as mackerel which are likely to shift to cooler waters, and affect population dynamics of other important commercial species such as anchovies and sardines. Rising sea levels will increase coastal erosion – already a serious issue for Rayong province and the focus of significant investment in groynes and sea walls. Sea level rise and storms will push mangroves, corals and seagrasses in landward directions as these ecosystems seek their favoured range of environmental conditions. Slow-growing species are most unlikely to be able to keep pace with the rising sea level. The survival of coral reefs, mangroves and sea grasses hinges on their ability to move into shallower waters. Yet, much of Rayong's coastline is built up, and these ecosystems already degraded and under development pressure will run out of viable space.

The land based activities are a special management concern for the quality of coastal waters. More intensive zoning and development controls are needed to reduce negative influences and to safeguard land bases assets against the potential impacts of climate change. Figure 9-1 and Figure 9-2 show the land areas at risk from flooding to 2050 due to sea level rise, tides and storms. The areas shaded red reflect places that are lower than local sea-level and coastal flood projection in 2050. The maps do not take engineered coastal defenses or long-term dynamic changes into account – they are a tool to identify area needing detailed assessment and protection.

Figure 9-1: Land in Rayong province projected to be below annual flood level in 2050

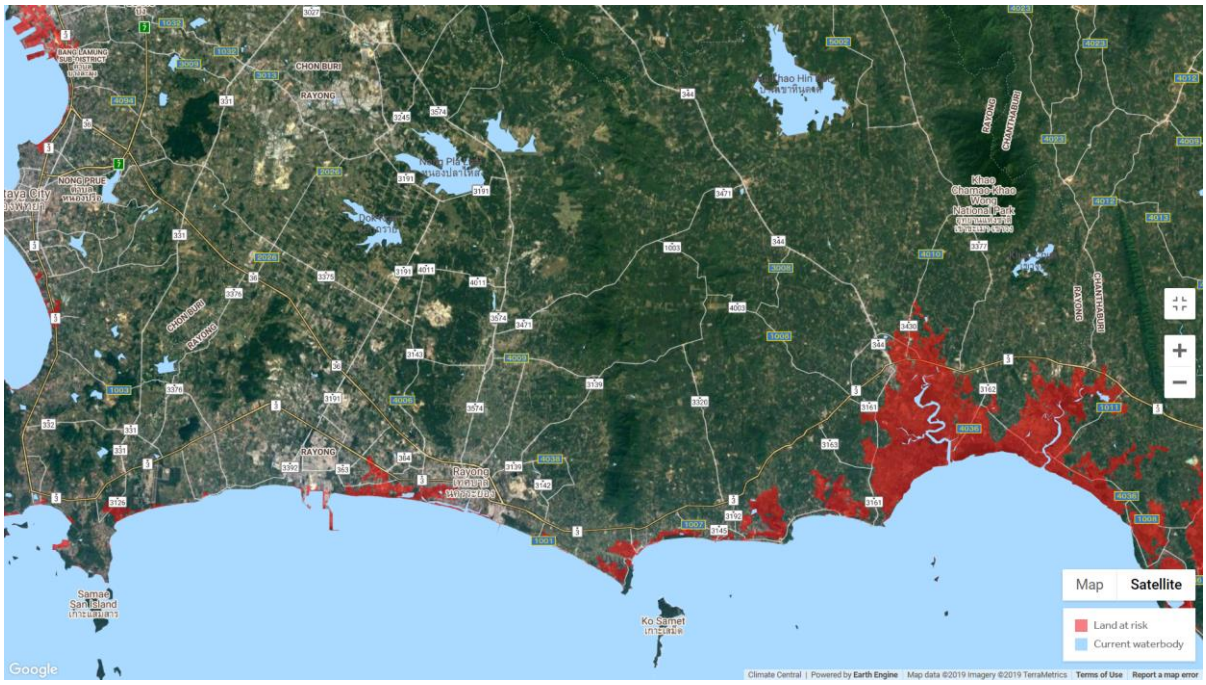
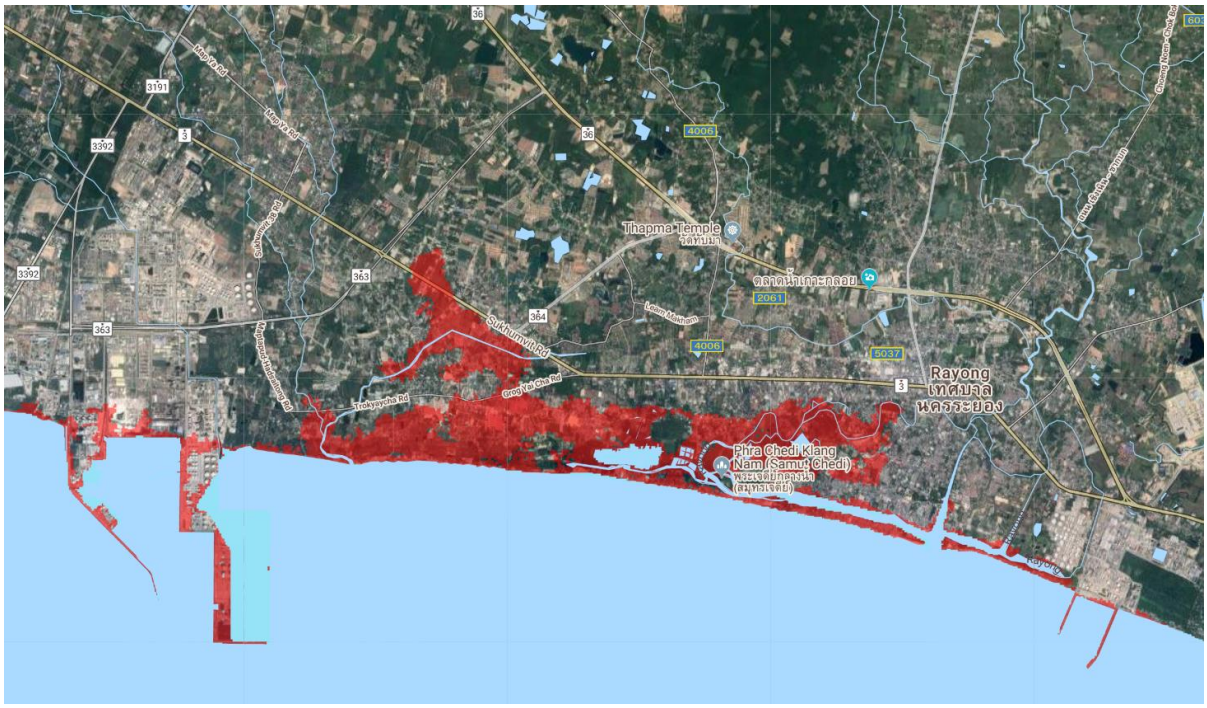


Figure 9-2: Rayong municipal and port area – land at risk from flooding by 2050



Source: Climate Central 2019[49]

9.1.2 Poor management of solid wastes and effluent discharges

Pollutant discharges from domestic, agricultural, tourism and industrial sources, are stressing provincial coastal and marine ecology. Common pollutants that are found in Rayong's estuarine and coastal waters include pesticides, herbicides, fertilizers, detergents, oil, industrial chemicals, and sewage, all with an impact on biodiversity and ecosystem services.

The prevalence of marine debris including plastic waste is associated with high mortality rates among Rayong's important populations of endangered marine species such as marine turtles, cetaceans and dugongs. Various pieces of solid waste have caused entanglement, starvation, and drowning in Rayong's waters. When it washes up onto beaches and into wetlands, it degrades breeding grounds and habitats. Marine plants may be smothered by debris and die. Even needed intensive debris removal efforts can damage and alter ecosystems in the short term. Degradation of Rayong's coastal and marine environmental from solid waste is likely to continue, especially due to increasing resident population and tourism and linked provincial waste generation and its poor management.

Oil is dangerous to marine life through ingestion, inhalation and absorption as demonstrated in past oil spills in Rayong. Oil affects most marine animals. It clogs the gills of fish and coats and debilitates birds and marine mammals. On the surface, oil blocks sunlight and prevents marine plants from using light for photosynthesis. Oil washes up on beaches, and contaminates nesting areas and feeding grounds. Fish living, feeding or spawning in shallow waters can be vulnerable. Fish contaminated from oil residues become unfit for human consumption.

[49] Sea level rise and coastal flood risk maps -- a global screening tool by Climate Central. 2019 Interactive global map showing areas threatened by sea level rise and coastal flooding by 2050. https://coastal.climatecentral.org/

Other toxic chemicals are found in Rayong's waters and in fish and shell fish, especially in areas close to the industrial Map Ta Phut and port area. Map Ta Phut industrial area houses five industrial estates, one deep-sea port, and 151 major factories, including petrochemical plants, oil refineries, coal-fired power stations, and iron and steel facilities. Sediments have been found to be enriched in radium likely from fly ash waste from a nearby power plant and petroleum hydrocarbons.

9.1.3 Limited environmental monitoring and reporting to support effective evidence-based management

Calls for improved monitoring and reporting of the environment from local communities reflect concerns over the paucity of information on water quality, industrial waste, and potential contamination of seafood. Gaps in information hinder effective and sustainable management of coastal and marine resources. The RPDP does include some elements to bridge existing monitoring and reporting gaps. Increased monitoring and reporting would help track the effectiveness of discharge and waste management efforts in other sectors such as urban development, industry, agriculture and transport. Increasing availability of information on fish catches and testing for contamination would provide the means for more effective management to improve ecosystem and public health.

9.2 Gaps in the existing Rayong Provincial Development Plan

While the RPDP does not explicitly promote sustainable fisheries practices, it does include projects to rehabilitate coastal ecosystems (e.g. mangroves and coral reefs) that are known to be important fisheries habitats. However, the RPDP does not includes any elements to improve spatial zoning of the coastal zone, which could enhance sustainable management through standards, development controls and avoiding conflict between users.

Management of municipal solid waste, industrial wastes and wastewater treatment are all issues of concern in Rayong province. This is acknowledged in the RPDP, along with the public health consequences. Yet, the RPDP does not include measures to improve municipal wastewater treatment, and the only solid waste management project of significance is to improve capacity on Koh Samet. A key gap in the plan is the lack of action to decrease plastic waste.

Environmental monitoring and reporting is not adequately addressed in the RPDP, despite its nationally recognised importance (see e.g. the 12th NESDP (2017-2021)[50]). While the RPDP does include monitoring for natural resource uses, the inclusions in the plan are not sufficiently broad ranging to provide data relating to sources, a broad range of parameters, concentrations, and trends.

9.3 SD objectives and indicators

Two Sustainable Development Objectives, three Strategic Issues of concern to Rayong's coastal and marine environment (including fisheries and aquaculture), and two core SEA indicators were identified in the earlier baseline and impact analysis phases of the SEA (Table 9-1). In order to address the gaps in the RPDP, several core indicators are proposed to facilitate measurement and progress in addressing strategic issues at provincial level. The indicator framework for tracking implementation of the RPDP can be expanded based on enhanced capacities within relevant local and regional agencies.

[50] Thailand's 12th National Economic and Social Development Plan (12th NESDP) is available at: http://www.nesdb.go.th/nesdb_en/ewt_w3c/ewt_dl_link.php?nid=4345

Table 9-1: Strategic issues, sustainability objectives and indicators for the coastal and marine environment

Strategic issue	Sustainability objective	Indicators
12. Unsustainable fisheries sector and fishing practices	Sustainably use marine and coastal resources	▪ Measures of inshore and offshore fisheries catch including: total fisheries catch; total catch of specific target species; catch per unit effort ;
13. Poor management of solid wastes and effluent discharges	Restoration, enhancement and protection of marine and coastal ecosystems and resources	▪ Investment in protection and restoration of marine and coastal ecosystems and recovery of endangered species
14. Limited environmental monitoring and reporting to support effective evidence-based management	A science evidence base for effective environmental management	▪ Number of monitoring stations and parameters used in regular monitoring and reporting

More broadly, Thailand is seeking to meet the international SDGs and associated targets. SDG 14 addresses the marine and coastal environment and calls on countries to "Conserve and sustainably use the oceans, seas and marine resources for sustainable development". SDG 14 targets to be met by 2020 and 2025 of relevance to Rayong Province include:

14.2: Sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including action to strengthen their resilience and for their restoration
14.4: Effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans
14.5: Conserve at least 10 per cent of coastal and marine areas
14.1: Prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution
14.B Provide access for small-scale artisanal fishers to marine resources and markets

The RPDP needs to contribute in meeting those targets.

9.4 Measures for sustainable coastal and marine environment development in Rayong

For each of the strategic issues, measures are proposed to augment the current RPDP to address identified gaps and enhance sustainability outcomes (Table 9-2). Including within the RPDP a requirement and linked projects for coastal and marine spatial planning and zoning would prove especially beneficial and an initiative strongly advocated by the Rayong fishers association represented in the SEA. The aim is to establish a framework of zones and associated use controls and safeguards which all stakeholders have helped define and agree to enforce. Zones which were discussed by stakeholders during the SEA include, for example:

(i) Fishing zones, no-take zones, selective extraction zones: allowing only fishing for certain species or limited levels of extraction, for example no-trawl areas or fishery closure areas, including seasonal closure
(ii) Mariculture zone[51]: allowing cultivation of aquaculture in a specific zone, aquaculture management areas

[51] FAO/World Bank. "Aquaculture Zoning, Site Selection and Area Management under the Ecosystem Approach to Aquaculture." Policy Brief, 2015.

(iii) fishery resource conservation areas, e.g. fish refugia or areas important for productive species
(iv) Industry zone: zones specifically designated to infrastructure, marine transportation, construction, public utilities, mining, petroleum, ocean energy, military. These zones often include mapping or limiting shipping routes
(v) Tourism or recreation zone: see tourism SD pathway section
(vi) Zones of social, and/or cultural significance e.g. religious, scientific, archaeological
(vii) Areas of high conservation value, including ecologically or biologically significant areas (EBSA), marine protected areas (MPA) and locally managed marine areas, also focusing on areas that are not yet protected, but have high conservation value;
(viii) Establish buffer zones around high conservation value zones as well as around existing protected areas;
(ix) Areas with important ecological functioning or vulnerable and degraded areas.

Wastewater and solid waste management is of key concern for sustainable development of coastal and estuarine regions, with major contributions from industry, urban areas, tourism, transport and agriculture. The impact from the tourism sector on solid waste generation, for example, is especially high in coastal areas, where the majority of tourist destinations are located. More detail on tourism-related waste management can be found in the sustainable development pathway for tourism.

Additional actions to be undertaken at higher levels of policy and planning, which are outside of the remit of the RPDP, are identified in Table 9-3. Those actions are needed to compliment or support the initiatives defined under the RPDP and its priority actions for increased sustainability.

Table 9-2 Actions for inclusion in next RPDP

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
Unsustainable fishing practices	**9.1: Prepare and implement a coastal zone management plan** Spatial planning aims to promote sustainable management of resources and pre-empt conflict between users. Integrated coastal zone management planning is widely adopted internationally, with some 70 countries known to be developing coastal zone plans at local, national, and regional level.[52,53] (i) Establish expert team to lead the coastal spatial planning effort (e.g., specialists from government, academia and NGOs, and community representatives). (ii) Review approaches for coastal zone spatial planning, and processes for reaching consensus on key aims and conservation targets through stakeholder consultations. (iii) Follow best practice Integrated Coastal Zone Management (ICZM) planning including [54] defining the coastal zone boundary, taking an ecosystem-based approach and engaging in a participatory process involving all stakeholders (iv) Draft a spatial plan which defines coastal and marine zones (v) Identify conservation values and priorities of each zone along with safeguard frameworks and development controls: [55,56,57,58,59] (vi) Assign development controls for each zone to finalise the spatial plan. There are different measures which can be specified in each zone: input measures (e.g. no-take zones), process measures (e.g. type of fishing gear), output measures (e.g. limitations in amount of catch) and spatial and temporal measures (e.g. seasonal ban on fishing).	Department of Marine and Conservation Resources; Rayong Department of Town and Country Planning The Port Authority of Thailand Department of Fisheries Other sectors	Next 5 years

[52] http://www.mspglobal2030.org/about/
[53] Santos et al. (2019) Chapter 30 - Marine Spatial Planning. In World Seas: An Environmental Evaluation. https://www.sciencedirect.com/science/article/pii/B9780128050521000334
[54] https://unesdoc.unesco.org/ark:/48223/pf0000186559
[55] http://gobi.org/ebsas/
[56] https://seymsp.com/the-initiative/planning-scope/
[57] https://www.icriforum.org/sites/default/files/4.1.1%20MPA%20MSP%20EBM%20Presentation2.pdf
[58] Hao, Huang, Chen Bin, and Lin Jinlan. "The Marine Spatial Classification and the Identification of Priority Conservation Areas (PCAs) for Marine Biodiversity Conservation – A Case Study of the Offshore China." *Ocean & Coastal Management* 116 (November 2015): 224–36. https://doi.org/10.1016/j.ocecoaman.2015.06.027.
[59] https://www.iala-aism.org/content/uploads/2016/06/0930-MSP-Australian-experience1.pdf

	(vii) Develop communications and management strategy to raise awareness and compliance of marine and coastal zoning in Rayong. Zone boundaries markers need to be clear and the zones should be enforced		
	9.2: Establish a system of fisheries catch reporting To improve fisheries management in Rayong, the paper-based reporting of fisheries catch need to be replaced with a digital system. The Royal Ordinance on Fisheries 2558 (2015) requires national government to collect up-to-date fisheries information to inform fisheries management.[60] The use of electronic reporting of catch is being applied for specific fisheries internationally. In New Zealand, new digital reporting regulations require that fishers adopt electronic reporting of catch, and a mobile application has been developed. [61] A mobile application was similarly developed by The Nature Conservancy to investigate electronic logging of catch in California.[62] (i) Review options for replacing the current reporting systems to support effective adaptive management, ie. optimizing management decisions based on near real-time catch-based evidence.[63] (ii) Replace the paper-based reporting of fisheries catch with an accessible web based digital system with analytical and communications components [64] (iii) Apply electronic logging of fisheries catch in Rayong to support improved fisheries management and acquire catch statistics from inshore and offshore fisheries (Table 9-3 below).	Department of Fisheries	Next 5 years
Poor management of solid wastes and effluent discharges	**9.3: Prepare and implement a coastal-marine zone plastic debris management plan** Develop a Rayong action plan for managing plastic waste at provincial level, reflecting approaches adopted internationally:[65] (i) Organise regular beach, mangrove, coral reef clean-up events for participation of local communities and private sector in order to raise awareness (ii) Set goals for 3Rs for Mu Koh Samet Marine National Park, and other islands of Rayong. (iii) Explore value of implementing fee and tax-based systems to encourage compliance (iv) Raise public awareness through campaigns on plastic pollution and its impacts on marine life and human health	Pollution Control Department; Department of Coastal and Marine Resources	2 years, then Next 5 to 10 years

[60] Lieng et al. (2018) Global Ecolabelling Certification Standards and ASEAN Fisheries: Can Fisheries Legislations in ASEAN Countries Support the Fisheries Certification?Sustainability 2018, 10, 3843; doi:10.3390/su10113843
[61] https://ecatch.co.nz/
[62] https://www.ecatch.org/
[63] TNC (2018) Catalyzing the Growth of Electronic Monitoring in Fisheries. The Nature Conservancy. URL: https://www.nature.org/content/dam/tnc/nature/en/documents/Catalyzing_Growth_of_Electronic_Monitoring_in_Fisheries_9-10-2018.pdf
[64] Merrifield et al. (2019) eCatch: Enabling collaborative fisheries management with technology. Ecological Informatics, Volume 52, July 2019, 82-93 https://doi.org/10.1016/j.ecoinf.2019.05.010
[65] Lohr et al. (2017) Solutions for global marine litter pollution. Current Opinion in Environmental Sustainability, 28:90-99. URL: https://doi,org/10.1016/j.cosust.2017.08.009

	(v) Apply innovative technologies for screening out plastic waste from rivers, canals and waterways. (vi) Improve and replicate plastic reuse and recycling centres and management of landfills to separate out plastics for recycling.[66] (vii) Advise industry on management and prevention of spills of micro plastics. (viii) Explore additional policy instruments to improve municipal solid waste generation and recycling in the province, including 'pay-as-you-throw' schemes and landfill taxes as used in the EU.[67] In Canada, a strategy on zero plastic waste was recently approved in principle in November 2018.[68]		
	9.4: Institute a program for private sector environmental performance certification including management of solid waste and wastewater discharges	Pollution Control Department; Department of Coastal and Marine Resources Ministry of Finance NESDC EEC	2 years 5 years implementation
	(i) Private business facilities in coastal and riverine areas (e.g. hotels, dive centres, restaurants) should be required to have environmental performance certification including waste stream, and water and energy use audits.[69] (ii) Assess application of the 3Rs (reducing, reusing and recycling) policy and barriers to implementation; (iii) Provide incentives for private sector to adopt green purchasing practices (i.e. sourcing for consumables and other resources) (iv) Provide incentives for on-site waste water treatment systems, including natural and engineered solutions; or connection to the three main waste-water treatment systems in the province (v) Require self-monitoring and reporting against environmental management plans for all commercial enterprises (irrespective whether or not they are captured through the EIA systems) (vi) Establish a system of public naming and shaming poorly performing enterprises Actions to address municipal solid waste and wastewater are further elaborated in the sustainable development pathway chapter for urban development, which recommends a review of building and planning regulations for commercial and residential properties with regards to wastewater.		
	9.5: Establish a provincial program to improve and replicate solid waste separation and management	Pollution Control Department; Department of	2 years 5 years implementation
	(i) Increase incentives for separation at the source, such as garbage in exchange for goods in rural areas and drop-off and buy back centres in urban areas (ii) Enforce application of 3Rs in government agencies and private enterprise		

[66] https://recyclinginternational.com/plastics/floating-garbage-truck-to-rid-ocean-plastics-in-key-rivers/28491/
[67] https://www.eea.europa.eu/themes/waste/municipal-waste
[68] https://www.ccme.ca/en/current_priorities/waste/waste/strategy-on-zero-plastic-waste.html
[69] UNEP (2003) A Manual for Water and Waste Management: What the Tourism Industry Can Do to Improve Its Performance. United Nations Environment Programme. URL: http://www.unep.fr/shared/publications/pdf/WEBx0015xPA-WaterWaste.pdf

	(iii) Conduct frequent quality control inspection of solid waste management facilities with public reporting on performance (iv) Conduct training and awareness raising program for public and private sector in solid waste management (v) Increase funding for private-public partnership schemes and community involvement (vi) Budget for the Rayong program to implement the National Master plan for Waste Management 2016-2021, especially replacement of open dumping sites with sanitary landfills and incineration.[70]	Coastal and Marine Resources	
Limited environmental monitoring and reporting to support effective evidence-based management	**9.6: Establish a comprehensive program and capacities for coastal and marine water quality monitoring** (i) Review and identify gaps (measured variables, sampling locations and frequency) in water sampling programmes of PCD, DMCR, and other agencies with responsibilities for water quality monitoring in Rayong, including the provision of real-time or near real-time reporting which are beneficial for managing disasters, including oil and chemical spills, and floods. (ii) Review new and innovative methodologies to assess marine environmental status including the use of remote sensing and in situ sensors which may prove beneficial for use in the Thai and Rayong context (e.g., Danovaro et al. 2016 explored innovative technologies for implementing the EU's Marine Strategy Framework Directive (MSFD).[71] (iii) Develop a programme to address the identified gaps, ensuring that monitoring regimes reflect the variability of local conditions and potential sources of pollution. (iv) Focus on water quality monitoring as stakeholders have expressed concerns about the lack of information on the status of the marine environment and expert judgement considers the current monitoring of water quality to be insufficient for effective evidence-based management. (v) Explore approaches adopted by other countries to inform the Rayong program. For instance, the EU's MSFD provides guidance on monitoring and assessment for achieving Good Environmental Status (GES)[72], and the UK's *Marine Strategies*[73,74] provides an example of its implementation. (vi) Develop a Rayong coastal and marine environmental web-based portal to provide single-point access to data and information from government agencies and other stakeholders across the province to facilitate sharing of data, information and news with local communities.	Pollution Control Department, Department of Marine and Coastal Resources	2 years 5 years implementation

[70] Funatsu, Tsuruyo. "Chapter 4: Municipal Solid Waste Management in Thai Local Governments: The State of the Problem and Prospects for Regional Waste Management." In Toward Regional Cooperation of Local Governments in ASEAN, by Michikazu Kojima, 22. ERIA Collaborative/Support Research Report. IDE-JETRO, 2019.
[71] Danovaro et al (2016) Implementing and Innovating Marine Monitoring Approaches for Assessing Marine Environmental Status. Front. Mar. Sci. 3:213. doi: 10.3389/fmars.2016.00213
[72] https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm
[73] https://www.gov.uk/government/publications/marine-strategy-part-two-uk-marine-monitoring-programmes
[74] https://www.gov.uk/government/publications/marine-strategy-part-one-uk-initial-assessment-and-good-environmental-status

Table 9-3 Actions for inclusion in the next RPDP (2021-2025)

Strategic issue of concern	Level	Action and description	Responsible Agency	Time horizon
Limited environmental monitoring and reporting to support effective evidence-based management	National line agencies	**9.7: Introduce eco-label certification for seafood** Digital reporting (action 10.2) could support eco-labelling or certification of seafood. For instance, the provision of geographic coordinates of fish catch could provide evidence on potential associated habitat impacts. Presently there is no official eco-labelling scheme for seafood in Thailand though the use of eco-labelling is advocated in the NESD Plan (2017-2021). (i) Review recognised international eco-label seafood certification schemes for adoption and implementation in Thailand – e.g. Marine Stewardship Council (MSC) and Aquaculture Stewardship Council (ASC) (ii) Consider development and implementation of an equivalent Thai national certification standard for seafood in the national market and for use in international certification for sea food exports	Department of Fisheries	Next 5 to 10 years
		9.8: Coastal and marine water quality monitoring and reporting (i) Provide additional technical, budgetary and institutional support for establishing and implementing a comprehensive Rayong program for coastal and marine water quality monitoring and reporting (Measure 10.6) (ii) Provide training and innovation in water quality monitoring drawing from international best practice. (iii) Support introduction and piloting of an online databases and knowledge sharing platform for Rayong for the purpose of sharing data and information on the status of the coastal and marine environment, including where possible the provision of real or near real-time reporting.	Pollution Control Department Department of Marine and Coastal Resources	Next 5 to 10 years

9.5 Effect of measures on trends in strategic issues of other themes/sectors

Implementation of the proposed actions would improve the overall sustainability of development in the coastal and marine zone of Rayong Province. Measures to increase the sustainability of fishing activities benefit the quality of the coastal environment through a system of zoning and controls, careful assessment and management of development impacts, and safeguarding future yield of fish by effective monitoring, reporting and enforcement to avoid overexploitation. Those improvements will lead to high standards of fish quality and food safety with immediate benefits for the coastal tourism sector and associated services such as seafood restaurants and hotels. Measures to reduce pollution will directly contribute to improving environmental quality and the quality of life for Rayong residents, with benefits to the tourist industry, local fishers' livelihoods and maintenance of heritage and traditional practices, the aquaculture industry and to nutrition and public health through consumption of "safe" seafood.

Measures to increase environmental monitoring, reporting and enforcement will also increase the effectiveness of urban and industrial waste management by providing widely accessible information and incentives for good environmental performance. The provincial economy will benefit by directly supporting fisher communities and aquaculture businesses and by encouraging businesses that are considering locating to Rayong or planning other investments in the province.

9.6 Conclusions

There are a number of gaps in the current version of the RPDP that should be addressed for sustainable development of the coastal and marine zone in Rayong. The gaps have been outlined in relation to the three strategic issues of concern to Rayong's development identified by SEA stakeholders. In response, key measures for inclusion in the next revision of the RPDP have been proposed.

In implementing the proposed measures the definition of a coastal zone and integrated coastal zone management plan with controls and safeguards is the most important. That initiative will need to be strongly supported by national agencies through technical and budget support and training of local managers and enforcement staff. Reducing plastic waste is another high priority issue requiring action at national and provincial level. Replication and strengthening of existing good pilot and demonstration 3Rs centres is needed. Other important measures include segregation of harmful development and resource uses from environmentally sensitive areas, reporting on fisheries catches, improving private self-sufficiency in source solid waste and wastewater management, and expanding comprehensive monitoring and reporting on coastal water quality.

Applying the measures included in this chapter will bring Rayong into line with broader regional and national practices in relation to ensuring sustainable use of coastal and marine resources, including fisheries and aquaculture.

PART II: SUSTAINABLE DEVELOPMENT MEASURES FOR THE QUALITY OF LIFE SECTORS

This part of the SD pathways volume is concerned with themes or "sectors" impacted by the development sectors considered in Part I. In this case "quality of life" is taken in its broadest meaning to encompass the happiness and wellbeing of people as well as other forms of life. Included here are chapters on social equity, environmental quality and forests and biodiversity enrichment and conservation. Each of those sectors are affected by economic activities in Rayong province. For that reason, many of the measures set out here are a synthesis of the SD measures appearing under various sector chapters in Part I. Others, relating to the expansion and management of forests across the province for example, are unique to that quality of life theme and contribute to the achievement of other SD measures, such as improved environment quality and living conditions.

One chapter stands out against the rest – that concerns climate change. It is both impacted by and impacts on the development sectors and other quality of life themes. In this case too, many of the measures are consistent with and often the same as those for achieving resilience in development sectors and enhancing quality of life across the other themes.

Part II also includes a concluding chapter which sets out next steps in the fifth phase of the SEA – implementation, as well as lessons learned of relevance to the conduct of future SEAs in Thailand.

10 SOCIAL EQUITY

10.1 Introduction

Over the last three decades, demographics and ways of life in Rayong have gone through fundamental changes, largely driven by industrialisation. The provincial agricultural backwater that hosted a rural and agrarian population in 1980 is now the backbone of Thailand's heavy industry with the highest per capita GDP of any of Thailand's provinces. Moving forward, under EEC development planning, Rayong is slated to be a central player in Thailand's efforts to move into high technology and high value-added industries such as avionics and robotics. These plans highlight the future requirements for a skilled and well-educated workforce in Rayong.

The purpose of this chapter is to ensure that social equity issues are considered within the framework of provincial planning and as a key component of provincial sustainability. It provides recommendations to enhance the quality of life and well-being of urban and rural residents in Rayong. That goal is particularly important given the rapid pace of social and environmental changes that are continuing to take place in the province. Social equity is one of the quality of life themes identified by stakeholders in the SEA. Like environmental quality, it is shaped by the actions of the development sectors which are considered in the first part of this report. Inequalities have arisen, for example, due to poor provisioning of basic services such as connection to a functional municipal sewage system, waste collection and disposal services, and publicly accessible green space. The identification and analysis of social inequities is constrained by the paucity of data on the rapidly growing and dynamic population in Rayong because of the long interval from the last national census in 2010.

SEA stakeholders identified three strategic social equity issues of concern for sustainable development in Rayong - rapid growth in the registered and unregistered population; availability of infrastructure and services, and growing socio-economic inequality.

Guided by these three strategic issues, and by the social equity baseline assessment (Volume II of the SEA) and sustainability analysis (Volume III of the SEA), this chapter sets out social equity sustainability measures. These are measures that should be integrated into the existing and future iterations of the RPDP, as well as into other plans and strategies that are shaping provincial development in order to enhance the social aspects of Rayong's sustainable development.

The historical trends, their drivers and future directions in the key issues are summarised below.

10.1.1 Rapid population growth

Accurate population figures for Rayong are challenging to find. Official Rayong population figures don't include unregistered domestic or foreign arrivals, which according to some estimates make up between a third and half the population. Even without considering unregistered residents, population growth in Rayong is almost 7 times the national population growth rate (1.92% p.a. in Rayong, compared with 0.28% p.a. for Thailand[75]). Population growth in Rayong is occurring almost exclusively in urban areas, with the registered rural population remaining static between 1993 and 2018. The lack of good quality data and information about how many people live in Rayong, and what their circumstance are, undermines the ability of the Rayong authorities to adequately supply municipal services or to address issues relating to social inequality.

Moving into the future, the EEC development program is fostering new development focusing on industries that require highly skilled workforces. The future need for highly-skilled employees will continue to drive significant in-migration into the province, in part because currently Rayong has

[75] https://www.macrotrends.net/countries/THA/thailand/population-growth-rate

relatively poor educational outcomes and no structural adjustment strategy to meet changing demands in skills.

With limited urban planning and development controls, population growth in Rayong is feeding the ad hoc urban growth and urban sprawl along main transport corridors that characterizes its development. Rural to urban migration is increasing agricultural dependence on foreign labour. The growing urban population is demanding more water and other resources and services each year.

10.1.2 Availability of infrastructure and services

Thailand's national government allocates funding to the provinces largely based on official population data. However, because up to half of Rayong's population is not registered in the province, the funding that Rayong receives from the national government is only around 60% of what it should be. This budget shortfall is compounded by a lack of precision concerning responsibilities for managing and maintaining public service infrastructure such as waste water treatment plants. As a result, Rayong residents are poorly supplied with municipal services including access to green space, sewage provision and waste collection and treatment services. Many households use septic systems to treat their wastewater, but standards are not enforced and in general septic systems do no treat wastewater effectively.

Municipalities in Rayong have not grown according to sustainable practices such as Transit Oriented Development which considers urban compactness, pedestrian and cycle-friendly environments, public transport, public spaces near stations, green corridors and community hubs. Instead urban sprawl, unfair distribution and designation of land uses, and inappropriate infrastructure development have led to environmental degradation and unwanted social impacts. If sustainable urban planning processes and controls are not established and enforced, supply of basic services and infrastructure including sewerage connections and treatment, solid waste collection, and access to green space, will continue to become more challenging and complex.

10.1.3 Growing socio-economic inequality

With low education attainment in Rayong, some in the original provincial community are being left behind and unable to take advantage of expanding industry and commercial related opportunities. Rayong's migrant population forms more than half the total population, with many being well educated and highly skilled recruited for the industrial sector. Other migrants are taking on labouring work in the agriculture sector.

The inequities in employment opportunities are causing social discontent. Those inequities have numerous socio-economic and environmental implications for quality of life within the province. For example, employees recruited externally for work in industries are usually provided private health insurance cover. While medical care is technically free for registered residents, government run hospitals generally have long waiting times, while residents with health insurance are able to access priority treatment in private medical facilities such as the Bangkok Rayong Hospital, which is recommended by health insurer Allianz Care.[76]

Similarly, well paid and educated migrants are able to afford good quality air conditioned housing, often with water filtration and internal air quality regulatory systems. Poorer rural to urban migrants from within Rayong are more likely to live in lower standard accommodation where they are exposed to a variety of public health threats such as malaria and dengue, poor air quality and water-borne diseases.

[76] https://apps.allianzworldwidecare.com/poi/hospital-doctor-and-health-practitioner-finder?PROVTYPE=HOSPITALS&CON=Southeast_Asia&COUNTRY=Thailand&CITY=Rayong

Because of differences in living conditions between socio-economic groups including access to services, and employment opportunities, the gap between rich and poor in Rayong will continue to grow unless there is active government intervention. Those inequalities are not effectively addressed in the RPDP, or in regional and national policies and plans. Implementation of the existing RPDP and implementation of EEC development programs are likely to exacerbate the situation because their focus is on attracting more highly skilled and trained migrants to Rayong.

Future industrial growth in high-tech sectors anticipated in Rayong will amplify existing socio-economic inequality. Urban planning systems that don't take into account the needs of poorer residents, and prioritise their access to services, accentuate social differences.

10.2 Gaps in the existing Rayong Provincial Development Plan

The RPDP includes a number of objectives that relate to the strategic social equity issues of concern to development in Rayong identified by SEA stakeholders. Those objectives focus on (i) ensuring social and environmental needs are satisfied, (ii) moving towards a knowledge-based economy, and (ii) having economic goals that focus on a "middle of the road" path in line with Thailand's sufficiency economy principle.

Despite that positive vision, the SEA process identified a number of gaps in the plan relating to social equity:

(i) The need for the province to collect census data more frequently in order to have a clearer picture of shifting provincial demographics;
(ii) Development of rural to urban migrant transition support programs;
(iii) Expansion of vocational education and other training programs, with particular emphasis on the skill sets that will be needed with planned industries under the EEC development program;
(iv) Environmental and public health awareness raising and training programs, with focus areas including:
- Communicable disease prevention;
- Air and water quality management;
- The importance of handwashing and hygienic living and cooking conditions;
- Community solid waste management and recycling/clean-up programs;
- Environmental health awareness raising programs in schools.

(v) Spatial zoning and urban renewal programs to improve access to parks, green spaces and public transport;
(vi) Policies and incentives placing nature-based urban development solutions at the centre of provincial planning and development, including:
- Focusing on developing accessible green spaces to enhance liveability, (which will have co-benefits including reducing urban heat-island effects and air pollution levels)
- Developing nature-based and hybrid solutions for water management and waste-water treatment.

Around 14% of the RPDP budget is proposed for expenditure on measures to improve livelihoods. However, there are no measures to more effectively manage the population growth trends. Additionally, social equity related measures included in the RPDP could further exacerbate social inequity issues because benefits will tend to flow to the better educated and wealthier groups. In terms of availability of infrastructure and services, implementation of the RPDP would lead to improved health care services, but does not address broader issues such as waste and wastewater management or access to green space. Because of the gaps in the RPDP, its implementation will not lead to fulfilment of its own social and equity related goals - nor will it provide substantive support for realising national and regional social and equity goals.

10.3 SD objectives and indicators

Social equity is a central consideration of national urban and regional planning in Thailand. For example, the objectives outlined in Thailand's 12th NESDP (2017 – 2021),[77] require that (i) provincial cities should be "liveable cities for all", (ii) economic development should enhance community living standards, and that (iii) regional growth and economic opportunities should be distributed equitably. And, in terms of ensuring Thailand's competitiveness, the Thailand 4.0 strategy emphasises "greening" cities.[78] Those national level commitments are reflected in the sustainability objectives and indicators for social equity that were developed with stakeholders during the course of the SEA (Table 10-1).

Table 10-1: Strategic issues, sustainability objectives and potential indicators for the urban sector

Strategic issue	Sustainability objective	Indicators
1. Rapid registered and unregistered population growth 2. Availability of infrastructure and services 3. Growing socio-economic inequality	Strengthen community resilience and inclusive development based on the sufficiency economy philosophy and environmental sustainability	▪ Poverty rate ▪ Graduation rates from secondary school ▪ No. of people per household, ▪ Access to public facilities i.e. hospitals, schools, public transport and green space ▪ Total number of residents in province ▪ Employment rates ▪ Doctors and hospital beds per head of population

10.4 Sustainability measures for social equity

The underlying purpose of development planning in Rayong is to improve the livelihoods, living conditions and health of its residents while making a major contribution to meeting national economic goals. To realise the goals defined in the RPDP and the 12th NESDP (2017 – 2021) practical measures and directions need to be included in the plan. Table 10-2 provides the details of measures that should be adopted during review of the current RPDP and included in future iterations of the RPDP (as well as in related national and regional policies and strategies). The measures in Table 10-2 focus on actions within the remit and influence of the RPDP and of the Rayong provincial authorities. The table includes measures which may require policy innovations, funding and technical support through national line agencies such as the Department of Health, in support of the programs of provincial authorities.

Table 10-3 details the actions needed to address the strategic equity issues of concern to development in Rayong that are likely to be outside the remit and/or influence of the RPDP and provincial authorities.

[77] https://www.nesdb.go.th/nesdb_en/ewt_w3c/ewt_dl_link.php?nid=4345

[78] There is a growing literature linking the competitiveness of urban economies with urban liveability, this is of particular importance as countries try and avoid the middle-income trap. 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

Table 10-2: Actions for inclusion in next RPDP (2021-2025)

Strategic issue of concern	Action and description	Responsible Agency	Time horizon
Rapid registered and unregistered population growth	**10.1 Regular provincial level census data collection** Rayong attracts both domestic and international migrants who range from highly-skilled to low-skilled. The increasing in-migration means that Rayong has a significantly higher population growth rate than the national average. Many migrants do not register as having moved into the province, meaning data on their residential status in Rayong is not officially collected. To address this, the province should implement census data collection programs on a 2 or 3 year rolling basis. To minimise costs, simplified census protocols as well as data collection and analysis should be used. Priority actions to implement this are: i) Identify whether town and country planning has sufficient (and trained) staff to undertake regular rapid provincial censuses; ii) Recruit and train additional staff as necessary for data collection and analysis; iii) Resource provincial census taking (vehicles, census equipment, GPS systems); iv) Develop the rapid census protocol to ensure a consistent approach among data collection and data analysis teams; v) Mandate a regular census taking period (e.g. every two years or every three years), including day or days during the year when the census will take place.	Town and Country Planning Department Rayong and Rayong Governor's Office.	Next 2 years
Availability of infrastructure and services	*Necessary improvement of urban planning controls and public transport systems is detailed in the urban development chapter. Rayong should give priority to policies and incentives for nature-based infrastructure solutions. With the poor state of existing wastewater treatment capacity in Rayong, priority nature-based infrastructure should include waste-water management. There are other opportunities in Rayong for enhancing sustainability and liveability through the use of nature-based infrastructure and services.*		
	10.2 Implement nature-based and hybrid water and waste-water management systems There is significant opportunity in Rayong to use nature-based infrastructure for enhancing health and well-being outcomes. For water management and flood control, nature-based systems can conserve water resources, recharge ground water, and slow down water flows, particularly during heavy downpours, thus improving the flood management capabilities of urban areas. Nature based measures have significant benefits for the wellbeing, amenity and health of residents. The following measure should become standard practices in Rayong's urban development: bioswales, permeable pavements, bio-retention ponds, urban and natural drainage channel restoration, green roofs, rainwater harvesting systems, soakaways, infiltration trenches, rain gardens, and detention basins. While not yet included in the RPDP, there are plans to install new wastewater treatment systems in Rayong. The recognised need for wastewater treatment is an opportunity to enhance sustainability, by considering and using	Department of Public Works, in collaboration with the Town and Country Planning Department	Next 5 years

	decentralised nature-based and/or hybrid systems in addition to rehabilitation of the three existing treatment plants. For example, there are numerous areas in Rayong where constructed wetlands (CWs) could complement conventional drainage to treat storm water and domestic grey water. CWs are a cost-effective way of reducing BOD/COD, nitrogen, phosphorous and suspended solid loads in wastewater.[79]		
	10.3 Establish accessible parklands and green space for recreation, temperature moderation, and for improving air quality.	Town and Country Planning Department, with the Rayong Provincial Administration Office	Next 5 years
	Accessible green space significantly increases the liveability of urban areas, in line with Thailand's 12th NESDP (2017 – 2021). For example, the World Health Organization notes that 3.3% of deaths worldwide can be linked to a lack of access to green spaces because of their importance for physical and mental health.[80] Measure required in the RPDP include: ▪ Develop targets for green space and its accessibility - The target for total green space in urban areas should be at least 9 – 10m^2 of publicly accessible green space per urban resident in line with global standards and the EEC environmental management plan; ▪ Ensure the total green space target takes into account all residents (i.e. unregistered and registered); ▪ Targets for urban green space should include a target for the average amount of time it takes for residents to walk to their nearest publicly accessible green space (e.g. in the European Union, universal access to green space means that every household should be within 15 minutes walking distance of public green space[81]). ▪ Universal access (as per sustainable development goal (SDG) 11.7[82] means that all groups have access to green space, including women, children, elderly people, people with disabilities, poor people, and unregistered migrants.		
	10.4 Implement a city greening program	Town and Country Planning, Rayong	Next 5 years
	Greening programs can extend far beyond provision of public parks. For example, in Rayong, an urban greening program should include the following measures: ▪ Develop roof gardens for energy and water conservation and to reduce the urban heat island effect – while enhancing amenity and benefits to public health,		

[79] For an analysis of CW systems, see Polprasert, C. (2004) "Constructed Wetlands for Wastewater Treatment: Principles and Practices" Available at: https://doi.org/10.1016/B978-044451691-6/50019-3

[80] See the WHO webpage: Health and Sustainable Development (Urban Green Spaces), available at: https://www.who.int/sustainable-development/cities/health-risks/urban-green-space/en/

[81] See Pafi *et al.,* (2016) Measuring the Accessibility of Urban Green Areas, available at: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC102525/190916_siragusa_%20jrc_techrep_accessibility_online.pdf

[82] See SDG indicators and monitoring framework, at: https://indicators.report/targets/11-7/

	▪ Develop vertical gardens. Vertical gardens means trees, grasses and other edible plants grown on the walls of buildings, and on other vertical surfaces.; ▪ Reduce the area of hard surfaces and replace with permeable surfaces wherever feasible. ▪ Establish a network of natural corridors throughout the province for cycling, walking and jogging.[83];84 Nature corridors promote physical activity, which has public health benefits, and if linked to transport can help to reduce transport related pollution.		
Growing socio-economic inequality	*With expected continued high rates of in-migration, with a likely increase in the proportion of highly skilled migrants under EEC development planning, Rayong needs to look for ways to deliver benefits in an equitable way for new and existing residents, and particularly for those at the lower end of the socio-economic scale.*		
	10.5 Implement transition support programs to assist rural to urban migrants (and other poorer socio-economic migrants), as more young people are leaving their family farms looking for livelihood opportunities in industry, commerce and services	Rayong Provincial Administration Office,	Next 2 – 3 years
	Transition support should include: ▪ Assistance with finding suitable accommodation (including assistance negotiating with landlords); ▪ Retraining opportunities matching available work and new skills needed in industry, commerce and services; ▪ Assistance in accessing the vocational and other training opportunities (for example, locating suitable courses and tuition loans and relevant apprentice schemes); ▪ Assistance with social networking and support		
	10.6 Expand vocational and other training opportunities, focussing on training that is in line with the likely needs of new industries under the EEC development program;	Rayong Governor's Office, Vocational Education Commission	Next 5 years
	Measures in support of vocational training programs include: ▪ Employment of teaching staff ▪ Establishment of training facilities including classrooms and equipment ▪ Developing linkages so that industry placements are included in training programs; ▪ Targeting groups most in need to support and enterprises most in need of skilled workers		
	10.7 Expand and establish environmental and public health awareness raising and education, and community action programs	Department of Health, Rayong Provincial	Next 2 – 5 years
	Rayong should develop and implement sustained public awareness raising and community action programs in the following areas:		

[83] See e.g. https://climate-adapt.eea.europa.eu/metadata/adaptation-options/green-spaces-and-corridors-in-urban-areas
[84] See e.g. https://www.mvrdv.nl/projects/208/seoullo-7017-skygarden

	▪ Disease awareness and prevention for communicable diseases (e.g. avoidance of food and water borne illnesses) ▪ How to manage community solid waste to avoid attracting disease carriers such as rats, cockroaches and mosquitos; ▪ Environmental health awareness raising programs to be delivered in schools and to community groups ▪ Community clean-up and solid waste management programs; ▪ Community-based reduce, reuse and recycling programs; ▪ Community level disaster preparedness plans (e.g. forming flood management groups, developing evacuation plans and "buddy systems", as well as food and medical aid plans)	Administration Office	
	10.8 Develop and use indicators for measuring social inequality in regular surveys Because access to information is the basis of evidence-based policies and programs, it is important for Rayong to map data on social inequality across socio-economic groups. For example, Rayong should be collecting and publicly publishing the following types of data: ▪ Educational attainment indicators disaggregated by gender and household location; ▪ The proportion of industry employees who were born or grew up in Rayong, disaggregated by gender; ▪ The proportion of commercial sector enterprises with a head/director who was born or grew up in Rayong, disaggregated by gender; and, ▪ The inclusion of poverty indicators in the 2 or 3 yearly census, including the birthplace of those who live below the poverty line.	Rayong Provincial Administration Office	Next 2 – 3 years

Table 10-3: Actions by national agencies to support the next RPDP (2021-2025) and sustainable development in Rayon

Strategic issue of concern	Level	Action and description	Responsible Agency	Time horizon
Growing socio-economic inequality	National	**10.9 Integrate of environmental health into national primary and secondary school curricula with pilot application in Rayong Province** Behavioural change is very difficult to measure, and is difficult to achieve without a clear simple message that is delivered repeatedly to the target audience.[85] For this reason, action at the provincial level will be insufficient without a nationally developed curriculum based on most up to date environmental health teaching	Ministry of Education, Ministry of Health	Next 5 years

[85] See https://www.lboro.ac.uk/orgs/well/resources/well-studies/summaries-htm/%23brief165.htm

		methodologies. Development of a national curriculum for environmental health should follow the following steps including piloting in Rayong Province: ▪ Review of international best practice on environmental health teaching; ▪ Design of a Thai curriculum suitable for local circumstances, which is then compared with the international best-practice review; ▪ Training of teachers and implementation of a pilot intervention in selected schools of Rayong province, with a well-defined target audience that includes representation from lower socio-economic groups such as rural-urban migrants, low-skilled groups, and people living in poor accommodation. ▪ Selection of a second EEC province as a control that has similar characteristics to Rayong province, so that pilot intervention induced changes can be documented and compared with a non-intervention site; ▪ Evaluation of impacts of the environmental health teaching program at regular intervals over a two year period, using the control province as a comparison bench-mark		
		10.10 Study the declines in agricultural land area and numbers of farming families in Rayong While it has been well documented that agricultural land area and numbers of farming families in Rayong are both reducing, the reasons behind this are not clear. In order to better understand the issue and address its root causes, Rayong should implement a short-term ethnographic study to identify and interview families who have given up their farming lands. The purpose of the research should be to: ▪ Better understand of the reasons that families are leaving their farms; ▪ Better understand the experiences and challenges faced by families who leave their farms; ▪ Inform and define policies and actions to more effectively target declines in the agriculture sector. ▪ Inform and define special structural adjustments programs to support Rayong farming families which leave the land to adjust to new conditions and lifestyles with gains in quality of life	Ministry of Agriculture, Department of Agriculture	Next 2 years
	National line agencies	**10.11 Expand Environmental Health education and community action programs** Environmental health education programs need to be targeted and relevant. There are three areas of work that should be undertaken to help inform environmental health education programs: ▪ The Rayong Health Department should work with the Rayong Provincial Administration Office to establish target groups (e.g. those who are vulnerable to environmental health threats because, for example, they live in flood prone areas, their housing is substandard, or they do not have the resources to pay for medical treatment and ancillary costs); ▪ Identify the most prevalent communicable environment related diseases in Rayong; ▪ Identify model community action program activities that will support improved health and engage community members.	Department of Health, in Collaboration with Rayong Provincial Administration Office	Next 2 – 5 years
	Reg..	**10.12 Expand vocational education and development for Rayong**		Next 5 years

		Vocational education and training needs to be targeted at an appropriate population, and needs to be training people for the opportunities that will be available when they graduate. For this reason, the EEC Office and the Vocational Education Commission should: ▪ Conduct a review of the current skills needed for industry in Rayong, as well as the projected trends in skills and vocational training in order to satisfy industry labour demand over the next 10 years. ▪ As part of Thailand's efforts to escape the middle income trap, and in line with the Thailand 4.0 strategies,86 the Vocational Education Commission should use the review results to invest in training centres in Rayong, with a specific goal of training Rayong people for EEC related opportunities	EEC Office in collaboration with Vocational Education Commission	

[86] See e.g. https://www.boi.go.th/upload/content/Thailand,%20Taking%20off%20to%20new%20heights%20@%20belgium_5ab4e8042850e.pdf

10.5 Effect of measures on trends in social equity strategic issues on other thematic areas

The measures included here to better understand population growth and population movement into, as well as within, Rayong will have a number of mutually reinforcing effects that relate to other thematic areas of the SEA. It will provide more detailed and up to date information on population trends and other demographic factors, which will greatly assist with town planning and provide a strong basis for major investments such as those relating to wastewater management, public health services and public transport. Expanding vocational education programs in the province will support industry by providing a ready source of appropriately skilled and qualified labour.

Incorporating green infrastructure and nature-based solutions in Rayong, including green space and parkland development, nature-based grey water management, and green corridors will have a variety of cross-thematic benefits, particularly in relation to urban development. They will have a positive impact on environmental quality, such as air quality and water quality; and improve public health outcomes, particularly if green corridors and parklands are implemented in conjunction with initiatives to promote an active lifestyle and active modes of transport. They will lead to water and energy conservation benefits. Also, they will support Rayong's long-term viability as a cutting edge industrial centre, by enhancing its attractiveness for potential workers and managers, as well as enhancing Rayong's attractiveness as a tourism destination. Nature based solutions help to address climate change related impacts such as the urban heat island effect.

10.6 Conclusion

Rapid population growth, including both registered and unregistered migrants, as well as poor availability of infrastructure and basic services are contributing to growth of social inequality in Rayong. Registered migrants tend to be better educated and have access to better quality housing and better medical care. Unregistered migration raises population levels, but does not add to provincial budgets to provide much needed public services. Livelihood and health related impacts of poor waste and wastewater management in Rayong tend to have adverse effects on poorer socio-economic groups.

Failure to address issues of widening social inequality will undermine provincial development and the image that regional and provincial authorities are trying to create of the EEC provinces as liveable, attractive places to come and work. For example, a further widening of the gap between rich and poor is likely to result in more visible slum areas, pollution havens and petty crime. Without active intervention by government, increasing urbanization in Rayong is likely to be linked to lowering living standards and reduced overall well-being for significant segments of the population. This would reduce Rayong's ability to contribute to regional and national goals and aspirations, such as those included in the EEC development plans and the Thailand 4.0 strategies.

The current RPDP should address these issues much more effectively. Table 10-2 and Table 10-3 provide measures for Rayong authorities, as well as regional and national bodies, to achieve social equity and broader macro-economic and environmental goals.

11 FORESTS AND TERRESTRIAL BIODIVERSITY

11.1 Introduction

This chapter is concerned with increasing forest cover and connectivity in Rayong Province. It sets out sustainable development measures for reinforcing and enhancing the management of areas where natural forest remain, in particular protected areas. It gives special emphasis to expanding forests across the province's agricultural landscape, especially within rubber plantations which cover much of the province. And it stresses the importance of expanding green spaces within urban and industrial zones.

Over the last decade, there has been little forest cover change in Rayong with loss at less than 0.3% each year. Remaining original forest is concentrated in protected areas (i.e. national parks and wildlife sanctuaries) which are increasingly well-managed. Most of the remaining forest is in Khao Chamao District and the islands off Muang and Klaeng Districts. Known endangered and endemic species of Rayong Province are found in these protected areas, where they have the best chances of survival. Wildlife poaching and illegal logging do not appear to be major issues, and forest encroachment is negligible.

Connectivity between Khao Chamao National Park and the rest of the large Eastern Forest Complex (EFCOM) spread across parts of five provinces is essential for maintaining large-scale ecosystem processes, and populations of large wide-ranging species including elephants and other large mammals. Human-elephant conflict is a growing issue, especially in the area of mixed patches of forest and agricultural land in the landscape connecting Khao Chamao with Khao Ang Rue Nai, and traffic accidents involving elephants are increasing.

The situation across the rest of the province is very different with small patches of degraded forest remaining but limited effort to protect or rehabilitate them or to establish corridors to increase cover across the landscape – a strategy which is critical if Rayong is to contribute to the 40% national target for forest cover and net gains in biodiversity and for increased green space in urban areas. It is essential for enhanced quality of life within the province.

Patches of National Reserve Forest are scattered across Rayong managed as community forest. Some reforestation activities are being conducted on a small scale. There is increasingly interest in restoration planting/enrichment planting in these small forest areas, sometimes supported by private sector CSR initiatives. These community forests could see increases in both area and quality of forest over time and form the basis for re-establishing forest corridors. As things stand, most patches are too small to be of significant biodiversity value, although they are likely important for local ecosystem services and certainly for recreation and amenity values.

11.2 Gaps in the RPDP

The RPDP supports economic development of the province, led by continued industrial development as well as by the transport, tourism and agriculture sectors. It is not a plan which effectively promotes and has content to realise ecological sustainable development. Apart from some small coastal forest initiatives, there is no recognition in the plan of the importance of forest cover and of protected areas in Rayong's economic and social development. There are no measures to increase urban green space from one of the lowest levels in Thailand as an essential strategy for community quality of life. There are no measures to plan and to create forest and biodiversity corridors across the urban and agricultural landscape and to bring back vegetated natural drainage corridors. And there are no measures to support and extend the connectivity between protected areas in the North East before opportunities to do so are lost to poorly planned road expansion and potential ribbon development.

In the coming decade, growth in the economic sectors will lead to large increases in water demand. Continued employment driven migration into Rayong from other provinces and from neighbouring

countries will increase household water consumption. The RID and East Water are planning to meet demand through a strategy of continued increases in supply. That approach involves the construction of new reservoirs, and inter-basin transfers, including transfers from Chantaburi Province – and further into the future, even from Cambodia. Construction of these reservoirs and the pipelines for inter-basin transfers could cause some additional losses and degradation of forests – if not directly in Rayong Province, then in the interconnected forests of the Eastern Forest Complex (EFCOM) as a whole – a landscape of global biodiversity importance.

The RPDP does not consider the province's resource use footprint on forests and biodiversity of the neighbouring provinces, and offers no activities to address this issue. Most investments planned in the RPDP are for the transport sector. Widening and upgrading of roads that already have fragmented, degraded and replaced forests in the province will further reduce the possibilities for reconnecting them in the future. The RPDP does not contain an overall strategy to avoid or minimize impacts of road construction on forests and the EIA process is proving to be an inadequate tool for the task. Broader landscape planning and standards are required.

The RPDP has a number of small activities aimed at replanting forests and ecological restoration. Yet, these are not of sufficient size to increase in any significant way Rayong's very low level of forest cover. The plan does not foresee the application of new policy approaches and tools such as PES, and does not provide any mechanisms for mainstreaming ecosystem enhancement and conservation in economic development sectors and in urban expansion within the province.

11.3 Sustainable development objectives and indicators

During the scoping phase of the SEA the strategic issues of concern to development of Rayong were identified for each theme or sector with stakeholders. Sustainability objectives were identified for each of those strategic themes and issues linked to indicators for measuring progress in their achievement. The two strategic issues of concern identified for the forests and terrestrial biodiversity theme are forest fragmentation and forest cover (Table 11-1).

Forest fragmentation is the breaking of large, contiguous forested areas into smaller pieces of forest. Those pieces are separated by roads, agriculture, utility corridors, urban expansion and subdivisions, and other development.[87] Over time, those non-forest patches tend to multiply and expand until eventually the forest disappears or is reduced to scattered, disconnected islands, seriously threatening the health, function, and value of the remaining forest ecosystems. That process of fragmentation occurred in Rayong province mainly during the period 1950 to mid-1980. The aim of the sustainable development objective for this issue of concern is to increase forest connectivity – which is the opposite of fragmentation.

Land which is forested, usually has a crown cover equal to or greater than 20 per cent for any given area. Forest cover is really an indicator of the condition of forest ecosystems and of the environmental and social benefits they bring. In urban, agricultural and industrial areas forest cover can still be measured according to the canopy created by remaining forest patches and trees planted. Usually urban tree cover includes vegetation in streets, parks, gardens, plazas, campuses, river and creek embankments and buffer zones, wetlands, railway and road corridors and community gardens (Figure 11-1 (a) and (b)). For example Melbourne in Australia has a forest cover target of 40% by 2040. The concern of stakeholders in the SEA was more the loss in forest cover as development progressed in Rayong; that the current forest cover is inadequate for continued community well-being and public

[87] Michael Snyder. 2014. What is forest fragmentation and why is it a problem, Northern Woodlands, https://northernwoodlands.org/articles/article/forest-fragmentation

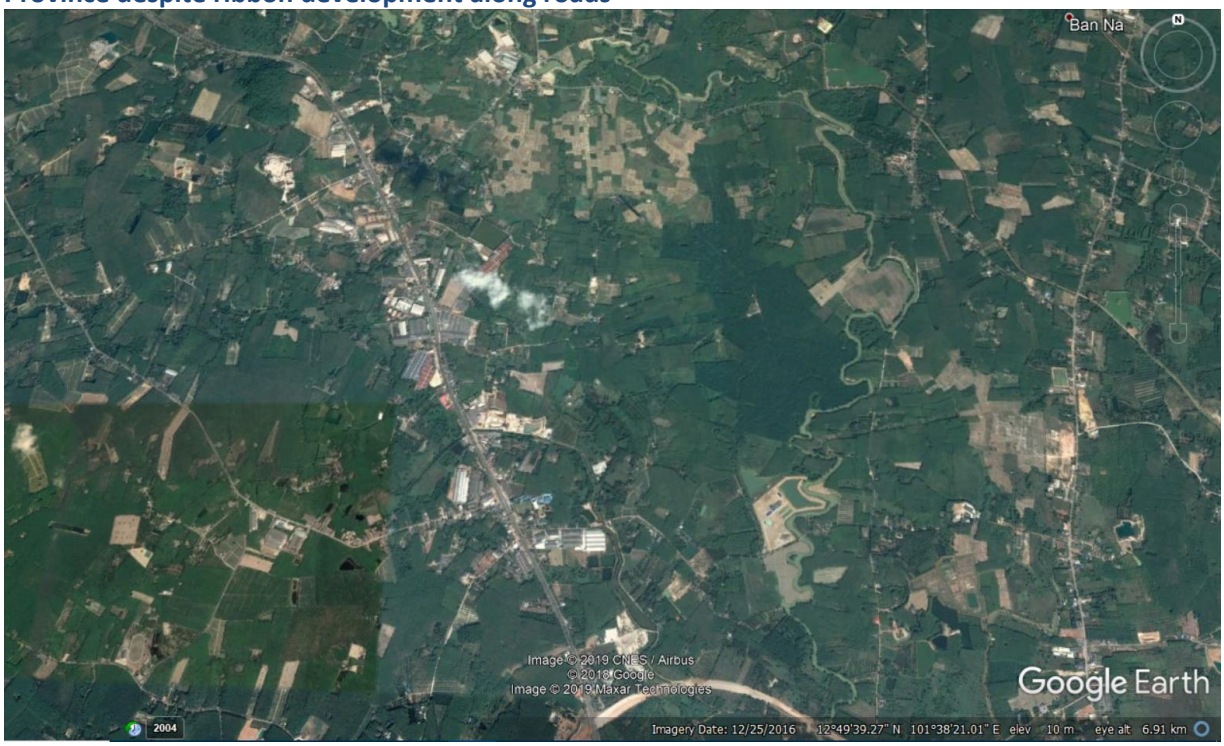
health. The aim of the sustainable development objective for this issues of concern is to increase forest cover throughout Rayong Province.

Table 11-1: Strategic issues, sustainability objectives and indicators for forests and terrestrial biodiversity in Rayong

Strategic issues of concern	Sustainability objectives	Indicators
Forest fragmentation	Conserve, restore and enhance biodiversity in Rayong	▪ #/size of areas where forest connectivity has been restored ▪ Management effectiveness of protected areas in Rayong ▪ # of visitors to national parks and their satisfaction rating
Forest Cover	Increased forest cover throughout the province	▪ Total forest cover of Rayong Province

Figure 11-1 (a): Lost opportunities for creating forest cover and green space in Rayong's urban development

Figure 12.1 (b): Remaining opportunities to increase forest cover in agricultural areas of Rayong Province despite ribbon development along roads



More broadly, Thailand is seeking to implement the SDGs and to meet associated targets. For biodiversity SDG 15 calls for "Sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss". The SDG 15 2020 to 2030 targets of direct relevance to Rayong Province are:

15.1: Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests and wetlands

15.2: Halt deforestation, restore degraded forests and substantially increase afforestation and reforestation

15.5: Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and protect and prevent the extinction of threatened species

15.8: Introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species

15.9: Integrate ecosystem and biodiversity values into local planning development processes and poverty reduction

15.a: Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems

11.4 Forest and terrestrial biodiversity sustainability measures

The two priorities for sustainability under this theme are to protect and enrich existing forests and to create new forested areas.

A key component of the SD pathway will be effective management of Rayong's protected areas and any remaining forest to ensure no further major losses of forest and terrestrial biodiversity. The Provincial goal from now on should be "no net loss of biodiversity" or better still - "net gain in biodiversity". That commitment requires a special focus on the protected areas and the relatively small patches of national forest and community managed forests. From those forest nodes or core areas, the aim is to extend forest cover across all land uses – agriculture, urban and industry – to create

corridors, extend forest patches and to "green" all forms of development so they contribute to increased forest cover and biodiversity enhancement.

Together with forest restoration and other forms of well-planned tree planting and green space expansion across the province, these measures 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.

Principles embraced in Thailand's 2019 forest and conservation legislation should guide implementation of the forests and biodiversity SD pathway measures in Rayong including:[88] [89] [90]

(i) Each sector should mainstream forest and biodiversity concerns into its sectoral planning
(ii) Provincial and sectoral development plans must avoid serious or irreversible damage to forests. Alternative development options that would cause no, or minimal damage should be prioritized.
(iii) Environmental management plans (EMP) should be prepared for each of the eight districts (amphoes) in Rayong province focusing mainly on environmental quality but reinforcing the Rayong and district Forest Strategies and actions plans proposed in this chapter and to ensure any unavoidable damage from development actions is subsequently restored (the EMP requirement for districts is described in more detail in Chapter 13 on environmental management).
(iv) In the worst case scenario where damage is unavoidable and cannot be restored at the site, or when a developer cannot meet a required forest cover target for the site then biodiversity offsets should be required.[91]
(v) In future development of Rayong there should be No Net Loss (NNL) but a Net Gain (NG) of biodiversity when projects take place.
(vi) Local communities should be involved in identifying, designing, implementing, managing and monitoring replanting of forest and should share in the benefits derived from the restored forests
(vii) Cost effective and flexible policy instruments should be adopted to drive ecological sustainability, such as valuation of biodiversity and ecosystem services; adequate pricing of natural resources (including raw water), payment for ecological services (PES), and other incentive mechanisms.

In practice, in areas where little or no forest and biodiversity remains, the principals concerned with protecting forests have little relevance for the immediate future. In most areas, the emphasis needs to be on establishing and expanding forests and progressively protecting them from future encroachment and degradation.

In the following sections SD measures for increased forest cover and connectivity are considered for Rayong's protected areas and buffers, its agricultural landscape and for urban and industrial areas.

[88] Wild Animal Reservation and Preservation Act (WARPA), 2019 (an updated version of WARPA 1992, itself an update of WARPA 1962 - http://www.ratchakitcha.soc.go.th/DATA/PDF/2562/A/071/T_0104.PDF
[89] National Park Act 2019 (an update of the National Park Act of 1961) http://www.ratchakitcha.soc.go.th/DATA/PDF/2562/A/071/T_0145.PDF
[90] Community Forest Act (2019) - http://www.ratchakitcha.soc.go.th/DATA/PDF/2562/A/071/T_0071.PDF
[91] Biodiversity offsets are measurable conservation outcomes designed to compensate for adverse and unavoidable impacts of projects, in addition to prevention and mitigation measures already implemented - https://www.iucn.org/resources/issues-briefs/biodiversity-offsets

The objectives need to apply across the entire province but measures and targets will differ for each land use category.

11.4.1 Increasing forest cover and connectivity in Rayong's protected areas

Institutional arrangements for managing Rayong's protected areas: A number of policies are already in place that help provide an enabling framework for the effectively managed protected areas within the province. DNP has a policy to support protected area managers and their staff in developing management plans for their protected areas. Key staff from each area receive training in how do this. The plans they develop are reviewed by experts in protected areas management from Thai universities. DNP also has a policy to establish Protected Areas Committees (PACs) for each protected area; as well as PACs for overall Protected Area Complexes such as EFCOM. Khao Chamao-Khao Wong National Park (KCKWNP) and Khao Ang Rue Nai Wildlife Sanctuary (KARNWS) each have their PAC. Also, steps are being taken to develop a complex-wide PAC for the entire EFCOM.[92]

The PAC is a formally recognized mechanism for participation of interested provincial stakeholders in management of the protected areas. It provides an institutional link between the protected area management planning, and the provincial development planning processes, providing opportunities to identify potential issues with planned development that might impact the protected area, as well as opportunities for synergy between the work of DNP and other agencies at the provincial level.

Re-establishing connectivity between protected areas: Connectivity between the forests of Rayong and the wider Eastern Forest Complex landscape covering parts of five adjacent provinces, will ensure the survival of significant populations of large wide-ranging mammals, and the maintenance of large-scale ecosystem processes.

Connectivity of Khao Chamao-Khao Wong National Park with Khao Ang Rue Nai Wildlife Sanctuary and the rest of EFCOM has been recognized as a priority by 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. Four new water sources, check dams and plantations of elephant food species have been developed in a corridor to encourage elephants to move through this part of the landscape, where they will create less conflict and have less chance of being injured. Salt-lick areas have also been enhanced. Much of this work is being funded as a CSR initiative by Kubota Farm Machinery Company. There is a plot of land at the elephant conflict area in the north that was purchased from villagers with money raised by monks through merit-making events. This is now being use for revegetation and protection of the elephants. This land will not be used for any development.

In the broader EFCOM landscape, DNP and The Highways Department are working on approaches to re-establishing connectivity through tunnels and fly-overs. A model for this already exists 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 EFCOM 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.

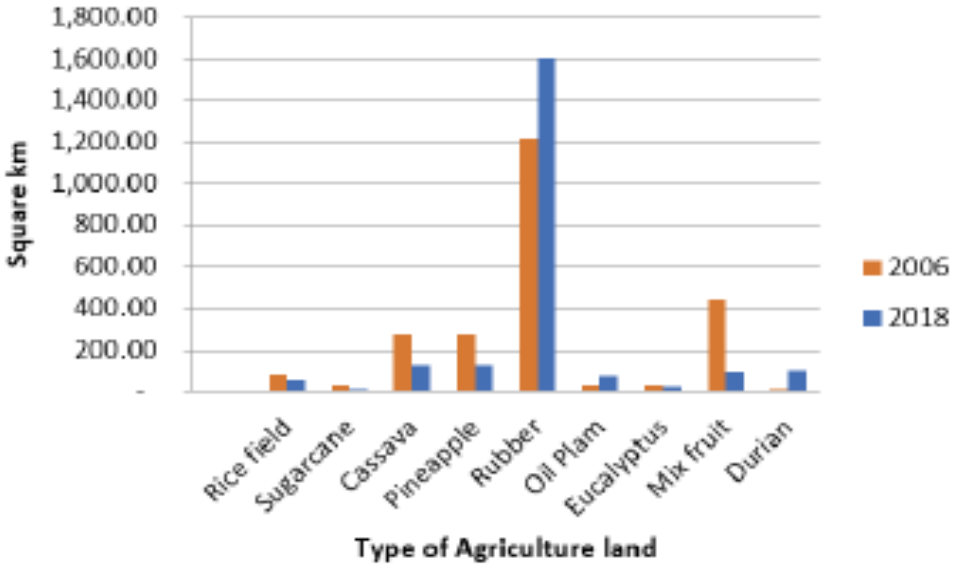
11.5 Increasing forest cover and connectivity across Rayong's agricultural landscape

[92] The process of setting-up an EFCOM PAC was initiated by the GEF/UNDP/DNP Project "Catalysing Sustainability of Protected Areas" (CATSPA). The EU funded project "Biodiversity Conservation and Protected Areas Management" (BCAMP), implemented by the ASEAN Centre for Biodiversity (ACB) will continue to build on this foundation, over the next 2-3 years.

As Rayong developed, an appreciation of the critical role that natural systems play in social and economic well-being was lost – it was a matter of development at all costs and largely driven from national level. The province was cleared of native forests and wetlands to be replaced with monoculture, and then urban settlements and industry. Now, as strongly reflected in the views of SEA stakeholders, there is a demand to bring nature back as an integral part of provincial development with all the economic, social and ecological benefits that entails. The very positive conclusion of this SEA is that there is great potential to do that within the agricultural sector to the benefit and diversification of farm livelihoods.

Rubber plantations as key areas for biodiversity enrichment: The main reason for that optimism is the substantial dominance of rubber in terms of land cover in the province and agricultural incomes. Many other crops are grown, but increasingly rubber has become the mainstay of the provincial agricultural sector. In 2018, agriculture occupied close to 68% of provincial area. Rubber plantations occupied 66% of agricultural area or 45% of provincial area (Figure 11-2).

Figure 11-2: Land-use type categorized in agricultural area in 2006 and 2018



Source: SEA baseline assessment report 2019

Generally, increasing the tree cover in agricultural landscapes can support plant and invertebrate biodiversity and significantly improve ecosystem functions that underpin ecosystem services.[93] Rubber plantations in particular provide opportunities for agro-ecological strategies because diversity in plant communities can be added without affecting – and potentially adding to – overall production and farm revenues.

Conversion of native forest to rubber is not good for biodiversity. But, the shift from an annual cash crop such as cassava to rubber - a trend in Rayong - has been shown to bring positive impacts on soil biodiversity and associated ecological functions through continuity of organic inputs, reduced tillage, lower input of mineral fertilizers and maintenance of soil moisture.[94] Those benefits are greatly

[93] Edmundo Barrios et al, 2017. Contribution of trees to the conservation of biodiversity and ecosystem services in agricultural landscapes, International Journal of Biodiversity Science, Ecosystem Services & Management, Volume 14, 2018 - Issue 1. Accessed from https://www.tandfonline.com/doi/full/10.1080/21513732.2017.1399167

[94] Ibid - Barrios 2017

multiplied if accompanied by proactive measures to increase mixed forest areas and habitat diversity within and bordering the plantations.

A modest start in rubber monoculture plantations to improve species diversity is the promotion of natural undergrowth vegetation to enlarge suitable habitat structures in connection with natural forest patches. This can be achieved by reducing weeding and herbicide application and potentially through the cultivation of useful wild plants.[95]

More significant, buffer zones, within and around rubber smallholder and rubber plantation areas, can play a key role in creating a fabric of interconnected forests as stepping stone natural corridors for animals and plants to move from one area to another. Native vegetation in rubber agroforest areas increases wildlife carrying capacity and diversity. Plantings are feasible along riparian areas, either side of main roads and within a plantation, along roads, in specially created pockets and on steep slopes. The aim is to create refuges and reproduce habitats for wild plants and animals in plantations to enhance the conservation of biological and genetic diversity that underpins regulation and production ecosystem functions.[96] Corridors and vegetation "bridges" need to be established between different parts of a plantation and on the outer boundaries between two land holdings. In those areas, a mix of native trees and understory should be planted to provide food and places for breeding and nesting.

Forest cover linked with wetlands and riparian zones in agricultural regions: Agricultural fields commonly contain natural depressions or marshy areas that concentrate water after storms. Rather than filling them in and planting crops, those areas can be planted with native vegetation as wetlands and drainage corridors. By reducing the rate of surface water flow, such waterways can reduce soil erosion and improve water quality. Similarly, vegetated buffers or filter zones adjacent to streams and watercourses reduce nutrients and sediments entering the water from surface runoff and erosion. A mix of trees, understory species and grasses enhance wildlife diversity and ecosystem services such as storm water storage, ground water recharge, nutrient recycling, sediment filtering, and biological habitats.[97] Most of Rayong's wetlands have been degraded or filled in, but progressively through economic incentives and regulation a network can be rehabilitated and created across the agricultural landscape.

High priority for that kind of wetland and buffer rehabilitation is the riparian areas along the Klong Yai and Prasea rivers mostly passing through agriculture lands. The Rayong Town and Country Planning Office has defined a 12m set back from river banks which should not be developed and instead retained as vegetated buffer. That standard has been largely ignored by land owners and developers with little effort going to enforcement. It is a very important principle that also needs to be applied to set backs along Rayong's canals. For the reservoirs, the intention of the provincial government was for there to be no agricultural activity in a large buffer covering the surrounding watershed – that objective has not be met with cropping up to the edge of each reservoir (Figure 11-3). Rectifying those serious infringements is a matter of high priority during the next round of the RPDP.

---

[95] Pia He and Konrad Martin, 2015, Effects of rubber cultivation on biodiversity in the Mekong Region, SURUMER - Sustainable Rubber Cultivation in the Mekong Region, January 2016 CAB Reviews, 2015, 10, No. 044, Accessed from https://www.researchgate.net/publication/301228715_Effects_of_rubber_cultivation_on_biodiversity_in_the_Mekong_Region

[96] De Groot RS, Wilson MA, Boumans RMJ. 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecol Econ. 41:393–408.

[97] Brian J. MacGowan and Brian K. Miller The Basics of Managing Wildlife on Agricultural Lands, Department of Forestry and Natural Resources, Purdue University, West Lafayette. Accessed 2019 from https://www.extension.purdue.edu/extmedia/FNR/FNR-193-W.pdf

Figure 11-3: Agricultural and industrial encroachment of the Dok Krai and Ngong Pla Lhai reservoirs in Rayong Province

The Industrial Estates Authority of Thailand (IEAT) requires that each estate must include at least 20% green cover. That standard is not well evaluated for quality and existing implementation leads to vegetation of little value for biodiversity and ecosystem services. Even so, a similar approach is needed for agricultural land holdings, especially large plantations, which need to contribute to biodiversity enrichment in a coordinated way against a set of standards and targets.

Measures for increasing biodiversity across agricultural areas: Agricultural regions in Rayong include a wide range of mixed land uses. Rubber dominates, but a further 23% of the province is occupied by other agriculture practices interspersed with still more land for infrastructure, urban and commercial developments. For increased forest cover and connectivity to be achieved in this context of diverse land holdings and uses, a landscape approach should be taken by local authorities with support from the Royal Forest Department and the Ministry of Agriculture and Cooperatives. Rayong Province needs to be identified as a pilot and demonstration of forest restoration and agro-forestry. It is going to require strong national backing to implement the SD pathway for this theme.

The IUCN Forest Program emphasises that to increase forest cover and connectivity requires embracing a number of guiding principles as set out below with adjustments for their application in Rayong:[98]

(i) Work at the landscape scale in creating forest networks and connectivity – Establishing and rehabilitating forests needs to take place within and across entire landscapes, representing mosaics of interacting land uses and management practices under various tenure and governance systems (Figure 11-4, Figure 11-5 and Figure 11-6). It is at this scale that ecological, social and economic priorities can be balanced. It is evident from this principle that national

[98] IUCN Forest Program. 2019. Forest Restoration. https://www.iucn.org/theme/forests/our-work/forest-landscape-restoration

authorities need to be fully committed and involved in an endeavor to make Rayong a well forested province with rich biodiversity – in the midst of agriculture, industry and urban development.

(ii) Rehabilitate, maintain and enhance natural ecosystems – Forest rehabilitation must enhance the conservation, recovery, and sustainable management of forests and other ecosystems across the landscape. This is challenging when so many private land owners are involved and when agricultural livelihoods are under stress. Increasingly, the maintenance of agriculture in Rayong is being viewed as a matter of heritage, cultural integrity and livelihoods diversity – with industry the driving force for economic development. In that case the agricultural sector, its products and livelihoods need to be subsidized by national and local government for their heritage values so long as it functions according to agro-ecological principles. Rayong is the wealthiest province in Thailand measured on a per capital GDP basis. At this stage much of that revenue leaves the province into national coffers. That flow needs to be reversed if broader goals of sustainability and equity are to be achieved.

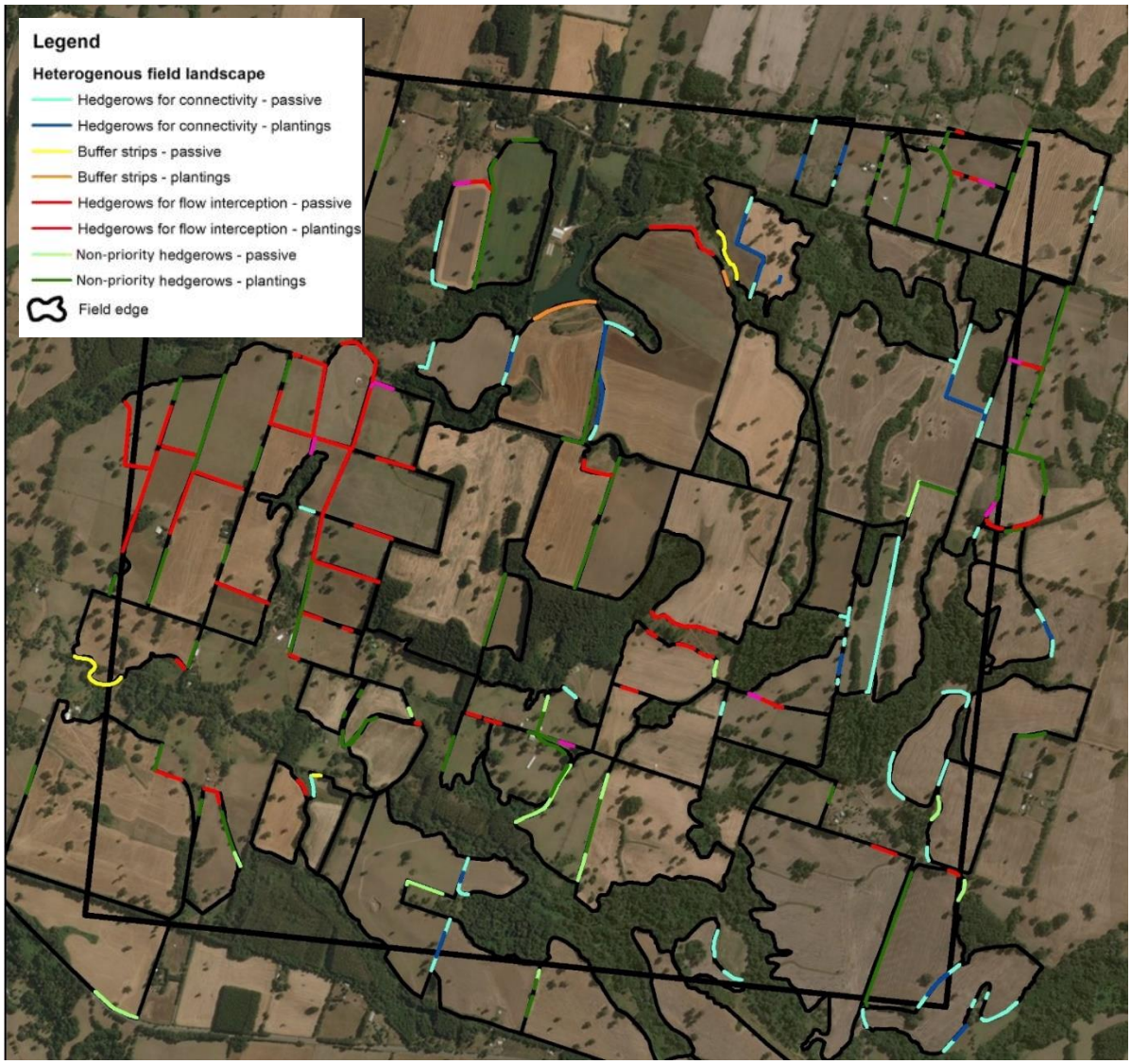
(i) Engage stakeholders – Effective community engagement is the most difficult to achieve with limited staff and financial resources available to local government. Yet, to be successful, the expansion of forest areas can only be achieved in ways that actively engage stakeholders at different scales in planning and decision making regarding landuse, restoration goals and strategies, implementation methods, benefit sharing, and monitoring and review processes.

(ii) Tailor to the local context and knowledge – Expanding forest cover and connectivity needs to be planned on a landscape basis. Yet, the approaches and measures required should be adapted to the local social conditions, ecological needs and potentials, and landscape history. Renewing and restoring degraded, damaged, or destroyed ecosystems and habitats by active intervention needs to be built on the latest science and best practice. Also, it must draw from traditional and local knowledge. And that information needs to be applied in the context of local capacities and conditions.

(iii) Restore multiple functions for multiple benefits – Increasing forest cover in Rayong aims to restore multiple ecological, social and economic functions across the province and to generate a range of ecosystem goods and services that benefit multiple stakeholder groups.

(iv) Manage for long-term resilience – Increasing forest area seeks to enhance resilience across the province over the long-term. Re-establishing forests should enhance species and genetic diversity and be adjusted over time to reflect changes in climate and other environmental conditions, knowledge, capacities, stakeholder needs, and societal values. In other words it is a process of adaptive management with continuing inputs from affected land owners, and local and national government. As rehabilitation progresses, information and lessons from monitoring and stakeholder feedback should shape site specific and landscape wide management. Regular review and revision of the district level environmental management plans proposed in this chapter provides an important vehicle for discussion and adjustment to the forest rehabilitation effort over time.

Figure 11-4: Identifying opportunities for establishing forest corridors across an agricultural landscape

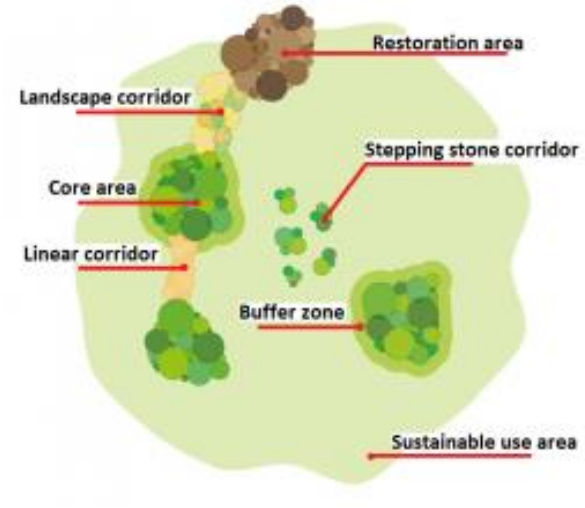


Source: Rey Benayas 2019[99]

In applying those principles the RPDP needs to give priority to establishing a habitat network across the province, with special attention to agriculture areas and the connectivity between them and any remaining forest patches (Figure 11-4, Figure 11-5 and Figure 11-6). Every connection increases the biodiversity of the province as well as enhancing ecosystem services. Figure 11-5 illustrates the concept of forest or ecological corridors made up of varying intensities of use and conservation – with areas for rehabilitation, cores of dense forest and linking areas which can include forests along roads or natural waterways.

[99] Rey Benayas, J.M., Altamirano, A., Miranda, A. et al. 2019. Landscape restoration in a mixed agricultural-forest catchment: Planning a buffer strip and hedgerow network in a Chilean biodiversity hotspot, Ambio (2019). https://doi.org/10.1007/s13280-019-01149-2

Figure 11-5: Habitat networks across agricultural landscapes to enhance biodiversity

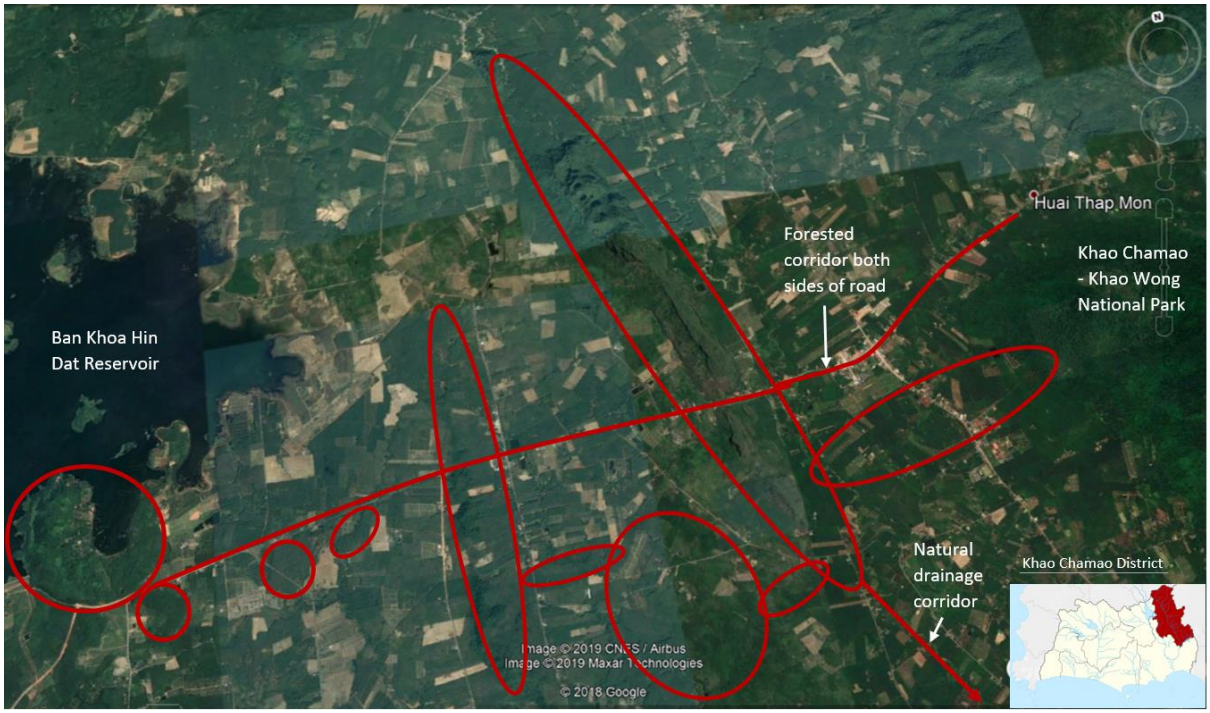


Source: TVERC 2019[100]

Figure 11-6 is an illustration of a rapid first cut at identifying areas which could be investigated for forest expansion, rehabilitation and enrichment in one location in Rayong Province. Similar sketches of potential corridor areas need to be prepared for all Rayong Districts to be followed by intensive field survey and consultation. In the Figure 11-6 example, the overall goal would be to establish a forest corridor between the Ban Khoa Hin Dat Reservoir buffer and Khao Chamao – Khao Wong National Park in the North East corner of Rayong Province and Khao Chamao District. As the corridor moves across and landscape from the reservoir to the national park, various categories of land cover are encountered which provide opportunities for expanding forest cover. They include rubber plantations, a road corridor, natural drainage corridors with streams, stretches of degraded forest and wetlands, and dense forest stands within the park. All land parcels would require special treatment to bring nature back driven by collaborative agreements with relevant national and provincial authorities and local land holders and communities.

[100] Thames Valley Environmental Records Centre, 2019. Accessed from http://www.tverc.org/cms/content/ecological-networks-0

Figure 11-6: Example of potential forest expansion and rehabilitation in corridor sites connecting Khao Chamao-Khao Wong National Park and Ban Khoa Hin DaT reservoir buffer



Source: ICEM 2019 with Google base map

11.6 Increasing forest cover and connectivity in urban and industrial areas

The goal of the SD pathway measures for forests and terrestrial biodiversity is to bring nature back across the entire landscape of Rayong Province to improve citizens' wellbeing, including environmental quality, resource conservation and amenity. That goal applies no matter what the existing and proposed land use in different areas of the province. Urban and industrial areas and infrastructure corridors make up around 25% of Rayong. For those areas, urban forest cover and green space targets needs to be set and monitored. Linked spatial planning and building code regulations should facilitate the steady expansion of forest cover over time so those targets are met.

Urban forest or tree cover acts as a proxy for urban green space. Various indicators can be used to keep track of progress in establishing green space. Total tree canopy cover within a town boundary or within areas designated for urban or industrial development is an important indicator which can be monitored through satellite imagery and GIS analysis. A tree cover baseline needs to be established against which progress in moving towards a target is measured. Green space also needs to be monitored using field survey and compilation of a green space register which locates and describes each area and its progressive improvement. Field survey is necessary to distinguish between public and private green space, the extent of public access and the quality of the vegetation and ecosystems.

11.6.1 Urban - industry forest targets and monitoring

The generally accepted minimum standard for public space in urban areas is 45%, consisting of 30% for streets and sidewalks and 15% for green space.[101] For Rayong which is experiencing a phase of dynamic land use change, and urban and industrial expansion and renewal, that target should be significantly more ambitious. The urban development chapter in this volume proposes 20% by 2040 green space as the target for Rayong's municipalities. For industrial areas a target of 15% forest cover

[101] UN-Habitat (2013.) *Streets as Public Spaces and Drivers of Urban Prosperity.* Nairobi.

and green space by 2040 for the overall industrial zone in the province and 25% for industrial estates (ie up from the current 20% requirement).

Melbourne has adopted an Urban Forest Strategy which sets a target of expanding forest cover from 22% to 40% by 2040. The Melbourne Strategy seeks to implement the following principles: 1. mitigate and adapt to climate change, 2. reduce the urban heat island effect, 3. design for health and wellbeing, 4. create healthier ecosystems, 5. become a water sensitive city, 6. position Melbourne as a leader in urban forestry, and 7. design for liveability and cultural identity.[102] The implementation process involves preparation of Urban Forest Precinct Plans – co-designed with the community – and a ten year planting program. A similar urban forest strategy and linked local government plans are needed for Rayong's municipalities.

Another indicator is tree cover per capita, measuring the tree cover per person living in a defined area. The UN-Habitat recommends that towns aim to establish a minimum of 15 m^2 of tree cover per capita in urban areas. Singapore has 66 m^2 of green space per capita compared to 6.18 m^2 in Bangkok. This indicator is important because it allows for the analysis of equity concerns. Population distribution affects the results of the tree cover per capita assessment. Some areas with heavy tree cover might have low population density, while other areas with low tree cover have high population density. Already, significant inequities exist in Rayong's urban areas, especially those close to industrial activities. These neglected areas need to be the target of urban renewal and green space expansion. The Sustainable Development Goal 11 includes the explicit objective of achieving equitable access to green spaces for all citizens (Target 11.7).[103]

Areas with existing high density development should receive innovative treatment to achieve green space targets. In Singapore, for example, the Landscape Replacement Policy requires developers to mitigate construction-related losses of green space by incorporating "Landscape Replacement Areas" into their new buildings. These areas refer to a landscaped space on the first or upper levels of the development with its total area equivalent in size to the development site's footprint.

11.6.2 Achieving forest cover/green space targets

At the municipal level, forest cover or green space refers to a strategically planned and managed network of natural areas necessary for the sustainability of any urban area. Green space includes use of vegetation, soils, landscaping and complementary technologies to manage water, temperature and air quality and to create healthier, resilient and beautiful urban environments. At the local level, green spaces include linked forested areas with street trees and more densely planted areas, restoration and rehabilitation of natural drainage corridors, and storm water and drainage management systems that mimic nature by soaking up and storing water, and by improving its quality. At all scales, achieving green space targets requires nature based solutions and uses of local resources and materials to build community self-reliance and resilience.[104]

[102] https://www.melbourne.vic.gov.au/community/greening-the-city/urban-forest/Pages/urban-forest-strategy.aspx

[103] Diego Manya, Yihao Xie and Genevieve Westgate, 2019. Urban Tree Cover, Urban environmental and social inclusion index, accessed from https://datadrivenlab.org/urban/issue-profiles/urban-tree-cover/

[104] ICEM. 2015. Nature Based Solutions for Sustainable and Resilient Mekong Towns, Volume 1 of the Resource Kit for Building Resilience and Sustainability in Mekong Towns. Prepared by ICEM – International Centre for Environmental Management for the Asian Development Bank and Nordic Development Fund. Manila (TA 8186). Accessible from https://icem.com.au/portfolio-items/resource-kit-for-building-resilience-and-sustainability-in-mekong-towns/

Green spaces in urban and industrial areas apply what is now referred to as green infrastructure measures including bioengineering. Green infrastructure can cover green streets and alleys, green parking areas, urban parks and gardens, green roofs and walls, and a wide range of water management measures such as bioswales and rain gardens.[105]

Expanding green space in urban and industrial areas and applying the full range of green infrastructure measures in Rayong will require adjustments to the Rayong Comprehensive Spatial Plan, its zoning and development controls and safeguards. It will require a wide range of green area and infrastructure regulations and standards including building codes and minimum standards for development land parcels. Many initiatives to bring natural back can be taken directly be the Rayong authorities in public areas such as road corridors, parking areas and government land and buildings. Other initiatives to be taken by industries and private developers and property owners will need to be directed through regulation and development standards. Effective monitoring of performance and enforcement will be the key to success – and that will require new skills and tools.

Overall the forest and green space expansion will require a major budgetary commitment by the provincial and national line agencies, possibly involving special grants from national government or through global sources such as the Green Climate Fund, and even low interest loans from regional financing facilities such as the ASEAN Catalytic Green Finance Facility set up in 2019 to provide loans and necessary technical assistance for green infrastructure projects such as sustainable transport, clean energy, and resilient water systems.

11.7 Measures for expanding forest cover and green space across Rayong

The tables in this section draw together and summarise the various measures identified throughout this chapter to expand forest cover and connectivity across Rayong Province. First they set out the province wide and landscape actions which lay the foundation for a Rayong Province Forest Strategy and action plan. Most of the province is zoned for agriculture so it is within those cultivated landscapes that greatest forest cover gains can be achieved. Important linked activities to improve connectivity and forest condition within and between protected areas and their buffers are defined. And then, perhaps the most challenging, but equally important, are measures to bring nature back into urban and industrial zones where most of Rayong's population live and work.

Table 2 provides a summary of the sustainable development measures that need to be included in a revised or next iteration of the RDMP together with the key agencies involved and the appropriate timeframe.

[105] https://www.epa.gov/green-infrastructure/what-green-infrastructure

Table 11-2: Sustainable development measures for expanding forest cover and green space in Rayong Province

Strategic issues of concern	Action and description	Responsible agency	Time frame
Province wide actions to expand forest cover and biodiversity			
Forest fragmentation and forest cover	11.1: Prepare a Rayong Province Forest Strategy and action plans for each of the eight districts (amphoes) in the province • Set out the challenges to be addressed, the key strategies for doing so, the institutional arrangements (ie "green governance"), the priority implementation actions, the framework for measurement, monitoring & review and the funding sources and resources. • Establish an overall forest cover target for Rayong Province of 25% by 2040. • Identify the role of each sector in mainstreaming forest and biodiversity concerns into sectoral planning • Embrace the principle of No Net Loss (NNL) but a Net Gain (NG) of biodiversity to be enforced when development projects take place.	Provincial Forest Office and Royal Forest Department with relevant provincial, regional and national line agencies	0-2 years
	11.2: Prepare a Rayong Environmental Management Plan (EMP) and district environmental management action plans • The aim is primarily to enhance environmental quality and management but also to reinforce the forest strategy objectives. • Require strong policy to ensure unavoidable damage linked to development is subsequently restored. • Require developers to establish biodiversity offsets where damage from a development project is unavoidable and cannot be restored at the site. • Requires municipalities and industrial estates and factories to adhere to standards for plantings and maintenance of green space • The EMP requirements are described in more detail in Chapter 13 on environmental management	Provincial environment office in collaboration with the Regional Environment Office, ONEP and the MONRE Department of Pollution Control – and consultation with the DPW and IEAT	0-2 years
	11.3: Establish a program of technical and financial support for reforestation and maintenance of National Reserve Forest areas managed as community forest • The aim is to increase the area and quality of forest over time with the National Reserve Forest patches forming the nodes for establishing forest corridors. • Promote CSR initiatives in support of community forest management and expansion.	Provincial Forest Office and Royal Forest Department with relevant provincial, regional and national line agencies	0-5 years
Expanding forest cover and corridors across agricultural landscapes			

Strategic issues of concern	Action and description	Responsible agency	Time frame
Forest fragmentation and cover	11.4: Establish a network of forest corridors across the province and links between them and any remaining forest patches, with special attention to agriculture landscapes	Provincial Departments of Agriculture and Environment with DNP, RFD and Department of Agriculture	0-2 years and 3-10 years
	• Identify potential corridor areas in agricultural landscapes in all Rayong Districts to be followed by intensive field survey and consultation • Pilot landscape planning and establishing a forest corridor between the Ban Khoa Hin Dat Reservoir buffer and Khao Chamao – Khao Wong National Park		
	11.5: Introduce standards and targets for establishing and retaining native forest and understory vegetation on agricultural land holdings	Provincial Departments of Agriculture and Environment with RFD and Department of Agriculture	0-2 years and 3-10 years
	• Give priority to large plantations, which need to contribute to forest cover and biodiversity enrichment in a coordinated way across the wider landscape • Within rubber plantations, promote natural undergrowth vegetation to enlarge suitable habitat structures in connection with natural forest patches. • Reduce weeding and herbicide application in rubber plantations and cultivate useful wild plants • Create buffer zones of native vegetation, within and around rubber smallholder and rubber plantation areas • Conduct plantings along riparian areas, either side of main roads and within plantations in specially created pockets and on steep slopes. • Establish corridors and vegetation “bridges” between different parts of a plantation and on the outer boundaries between two land holdings. • Plant a mix of native trees and understory to provide food and places for breeding and nesting.		
	11.6: Introduce a pilot program of heritage subsidies to agricultural holdings, their products and livelihoods	Rayong Governors Office, Provincial Finance office, Provincial Department of Agriculture and Department of Agriculture with the Ministry of Finance and NESDC	0-3 years
	• Applies only to those holdings which agree to function according to agro-ecological and sustainability principles and to approaches set out here as the basis for expanding forest area and biodiversity. • This tax innovation requires reforms to the system of agricultural subsidies and to introduce direct payments for heritage and ecological services. • The subsidy would involve direct payments to farmers able to meet biodiversity and heritage goals including expanded forest cover and linking with ecologically important areas.		

Strategic issues of concern	Action and description	Responsible agency	Time frame
	11.7: Progressively rehabilitate and create a network of wetlands across agricultural landscapes through economic incentives and regulation • Integrate restored and created wetlands within the established forest corridors to enrich biodiversity and habitats and expand ecosystem services • Plant depressions or marshy areas that concentrate water after storms with native vegetation to establish natural wetlands and drainage corridors. • Vegetate buffers or filter zones adjacent to streams and watercourses with a mix of trees, understory species and grasses to enhance wildlife diversity and ecosystem services • Restore riparian areas along the Klong Yai and Prasea rivers within the 12m buffer set back from river banks • Create forested buffers around reservoirs and along canals	Provincial Environment Office, with the Provincial Agriculture Office, Regional Environment Office, Department of Agriculture, ONEP, NESDC and Ministry of Finance	0-5 years
	Expanding forest cover and corridors in urban and industrial areas		
Forest fragmentation and cover	11.8: Prepare a Rayong Urban Forest Strategy and Urban Forest Action Plans for municipalities to provide more detailed direction for urban areas as a complement to the Province wide forest strategy and district action plans • Include ten year planting programs for each of Rayong's municipalities. • Review the building code and infrastructure and industrial zone regulations and standards to promote green infrastructure and nature based solutions • Review and adjust the Rayong Comprehensive Spatial Plan and Municipal Spatial Plans, their zoning and development controls and safeguards to guide and provide standards for the urban and industrial green space. • Provide additional enforcement capacity – staffing, equipment and budgets – for monitoring and enforcing Rayong's Urban Forest Strategy and action plans	Provincial and Regional Environment Offices, Provincial Town and Country Planning Department, ONEP, DPW, IEAT, NESDC	0-2 years and 3-5 years
	11.9: Set targets and enforce expansion of forest cover and green space in urban and industrial areas		0-2 years and

Strategic issues of concern	Action and description	Responsible agency	Time frame
	• Set a 20% by 2040 urban forest cover and green space target for Rayong's existing municipalities and urban zones • Set a 25% by 2040 urban forest cover and green space target for Rayong's new cities • Set a 15% by 2040 industrial zone forest cover and green space target with 25% for industrial estates • Introduce linked spatial planning and building code regulations should facilitate the steady expansion of forest cover over time so those targets are met. • Establish tree cover/green space baseline for urban and industrial zones against which progress in moving towards the targets are measured. • Compile an urban and industrial green space register which locates and describes each area and its progressive improvement • Establish a green space field survey program to identify and monitor areas, make entries to the green space register and recommendations on management actions required to improve forest and undercover condition and ecosystem services.	Provincial and Regional Environment Offices, Provincial Town and Country Planning Department, ONEP/MONRE, DPW, IEAT, NESDC Building Control Bureau, Ministry of Energy	3-5 years
Actions for protected areas and buffers - effective management of Rayong's protected areas to ensure no further major losses of forest or terrestrial biodiversity			
Forest fragmentation	11.10: Implement traffic calming measures in key hotspots for wildlife collisions in areas around Khao Chamao-Khao Wong, and Khao Ang Rue Nai	Led by Highways Department and Department of National Parks.	0-2 years
	▪ The first low costs measure is to put in place is traffic calming measures and warning signs about animals crossing the road. ▪ The next step is to ensure that that there are no plans for the existing minor road to be upgraded. If it turns out that there are plans to widen or otherwise upgrade the road, then a dialogue about alternatives for meeting the needs and delivering the benefits anticipated from the upgraded road should be initiated. ▪ At the same time surveys should be conducted of any households living along the road, and their use of agricultural and forest land in the landscape on either side of the road, both inside and outside of the boundary of the protected areas.		
	11.11: Reclamation of marginal agricultural land with unclear legal tenure, especially in areas used by elephants		3-5 years

Strategic issues of concern	Action and description	Responsible agency	Time frame
	▪ Wherever possible marginal agricultural land located inside the protected area, should be bought back from the communities and replanted as forest, and degraded forest should be protected from e.g. cattle grazing and fire, to allow natural regeneration. ▪ While the idea of the government buying back land inside a legally protected area from farmers who have no land title certificates, may be a legal impossibility, it is possible to build on the existing model of monks collecting donations and buying back the land, and then donating it to DNP for restoration. (Alternatively the donations can be used to buy replacement land outside the protected areas which the farmers can swap for their land inside the protected area). This will require close collaboration between parks staff, local community leaders and the Buddhist clergy. ▪ While the above activities are being implemented, research can also be conducted to identify the most appropriate sections of the road where the forest on either side of the road can be reconnected. Specific proposals should be developed and feasibility studies conducted.	Led by DNP in collaboration with senior Buddhist monks, local community leaders, the Provincial Forest Office and the Royal Project on Human-Elephant Conflict management.	
	11.12: Updating of PA management plans, training of staff, and implementation of METT in 3 protected areas in Rayong Province ▪ Train senior staff of Khao Ang Rue Nai Wildlife Sanctuary (KARNWS); Khao Chamao-Khao Wong National Park (KCKWNP), and Laem Ya-Mu Koh Samet National Park(LYMKSNP) on how to prepare updated management plans ▪ Update PA management plans ▪ Train protected area personnel of KARNWS, KCKWNP, LYMKSNP: ○ On use of the Management Effectiveness Tracking Tool (METT) and establish a baseline METT score for each protected area ○ On improved enforcement through Spatial Monitoring and reporting Tool (SMART) based patrolling and establish SMART patrolling at each site ○ In preparing questionnaires and collecting data from visitors; collect information from visitors about satisfaction with their visit, and educational aspects ▪ Establish EFCOM PAC	Led by DNP in collaboration with Tourism Authority of Thailand Provincial Office	0-2 years and 3-5 years
	11.13: Reconnect Khao Chamao-Khao Wong with Khao Ang Rue Nai by creating tunnels and overpasses at strategic points along the road running between them	National decision and budget allocation from	3-5 years

Strategic issues of concern	Action and description	Responsible agency	Time frame
	• The forest can be reconnected by taking some sections of the road through tunnels and reforesting the area above them – ie creating wildlife bridges; and/or by elevating some sections of the road and reforesting the area underneath them – ie creating wildlife tunnels. • The Highways Department would need to factor this demonstration project into their budget and development planning.	the Highways Department, followed by implementation by the Highways Department.	
Forest cover	11.14: Identify and prioritise potential areas for tree planting to restoring degraded areas and in buffer zones around protected areas and reservoirs	Led by Provincial Forest Office and Provincial Environment Office in collaboration with local land owners.	0-2 years and 3-5 years
	• The intension is to commence forest cover and corridors expansion quickly by identifying areas within or close to Rayong's existing protected areas. • That may require purchase of private land or special agreements with private owners to participate in the rehabilitation process • A survey report should be prepared which documents potential sites for forest extension • Implement tree-planting activities in protected area and reservoir buffer zones		
	11.15: Develop a Pilot REDD+ and PES project linked to the buffer zone rehabilitation	Led by DNP, Provincial Forest Office and one or more local communities	3-5 years
	• Develop a Pilot REDD+ and PES project in Rayong through collaboration between Rayong Forestry Office and one or more communities who are managing community forests. • This measure would require parallel action at national level to complete the Thailand REDD+ Strategy and institutional arrangements, including the Benefit Distribution Mechanism and Grievance Mechanism. • At the regional level (ie EEC/EFCOM Level) DNP and the RFD need to complete research and a feasibility study on the possibilities for establishing a PES scheme for the EFCOM landscape.		
	11.16: Implement pilot REDD+ and PES pilot project linked to the buffer zone rehabilitation	Led by DNP, Provincial Forest Office and East	5-10 years

Strategic issues of concern	Action and description	Responsible agency	Time frame
	• A pilot REDD+ project which promotes PES linked to the protected area, buffer and local communities could provide a model for replication across Rayong, especially in buffer zone areas associated with reservoirs, rivers, canals and coastal forests. • Evaluate implementation of first pilot REDD+ project in Rayong, and based on this experience and lessons learned develop additional projects for replication in Rayong**.** Continue to expand the PES scheme in EFCOM.	Water in collaboration with communities living inside or adjacent to protected watershed forests.	

11.8 Implications of Sustainable Development for forests and terrestrial biodiversity on other sectors

All development sectors have a role and responsibilities in ensuring Rayong Province can expand its forest cover, its diversity of ecosystems and species, and all the benefits that will bring to the provincial economy, livelihoods and social wellbeing. With an overriding emphasis on industry and major plans for infrastructure and associated population growth, it is a critical time for introducing the necessary government reforms and initiatives to bring nature back into Rayong's development process.

Forests need to be given a vital role in Rayong's economic health, with forest creation, restoration, maintenance, monitoring and enforcement potentially contributing significantly to the provincial stock of direct and indirect jobs for local residents and communities.

Forests also store carbon, preserve soils and nurture a diversity of species. Their role in building resilience to climate change will become essential as will the management, replenishment and quality control of water resources. Justifying expansion of forests as a high priority development strategy in Rayong is a difficult task in terms of economic rates of return, especially when faced with other development and land use options that have readily defined economic and income values. Yet, the consultation process in this SEA has shown that key economic sectors and the wider community increasingly recognize the many ecosystem services that forests provide, and the importance or green space and natural based solutions in the development process.

Those benefits include goods and services such as timber, food, fuel and bio-products, eco-tourism and maintenance aquatic ecosystem health and of fisheries and pollination and protection of crops. Ecological functions include nutrient cycling, water and air purification, energy conservation and maintenance of wildlife habitat; and social and cultural benefits such as recreation, education, traditional resource uses, heritage and spirituality. Of special value, forests and green space enhance the appeal of Rayong as a high quality of life environment to attract skilled workers and their families, an important feature in an increasingly competitive employment market.

Increased forest cover will help with local climate regulation counteracting the heat island effect of expanding urban areas. It will also enhance watershed functions, contributing to improved water supply and quality, thereby benefiting the water sector, and other sectors dependent on water – including agriculture, industry and the service sector. An increasingly forested Rayong province will support an increased population of pollinator species – especially the bats important for durian pollination. Increased forest area will also provide a more attractive landscape for tourists, and will provide additional recreational opportunities supporting better physical and mental health for Rayong's residents, who are increasingly living in a stressful and polluted urban environment. The connection of Rayong's forests to the wider Eastern Forest Complex will add to their regional and global importance, enhancing its appeal as a nature-based tourism destination.

11.9 Conclusions

The main issues for forests and terrestrial biodiversity in Rayong are the low overall forest cover and the increasing fragmentation of what remains of its forest estate. The main ways in which these issues will be addressed are through enrichment planting and extending the concentrations of forests in protected areas and National Reserve Forest patches, by identifying and rehabilitating remaining but degraded forest patches and wetlands across the agricultural landscapes, by working with land owners, especially of rubber plantations and fruit orchards to integrate natural forest and understory within and around their properties, and by requiring strict adherence to forest and green space targets and regulations in urban and industrial areas. It would be necessary to work towards linking up these new and expanding forest areas into networks and corridors throughout the province according to a systematic assessment of potentials and a comprehensive forest strategy and action plans.

Economic and social justifications for expanding forest cover need to be established through studies and valuations of practical values such as restoration of degraded lands, erosion control, disaster

prevention, resilience building, increasing amenity and public health. As long as the forest expansion is supported and carried out in line with technical guidelines, then there will also be significant benefits for biodiversity a wide range of ecosystem services. Forest restoration outside of protected areas in particular will require new funding mechanisms to be developed including, for example REDD+ and PES, new forms of economic incentives and special budget allocations. Enhanced financing will require decisions to be taken at the national level on the grounds of promoting Rayong nationally as a clean and green centre of development. Other forms of forest extension can be supported by the Rayong Provincial budget as well as CSR budgets of the many companies active in Rayong.

12 ENVIRONMENTAL QUALITY

12.1 Introduction

12.1.1 A strong policy framework for sustainability at national level

During the past decade, the Thai national government has introduced a broad range of environmental management policies, regulations and programs in an effort to come to grips with degrading environmental conditions throughout the country. Commitment to sustainable development is strongly reflected in national strategies and plans. The 20-Year National Strategic Plan (2018-2037) and the 12th National Economic and Social Development Plan are fully in line with SDG guidelines. The plans stress the need for a more integrated administrative structure, working process and budgeting and promote a more bottom-up decision-making process with greater responsibilities and authority going to local levels.

The Pollution Control Department (PCD), under the Ministry of Natural Resources and Environment (MONRE) lies at the heart of this all-of-government effort. The PCD administers Thailand's national air, water and land pollution standards. The PCD and its regional office in the EEC and provincial environment office in Rayong are responsible for setting policies, monitoring and reporting against ambient standards, and helping other sectors comply with the Thai Environment Act. Under its 20-Year Pollution Management Strategy and Pollution Management Plan 2017 – 2021, PCD is committed to building preparedness and capacity in Local Administration Organizations and related agencies for pollution management and supporting efforts to ensure budgets and subsidies are adequate for the purpose.

MONRE's environmental assessment process seeks to have environmental management plans prepared and implemented for development projects. The Environmental Impact Evaluation Bureau (EIEB), under the Office of Natural Resources and Environmental Policy and Planning (ONEP), is responsible for the administration of EIAs, which must be prepared for 35 project types and sizes.

The Department of Public Works and Town & Country Planning of the Ministry of Interior applies spatial planning tools to identify zones and environmental safeguards at the various levels of government. The Rayong Town & Country Planning Departments is currently working on revision of the provincial and town comprehensive spatial plans including improved zoning and standards.

A key PCD partner in pollution control is the Department of Industrial Works (DIW) under the Ministry of Interior. DIW has introduced and enforces detailed regulations for specified factory types and sizes and procedures for the control of discharges of wastes, pollutants, or any substances that cause adverse effects on the environment. DIW also manages special programs to promote sustainability in industry. It is implementing the ***Green Industry Project*** to work with the private sector to promote environmentally ethical behavior and a culture of environmental sustainability. Under its *United Industries to Protect Rivers Project*, the Department introduced stricter regulations to address waste water discharge into rivers and to promote river conservation, better water quality, and sustainable industrial development. The regulations include fines and imprisonment for up to two years, for factories which commit three consecutive violations of discharging wastewater into rivers, and increasing the distance of setting up a factory on a river bank from 50 to 100-500 meters.

Other good initiatives are in the pipeline. For example, the Fiscal Policy Office of the Ministry of Finance, together with PCD is working to introduce financial measures under the Thai Environment Act, in order to mitigate environmental pollution, including environmental taxes**,** pollution management fees, performance bonds and subsidies or low interest loans in support of environmental management innovation. There is little doubt that economic instruments and incentives which modify behaviour through financial self-interest and the market are needed.

12.1.2 A failure of the system to deliver on environmental quality policy commitments in Rayong

Those examples, reflect stated commitment of all levels of government to promote clean and green development supported by a strong regulatory framework. Yet, in Rayong the policy intent is not being thoroughly applied in practice. There is a significant gap between the law and the capacity of agencies to enforce it. Environmental quality is deteriorating with a lack of real and consistent commitment from industries, and from other development sectors in the province, which tend to avoid or minimize compliance. Despite good intent, government agencies are not bringing sufficient pressure to bear and are not providing an effective enabling environment to change behaviour. The required level of investment and consistent funding is not coming from central government. Staffing, skills, budgets and clarity in mandates are not up to the job.

There are several basic institutional obstacles which constrain progress. Three challenges are (i) a highly centralized system in which technical capacity and budgets are largely retained within national line agencies which tend to function with few lateral linkages in fulfilling their sectoral mandates, (ii) a parallel system from national to local level in which the pollution control and environmental authorities observe and encourage, but where enforcement and follow up is a function of line agencies such as DIW and the Industrial Estate Authority of Thailand (IEAT), and (iii) a disconnect between the environment authorities recommended management actions and what appears in line agency and provincial development plans (in this case, the Rayong Province Development Plan).

This chapter sets out measures to improve environmental quality in Rayong for integration into the next RPDP as well as into other plans and strategies that influence and shape development in Rayong.

12.2 Strategic issues of concern to environmental quality in Rayong

SEA stakeholders identified four strategic issues of concern to Rayong's development and environmental quality: (i) hazardous waste, (ii) solid waste, (iii) water quality, and (iv) air quality (emissions from transport and industry). The past trends and their drivers for the four issues were explored in the SEA environmental quality baseline assessment. The SEA sustainability analysis assessed the influence of a Business as Usual scenario and full RPDP implementation on those trends. This section summarises key points highlighted in the trend and scenario analysis.

12.2.1 Hazardous waste

While there is conflicting reporting on waste in Rayong, available data indicates that the province produces at least 500,000 to 600,000 tonnes of solid and liquid hazardous waste each year. Primarily this waste comes from Map Ta Phut industrial zone. The contribution of other factories and plants to the waste load, inside and outside industrial estates, is not well monitored or documented. Hazardous waste levels are increasing as a proportion of Rayong's total pollution load, as is the overall toxicity of wastes. Private companies are contracted to transport hazardous wastes to collection centres and to dispose of them effectively. In practice, collection centres are reaching capacity and wastes are being stored. Some hazardous waste is transported for incineration in Ratchaburi province west of Bangkok, which increases the risk of accidents and spillage. The expense of transport and incineration are likely causal factors driving illegal dumping of hazardous waste in Rayong. A related problem is the legacy in Rayong of improperly decommissioned factories where hazardous chemicals and other substances are left with no clear processes or responsibilities for their disposal and site clean-up. Already, contaminated groundwater is leaking from underground aquifers into Rayong's coastal water adjacent to Map Ta Phut industrial zone.[106]

[106] See: https://doi.org/10.1016/j.marpolbul.2019.07.071.

Existing hazardous waste stored and dumped and future generation of wastes of increasing toxicity pose serious risks for Rayong. Over the next 20 years, hazardous waste generation is projected to grow at a rate of around 10,000 to 15,000 tonnes per year. .

Hazardous waste generation comes almost exclusively from industry in Rayong, and it affects agricultural (e.g. pollution of waterways undermines GAP certification efforts), fisheries and aquaculture, the marine environment and, public health and well-being. Hazardous waste generation is likely to have flow-on effects for Rayong's future viability as an attractive location for the establishment of high-tech enterprises and as a centre for tourism.

12.2.2 Solid waste

Rayong's solid waste comes mostly from industry at around 1.5 million tonnes per year (excluding hazardous waste), with municipal solid waste (MSW) adding 350,000 - 400,000 tonnes of solid waste annually. While the amount of MSW generated is growing steadily, provincial data indicates that the amount being appropriately managed has not grown in recent years. Rayong's capacity to manage MSW through landfill appears to have reached capacity. Recycling and source separation programs are encourage by central government but have had little uptake, with around 7% of solid waste being recycled in the province. Waste-to-energy plants have been established in Rayong, but are hampered by poor source separation of waste.

Rayong is not investing adequately in waste-management capacity, even though the environmental, social and economic consequences well demonstrated and projections show a strong increase in solid waste through the next decade. Mounting solid waste is a problem for industry and municipalities to solve driven by economic and regulatory incentives for source treatment based on the government's 3Rs strategy of reduce, reuse, and recycle.

12.2.3 Water quality

Recent monitoring data show a declining water quality in Rayong. Anecdotal evidence suggest that surface water quality in the west of the province has been poor to fair for at least a decade, with pollution levels in the Khlong Yang River and many canals, for example, reaching a critical level. Untreated domestic waste-water is the most wide spread source of contamination. Commercial outlets and industrial plants contribute more concentrated and toxic effluents in specific locations. Rayong's three waste-water treatment systems operate at about 5% of their capacity leaving much municipal waste water to go untreated to rivers, canals and directly to the sea – a situation aggravated by poor management and performance of domestic septic tanks. Domestic waste-water generation is projected to grow by nearly 50% over the coming two decades, with potential slowing in the 2030s because of the possibility of water shortages and reduced consumption.

Environmental flows managed by the Royal Irrigation Department (RID) are totally inadequate to dissipate and flush out pollution from rivers and to maintain aquatic ecosystems in a state adequate to absorb and treat organic pollutants.

Groundwater in Rayong has become progressively more polluted in localised areas due leaching from industrial, landfill and commercial sites and – according to anecdotal evidence from farmers – more widely in agricultural areas. Pollutants which have been found in Rayong's ground water include iron, manganese, arsenic, lead, radium and 20 types of carcinogenic volatile organic compounds including benzene, butadiene and 1,2-dichloroethene. It is difficult to get a comprehensive picture of the ground water situation in the province as studies are ad hoc and monitoring is minimal.

Pollution to water raises the cost of raw water to industry and commercial enterprises once it reaches levels requiring treatment. Until now East Water (EW) has sourced water directly from RID's reservoirs in the North of the province which EW advises is of an acceptable quality to pass directly on to consumers. Reservoir managers are concerned that the situation will change with increasing incidence of algal blooms, inflows of sediment and chemicals from uncontrolled agriculture in the

buffer zone, and pollutants from upstream industrial operations. Already poor quality surface and ground water is affecting agricultural value adding as well as fisheries and aquaculture. Public health problems relating to water quality are increasing along with related costs to local government and overall Rayong residents are experiencing a reduced sense of well-being because of pollution, a concern articulated by SEA stakeholders at consultative events.

12.2.4 Air quality

Air pollution is one of the most challenging environmental problems facing the province, and one which authorities have been least able to curb. As Thailand's largest growing industrial hub with a growing population and transport volume, it is inevitable that air pollution will continue to be a key public concern shared by the PCD and local environment agencies.

The main sources of pollutants to air in Rayong are the industry and transport sectors. Thailand's national government has adopted vehicle emissions standards and ambient standards for area based air quality. Also, under the EEC program, there are plans to encourage modal shifts of land transport from road to rail. The DIW applies air quality controls in environmental management plans linked to factory licensing – and generally, industry enterprises consider they have the equipment, capacities and budgets to meet national standards. Yet, neither the government or private sector conduct systematic point source or even comprehensive ambient air pollution monitoring so performance is uncertain.

Article 9 of the Enhancement and Conservation of National Environmental Quality Act provides for the designation of "pollution-control areas" and subsequent actions that would reduce pollution. PCD has identified 12 areas as pollution-control zones - Map Ta Phut Industrial Estate was one of the first in 2009. PCD prepared a Pollution Reduction and Mitigation Action Plan for the area but has no authority to monitor inside industrial estates and no capacity for point source monitoring. The responsibility to enforce and monitory goes to DIW and IEAT (which does not make data it collects publicly available). Generally, pollution data sharing arrangements are inadequate.

Air pollution levels in Rayong may well decline in the medium term due to a planned shift under the EEC from polluting heavy industries to higher value cleaner industries. That will take some time to achieve. In the meantime there is a growing air pollution problem from industry and transport. Despite the national government bringing in progressively stricter vehicle emissions standards, transport related emissions of both carbon monoxide and nitrogen oxides are projected to climb over the next two decades. Also, anticipated continued expansion of industrial and power facilities will bring with it mounting emissions to air even if relatively well managed. For example, the Asian Development Bank has agreed to fund a gas fired power plant in in the Rojana Rayong 2 Industrial Park – among the largest in Thailand.[107] Natural gas is a fossil fuel, though the air pollutants and global warming emissions from its combustion are much lower than those from coal or oil. Even so, gas fired plants do pollute, some producing many tons of NOx annually, which brings with it public health impacts and adding to Rayong's total air pollution loading.[108] Also, the drilling and extraction of natural gas from wells in the Gulf of Thailand and its transportation in pipelines results in the leakage of methane that is 34 times stronger than CO2 at trapping heat as a green-house gas.[109] If methane is allowed to leak from the gas plant, it can become a bigger source of greenhouse gases than a coal fired facility. Certainly, Rayong province is likely to consolidate its role as a key contributor to Thailand's climate change performance.

[107] https://www.power-technology.com/news/asian-development-bank-thailand/
[108] https://blog.ucsusa.org/mark-specht/natural-gas-power-plants-are-not-clean
[109] https://www.ucsusa.org/resources/environmental-impacts-natural-gas

12.3 Gaps in the existing Rayong Provincial Development Plan

Overall, the RPDP places a strong emphasis on dealing with environmental pollution. For example, the plan proposes preparation of guidelines to (i) improve solid and industrial waste management, (ii) promote environmental awareness and knowledge, (iii) involve communities in environmental preservation and protection, and (iv) establish an environment and pollution focused data base for tracking progress in environmental management – all important initiatives.

Yet, the RPDP investments for reducing environmental pollution account for only 3.8% of total proposed expenditure. Other fields of concern to environmental quality are not addressed including:

(i) Critical governance issues that are constraining effective environmental management in the province;
(ii) Introducing point source standards for industry and effective enforcement
(iii) mechanisms to improve the much needed monitoring and reporting on environmental pollution, including for industrial and domestic effluent and treatment systems;
(iv) Measures to rectify the poor performance of municipal wastewater systems;
(v) Expansion of measures to improve waste management capacity, including ensuring that hazardous waste is considered;
(vi) Consideration of environmental flows and rehabilitation of river systems to improve water quality and overall riverine health;
(vii) Measures to increase the area forest cover and green space throughout the province.
(viii) Sustainable urban design including a much improved zoning plan with development controls and safeguards.

Addressing those gaps in the next RPDP and linked sector and national plans will lay down a more effective framework of measures for achieving the environmental sustainability goals of the province and of national government. The aim is to have in place a comprehensive road map for improving environmental quality as expressed through the RPDP, which all other arms and levels of government must follow.

12.4 SD objectives and indicators

SEA stakeholders worked to define strategic issues of concern to Rayong's development and environmental conditions and linked sustainability objectives and indicators set out in Table 12-1. The SD objectives provide the vision which specific measures contribute to achieving, and the indicators are initial parameters to form part of the monitoring program to keep track of RPDP implementation.

Table 12-1: Strategic issues, sustainability objectives and potential indicators for the urban sector

Strategic issue of concern to development in Rayong	Sustainability objective	Indicators
Hazardous waste	Hazardous wastes from industry, domestic and agricultural sources are identified, minimized and disposed without negative environmental impacts	▪ Proportion of hazardous waste disposed of in a controlled manner
Solid waste	Replace open dumping sites by sanitary landfills, green space, incineration and waste to energy and recycling schemes.	▪ Proportion of solid waste disposed of in a controlled manner
Water quality	Establish effective measures for the prevention, control and abatement of water pollution	▪ Annual average BOD
Air quality (emissions from transport, industry and construction)	Establish and enforce point source air pollution standards, especially relating to the industry, energy and transport sectors.	▪ Proportion of point sources of air pollution monitored

12.5 Sustainability measures for environmental quality

Environmental quality is one of the four "quality of life" themes identified by stakeholders as a focus for the SEA. As a quality of life theme, it is impacted on by the development themes and sectors. For example, industrial effluent, domestic wastewater, agricultural runoff, as well as activities in sectors such as tourism, energy and transport affect Rayong's water quality. For this reason, all the development sector sustainable development chapters include measures seeking to improve the trends in the environmental quality strategic issues (ie. solid and hazardous waste, and air and water quality). Rather than repeating all these measures here, Table 12.2 provides needed actions that are cross-cutting across the SEA other thematic areas. It does so by ordering measures in three categories:

(i) Governance, policy and planning;
(ii) Monitoring and reporting; and
(iii) Standards and environmental management plan enforcement capacity.

The measures in Table 12-2 are intended for inclusion in the next RPDP. The Rayong Governor's Office and local agencies do not have the authority or mandate to instigate most of the measures set out here. That will require strong commitment and support from central government and from national line agencies working closely with the Governor and his staff. Some of the changes involve complex policy and institutional innovations – many of which have been raised as solutions to Thailand's environmental management challenges in the past – but which have failed to gain traction in Cabinet and in lead line agencies such as the Ministry of Interior. The situation now is more urgent given the development path the province is on and the projected implications of inaction for the environment, economy and social situation.

There is a window of opportunity in Rayong before planned development rules out options for the future. It may be that an acceptable short terms approach is for the government to designate Rayong as a pilot province to test and demonstrate new and better ways of doing things. On the basis of testing and lessons, reforms can be instigated nationally – a process which could take many years. Those detailed conditions and arrangements could be writing into the policies and regulations relating to development within the EEC. Thailand cannot afford the EEC region becoming a pollution haven with steadily degrading environmental and social conditions – especially within Rayong as its development hub. The two conditions in Rayong of increasing economic returns (translated into the highest per capita GDP in the country) accompanied by reducing ecological sustainability are not compatible or consistent with Thailand's overall aspirations for the future.

Table 12-2: Actions for inclusion in next RPDP (2021-2025)

Type of measure	Action and description	Responsible Agency	Time horizon
Governance, policy and planning	**12.1 Reform environmental management arrangements to give greater authority to REO and PEO** (i) Review of barriers that are preventing provincial authorities from including in the RPDP REO recommendations made in the EEC Environmental Management Plan and for the province (ii) Develop ways to facilitate closer collaborative working arrangements between REO and the Rayong authorities including the PEO so that barriers are overcome; (iii) Establish formal communication and reporting channels between regional and provincial environmental authorities so they work closely together in monitoring and reporting functions. (iv) Transfer from DIW to the Pollution Control Department oversight of the environmental aspects of factory licensing and operations – and all monitoring and enforcement authority – if necessary this measure could be undertaking as a test in the EEC – or in Rayong prior to national application. It would also require transfer of environmental responsibility from IEAT for monitoring and enforcement within industrial estates. (v) Transfer to PDC, REO and PEO all roles and responsibilities for monitoring and enforcement of air quality, water quality, solid waste management and hazardous waste management – inside industrial estates and outside industrial estates (vi) Commit the necessary additional budget and staffing resources to PDC, REO and PEO to fulfil this expanding mandate.	Rayong Governor's Office, RPAO, REO, PEO, DIW, IEAT, PCD	5-10 years
	12.2 Prepare district level environmental management plans (i) District level environmental management plans (DEMP) prepared by REO/PEO in collaboration with the Rayong DTCP should a) identify environmentally sensitive areas for special management and protection, b) adjust zoning and develop comprehensive safeguards and development controls for each zone, c) define management actions required to improve the environmental quality within the district and forest and biodiversity coverage, and d) identify for action forces outside the district which are influencing environmental conditions within it. (ii) Review and adjust the provincial and town comprehensive spatial plans accordingly (iii) The district plans should include components for implementation at the district level, but should also inform (feed into and help shape) the provincial environment plan (iv) Introduce national regulations recognising district environment plans and their authority. All sectors and arms of government should be required to adhere to the district plans when considering development options, designs and siting.	District administration offices; Town and Country Planning; DPT, PEO; MONRE, MOI,	Next 1 -2 years
	12.3 Prepare a provincial level environmental management plan		

Type of measure	Action and description	Responsible Agency	Time horizon
	(i) The provincial environmental management plan (PEMP) should be a foundation framework identifying environmental and heritage assets and areas which require special protection and management. The plan should provide GIS spatial layers which set out zones and linked comprehensive environmental management actions and safeguards. The Rayong Provincial and town comprehensive spatial plans must adopt the PEMP as the environmental layer in the spatial development framework. (ii) The PEMP is a complement to the Provincial Forest Cover Master Plan recommended under the Forests and Biodiversity SD pathway chapter – that plan promotes increased forest cover and biodiversity across the province. (iii) The PEMP focus should be on environmental quality and management of pollution issues, and should complement/add to the spatial and town planning initiatives discussed in the Urban Development Chapter of this volume.	Rayong Governor's Office; RPAO; REO; PEO; ONEP	Next 2 -3 years
Monitoring and reporting	**12.4 Establish a wide network of air quality monitoring stations inside and outside industrial estates** In order to properly address concerns around air quality in Rayong province, provincial authorities (with PCD and REO) should install a wide area network of air monitors to track pollutants, including VOCs, particulate matter ($PM_{2.5}$ & PM_{10}), carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide. Point source and ambient monitoring should be focused on areas inside and around industrial estates, as well as along the main transport corridors, in and around industrial parks, and in other locations where factories are concentrated. (i) Point source and ambient monitoring should be used to provide quantitative data on air pollution hotspots in the province; (ii) Sampling should be conducted and made publically available in real time and consolidated each month into pollution reports (iii) Monitoring data should be made available on a publicly accessible environmental quality database; (iv) Data should be accompanied by standardised public health warning levels.[110] (v) PCD, REO and the PEO should be given the authority and resources to conduct comprehensive monitoring work [this will require a transfer of responsibilities from DWI and IEAT as recommended in measure 13.1]. (vi) All data should be shared in real-time with relevant agencies and made publicly available on the provincial database.	PCD; REO; PEO; MONRE;	Next 2 – 3 years
	12.5 Establish a wide network of water quality monitors across the province	PCD;	

[110] See e.g.: https://airnow.gov/index.cfm?action=aqibasics.aqi

Type of measure	Action and description	Responsible Agency	Time horizon
	In order to address water quality issues in the province, a wide network of water quality monitoring stations should be established, providing real-time monitoring of water quality for early warning, analysis and pinpointing of pollution sources. (i) Ambient and point source water quality monitoring data should be used to provide quantitative data on areas of high water pollution, and help inform point source monitoring for effluent quality; (ii) Monitoring data should be made available on a publicly accessible environmental quality database; (iii) The monitoring data should be used to provide early warning of pollution events for affected areas and communities; (iv) The monitoring, reporting and enforcement should be managed by a PCD, REO and PEO throughout the province – including within industrial estates. (v) PCD, REO and the PEO should be given the mandate, authority and staff and budget resources to effectively implement these expanded responsibilities. (vi) IEAT and DWE should work collaboratively with the PCD, PEO and REO through transparent data sharing, allowing access to industrial estates to identify point source polluters, and to harmonise monitoring methods and standards used.	REO; PEO; MONRE;	Next 2 – 3 years
	12.6 Establish a publicly accessible website where environmental quality monitoring data is provided in a accessible format supported by monthly analysis and reporting	PCD; REO; PEO; MONRE;	Next 1 year
	Government agencies and the public should have access to up to date data on environmental quality, to help build awareness as well as so they can contribute to control and preventive measures in cases where pollution levels exceed standards. (i) The database should be interactive so maps and graphs can be generated by users (ii) The point source and ambient pollution database should be publicly accessible; (iii) The database should help inform enforcement activities, management responses and early warning announcements in case of pollution events.		
	12.7 Assess and document illegal dumping sites and irregular disposal of hazardous substances including identification of improperly decommissioned factories and other hazardous sites	PCD; REO; PEO; MONRE;	1 – 5 years
	The national regulations relating to hazardous materials and waste management and the linked institutional arrangements are complex and lacking transparency. The aim for Rayong is to establish a one stop shop approach with relevant authority rested in the national, regional and provincial environment agencies. The following measures should be put in place to address irregular hazardous waste disposal and its environmentally damaging consequences: (i) Illegal dumping sites, poorly managed landfill sites, old industrial and commercial sites which may have left contaminated land and water, hospitals and hazardous pollution hot spots should be identified, mapped, assessed and described in a publically available report (s).		

Type of measure	Action and description	Responsible Agency	Time horizon
	(ii) GIS systems should be used to help identify possible illegal dumping sites and old factories where chemicals and other toxins are leaching; (iii) A management plan for clean-up should be prepared for each contaminated site. (iv) An online register of contaminated sites should be established along with the clean-up management plans for each site. (v) PCD, REO and PEO should be given the authority and resources to conduct this assessment throughout the province – within and outside industrial estates, ports and other private and government lands. (vi) Also the environment agencies should be given the authority and resources to fully enforce the laws relating to illegal dumping and irregular disposal of hazardous wastes as defined under MOI and MPH regulations for industrial, household and infectious wastes – those punitive regulations should be reviewed to include imposition of harsh penalties for infringements. (vii) Residents should be encouraged to contact provincial and regional authorities when they witness illegal dumping or locate an illegal dumping site (see for example Western Australia's Report Littering program[111])		
	12.8 Enhance monitoring, reporting and enforcement capacity in the province	NESDC MOF PCD; REO; PEO; MONRE;	Next 3 - years
	The environment agencies need financial, human and equipment capacity upgrades in order to monitor, report and enforce pollution control standards and regulations in Rayong. In order to effectively conduct tasks outline in measures 13.4 through 13.7, funding and capacity building is required for: (i) environmental monitoring of industrial, commercial, agricultural, and residential activities that impact on the province's environment; (ii) additional staff, and a program of training for existing and new staff (iii) provision of suitable equipment including vehicles, sensors, computers, and software for data capture as well as analysis.		
Standards & enforcement capacity	**12.9 Develop and apply a more comprehensive framework of point source industrial emissions standards**	PCD; IEAT DIW; MONRE	Next 5 years
	The national pollution standards and their application are based on assessment and monitoring of ambient pollution loads, on-site inspections and plant specific environmental plans. Monitoring of ambient air and water quality standards is used to highlight pollution hotspots and for early warning of needed adjustment in point source contributions. More effective measures are required to control pollution at its source.		

[111] See: https://www.kabc.wa.gov.au/report-littering

Type of measure	Action and description	Responsible Agency	Time horizon
	(i) Review and expand the national framework of point source standards. Greater emphasis is required on point source standards and enforcement – while capacities are built in more effective application of the ambient approach to pollution management. (ii) Conduct ecological assessments in Rayong to support the refinement of ambient standards. The science basis for modelling of receiving air, water and land bodies, for determining ecological capacities and for pollution disbursement require more comprehensive research and testing in the field before ambient management can come to grips with increasing pollution loads. (iii) The role of factories in monitoring and reporting on their emissions should be given greater emphasis and regulatory backing and enforcement. Self-monitoring and reporting data should be made publicly available via a website; (iv) While the process of transferring overall authority for monitoring, reporting and enforcement of pollution standards and environment plans to the environment agencies move forward DWI and IEAT should more rigorously: a. enforce individual factory monitoring and reporting inside industrial estates; b. enforce individual factory monitoring and reporting outside industrial estates; (v) Fines for breaching emissions standards for industrial effluent and air emissions should be reviewed and set at a level which provides stronger incentives for factories to monitor and self-regulate their emissions; (vi) PCD and NESDC should conduct a comprehensive economic study which assesses the costs to Thailand of the current and projected pollution and environmental conditions to provide the science evidence base and justification for urgent high level commitment and action to invest in resolving the pollution crisis.		

12.6 Effect of measures on trends in environmental quality strategic issues on other thematic areas

The measures included here to improve environment management governance in Rayong will have a number of effects that will benefit other thematic areas. It provides greater clarity in responsibilities for monitoring, reporting and enforcement. It will lead to a more transparent and certain decision making environment for factories, businesses and households. The one stop shop approach to monitoring, reporting and enforcement will ensure a simpler and more favourable and consistent environment for investors. The shift to point source standards and environment management obligations on industrial and commercial outlet will also increase certainty and transparency. Ultimately, the aim is for enterprises to fully embrace a much more effective system of self-regulation than the one currently in place. It will require increased awareness, skills and investment commitment within the development sectors.

It will be necessary to solve the uncertainties relating to the role and responsibilities of various government agencies in pollution control, and within the environment sector, clarifying and resolving responsibilities and collaborative arrangements between PCD, REO and the PEO. That will lead to improved relations with the other provincial authorities and a more effective update of environmental advice and recommendations in the RPDP and other planning instruments.

An improved system of point source standards, monitoring, reporting and enforcement will more effectively apply the national polluter pays policy. It will take the action to the source of pollution. It will ensure that polluters are held directly responsible for poor environmental performance and that incentives are readily applied and are sufficient to change behaviour. Improved information and analysis on pollution conditions and locations will lead to improvements in public health, by supporting early warning and coordinated and efficient response. Fisheries and aquaculture will benefit with better information on surface water quality and sources of contamination. It will support improved mechanisms and action to address root causes. Tourism will benefit by providing assurance of improved air, water and land conditions.

The aim of the SD measures set out here is to improve and maintain environmental quality in Rayong to enhance the province's long-term viability as a cutting edge industrial centre, built on ecosystem sustainability and liveability ideals.

12.7 Conclusion

This chapter on environmental quality has provided a synthesis of elements to address environmental pollution across sectors and themes. There are a multitude of environmental pollution related measures included within other chapters, relating particularly to the development sectors such as industry, urban expansion, transport, and agriculture. However, the thematic specific measures do not address some of the higher level and cross-cutting innovations required for an effective response to the pollution and environmental quality challenges Rayong is facing. This chapter fills that gap, by focusing on cross-cutting measures such as improving and simplifying governance, and frameworks for monitoring, reporting and enforcement. Of special importance is making sure that environmental monitoring and reporting is transparent and available to the public. Transparency builds trust and credibility, and will help to highlight positive trends and well as more finely targeted public disclosure of serious polluting incidence and behaviour.

Implementation of the measures included in Table 12-2 will help the next iteration of the RPDP to much more effectively address issues of environmental degradation in a cross cutting manner. These measures should be implemented in conjunction with the measures included in the other chapters in this volume, to support and further enhance environmentally sustainable outcomes and pathways as well as broader macro-economic goals.

13 CLIMATE CHANGE

13.1 Introduction

Climate change due to increased concentrations of Green House Gases (GHG) in the atmosphere is a global issue. It requires the need to reduce GHG emissions to minimize global temperature rises and to adapt to the unavoidable temperature rises that are to come. Achieving an effective response to climate change implies significant changes at global, national and sub-national levels. In the case of Rayong province, it implies the need to mainstream climate change considerations into provincial planning and policy decisions as a matter of urgency.

The mandate of Rayong provincial authorities is limited relating to many major industries and infrastructure investment decisions that are critical in addressing climate change issues. Rayong province has very limited influence over central government decisions on industrial, transport and energy planning and policy - core sectors for GHG emissions reduction. The province has more influence over issues such as local spatial planning, land use, waste services, water supply and treatment systems, local transport, and agriculture, which are important for adapting to climate change. Therefore, this chapter concentrates on adaptation measures.

In discussion on climate change, and based on the most recent projections described in the SEA baseline assessment, stakeholders identified four strategic concerns for development in Rayong which need to be addressed as a priority: i) increased dry season droughts; ii) increased wet season flooding; iii) increased number of hot days; and, iv) increased storm and wind intensity. Those projections described in the baseline assessment are summarized here.

13.1.1 Increased dry season droughts

Average temperatures across Thailand have increased by 1°C since the middle of the 20th century, with the temperature rise being particularly marked in coastal regions like Rayong. At the same time, eastern Thailand has been experiencing a significant decline in rainfall. With the number of consecutive wet days each year in Rayong gradually declining. Drought events in Rayong have increased in duration and severity with documented events in 2005, 2016 and 2018. Climate projections consistently suggest a 6-8% decline in rainfall in the province by 2050,[112] with the most extreme scenario (RCP 8.5), projecting a 10-15% reduction in rainfall by 2070. Overall, dry season temperatures in Rayong are projected to increase by 2.0 to 2.3°C above the 1990 baseline by 2050, and by 2.2 to 3.2°C by 2070. Increasing temperatures and drought conditions will affect agriculture, particularly in the non-irrigated zone. Water resource availability will also be affected, and this will have flow on ramifications for industry, agriculture and urban water usage and for the condition of surface and ground water.

13.1.2 Increased wet season flooding

While overall rainfall is decreasing, rainfall events are becoming more intense and accounting for an increasing proportion of total rainfall. This increase in extreme rainfall events has caused coastal and flash flooding. Numerous flooding events and warnings have occurred in Rayong in recent years, including in 2006, 2008, 2012, 2015, 2017, 2018 and 2019. At the same time, sea level rise is expected

[112] For all emissions scenarios, i.e. RCP 4.5 – 8.5.

to continue, with levels already increasing by 5mm per year between 1985 and 2009, and higher annual increases expected progressively through the century.[113]

Future rainfall projections present a mixed pattern, with declining wet season rainfall to 2050. The post 2050 projections suggest continuing rainfall decline in the east of Rayong up to 2070, and an increase (2%) in wet season rainfall in the west of the province. Despite these moderate changes, projected increases in precipitation events highlight that the risk of flooding will increase, with flood events more frequent and severe in the province. Increased flooding risks will compound existing pluvial flooding issues in urban areas.

13.1.3 Increased number of hot days

Drier dry seasons projected for Rayong will be accompanied by more hot days. For example, the number of days on which temperatures exceed 35°C is projected to grow from the current 50 days per year up to 80 per year during the 2030s, and 90 – 95 per year during the 2040s. By the 2050s hot days will have more than doubled to over 120 days exceeding 35°C each year. Increasing numbers of hot days will impact on the severity and concentration of air and water pollution, on public health (e.g. exacerbating existing conditions in ways that can result in disability and death[114]), and productivity across most sectors. For example, energy demand for cooling from the commercial, residential and industrial sectors will increase. High temperatures may also affect crop production and lead to increased water loss through evaporation.

13.1.4 Increased intensity of storms and winds

Projections for future storm activity in the province are not available. However, according to global assessments tropical storms will increase in severity, including total rainfall and maximum wind speeds.[115] The number of storms is not expected to increase. Increased storm related rainfall links with urban and rural flooding, increased wind speeds could damage crops and infrastructure.

13.2 Gaps in the existing RPDP

Despite the environmental aspirations set out in the RPDP, the plan includes just one dedicated climate change adaptation project with a proposed investment of THB 7,000,000. There are a number of other projects related to mangrove protection and restoration which will have beneficial climate change impacts in terms of carbon sequestration and coastal protection.

Other than this, the main areas that should be addressed in future RPDPs are:

- A Rayong climate change adaptation plan (RAP) should be prepared to give local expression to the National Adaptation Plan and shaped to suit the social, economic and environmental circumstances and needs in the province (similar plans should be prepared for all 76 provinces and two administrative areas of Thailand).
- The RAP preparation should be identified as a priority project in the RPDP with budgetary, staffing and responsibilities defined.
- ONEP will need to be the key partner, with the REO and PEO. A special budget allocation will be required from national government through MONRE. This pilot or demonstration provincial adaptation planning project could also be supported through an existing ONEP

[113] Projections for sea level rise included in the 5th Assessment Report of the Intergovernmental Panel on Climate Change show that sea level rise is likely to accelerate in the second half of the century, so that by 2080 – 2100 it will be rising at a rate of around 8 – 16mm per year.
[114] See World Health Organization guidance on heat and human health (https://www.who.int/globalchange/publications/heat-and-health/en/)
[115] See Chapter 5 of Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap5_FINAL.pdf)

project funded by Germany (2018 – 2021) to assist all Thai provinces to integrate climate related impacts into their development planning.

- As a major industrial centre in Thailand, and a major energy and petrochemicals hub, Rayong should, as a priority, begin the process of managing and tracking its greenhouse gas emissions.

13.3 SD Objectives and Indicators

Thailand is committed to applying the United Nations' Sustainable Development Goals in all aspects of national development. SD Goal 13 is to "Take urgent action to combat climate change and its impacts". Nationally, Thailand has eleven policy frameworks that address climate change issues. These frameworks mainly focus on mitigation activities, although Thailand's National Adaptation Plan (NAP) is in the final stages of preparation.[116] The NAP will cover many of the priority sectors and issues assessed in this SEA, including water resource management, sustainable agriculture, urban and land use planning, public health, marine and coastal zone management, increasing forest cover, conserving natural resources and ecosystems, and sustainable tourism.[117] Also, the Thailand 4.0 strategy includes within one of its four pillars directives for a shift to a low carbon society that can adapt to climate change.[118] The goals set out in the RPDP are in line with national sustainability goals in the Thailand 4.0 strategy and national climate change policies.

During the SEA process, stakeholders defined a set of objectives and indicators to address the climate change issues of strategic concern to sustainable development in Rayong (Table 13-1). The indicators are intended for form part of the overall monitoring framework for the RPDP and a future Rayong Adaptation Plan. Indicators should be selected and responsibilities identified which are within the capacity of local government to apply in practice. For some time Rayong authorities will need support from MONRE for monitoring and reporting on climate change adaptation and mitigation actions.

Table 13-1: Strategic issues, sustainability objectives and indicators related to climate change

Strategic issue	Sustainability objective	Indicators for all strategic issues[119]
15. Increased dry season droughts	Enhance capacities to adapt to more extensive drought conditions	▪ Private and public sector budgets explicitly allocated to climate change adaptation and mitigation activity ▪ Climate change considerations in water management plans for the province. ▪ Climate change considerations in all sector development plans ▪ Number of government staff that have received training on adaptation
16. Increased wet season flooding	Rayong Province, the EEC and sector agencies operating in Rayong prepare climate change adaptation plans and allocate budget for their implementation	
17. Increased number of hot days	Enhance capacity to adapt to increased temperatures	

[116] See Thailand's Third National Communication to the UNFCCC (https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/52047631_Thailand-NC3-1-Thailand%20TNC.pdf)

[117] See e.g. the NAP Global Network summary information on Thailand's NAP process (http://napglobalnetwork.org/wp-content/uploads/2018/02/napgn-en-2019-thailand-nap-process-poster-2.pdf)

[118] A summary of the Thailand 4.0 strategy is available on the website of the Thai embassy in Washington DC, available at: https://thaiembdc.org/thailand-4-0-2/

[119] A useful resource for defining climate change indicators is GIZ, 2014, Repository of Adaptation Indicators: Real case examples from national Monitoring and Evaluation Systems, https://www.adaptationcommunity.net/?wpfb_dl=221

Strategic issue	Sustainability objective	Indicators for all strategic issues[119]
18. Increased intensity of storms and winds	Enhance capacity to adapt to more intense winds and storms	▪ Local regulations considering adaptation measures

13.4 Measures for addressing climate change issues in Rayong

This section defines adaptation and mitigation measures for Rayong to implement to i) to safeguard lives, livelihoods and assets from climate change impacts; and, ii) to support Thailand's national efforts to address greenhouse gas emissions. Table 13-2 is divided into two sections, the first section relates to the preparation and implementation of a Rayong Adaptation Plan. The second section details the measures that Rayong should adopt to support national climate change mitigation actions, acknowledging that at the provincial level there is limited authority and capacity to direct emissions reductions.

Table 13-2: Actions for inclusion in next RPDP (2021-2025)

	Action and description	Responsible Agency	Time horizon
Rayong Adaptation Planning	**13.1: Develop a provincial level adaptation plan** Given past and projected climate changes, the development of a provincial level adaptation plan needs to be a priority. Key points for inclusion in Rayong's adaptation plan are: (i) Identify priority actions across a range of sectors including urban development, water resources, agriculture, forests and terrestrial biodiversity and public health; (ii) Identify timelines for actions, taking into account hot spots, resourcing opportunities and constraints, and the need to work across sectors to achieve many adaptation outcomes; (iii) Identify line agencies responsible for particular aspects of adapting to climate change in the province; (iv) Define a suitable funding options for adaptation projects considering provincial, national and international sources. (v) Require all line agencies to develop sectoral adaptation plans. These sectoral adaptation plans should include plans for inter-agency cooperation and collaboration. Measures that follow relate to sector adaptations which would be included in the RAP and contribute to achieving provincial adaptation plan goals in Rayong.	Rayong Governor's office; ONEP REO PEO MONRE NESDC	Next 2 – 5 years
	13.2: Conduct adaptation planning and actions in the water sector[120] The following national level water resource management measures should be modified and applied at the provincial level: (i) Assess future impacts on water quantity, changes to water flows and distribution of water resources - this will include integrated climate change and hydrological modelling against various scenarios of change. (ii) Develop water management policies and plans for Rayong that integrate climate change projections (iii) Assess the potential for managed aquifer recharge systems to help minimize flood damage, and recharge aquifers (iv) Ensure all stakeholders are made aware of how climate change will affect water availability, and have the opportunity to share their opinions and ideas about how to adjust and cope (stakeholders will include: farmers,	East Water; RID; RBCs EEC ONEP REO PEO	Next 3 – 5 years

[120] These national adaptation planning measures taken from a presentation on the first draft of Thailand's NAP prepared by the Policy and Strategy Section, Climate Change Management and Coordination Division, Office of Natural Resources and Environmental Policy and Planning, available at: https://www.adaptation-undp.org/resources/presentation/first-draft-thailand-national-adaptation-plan

	factory owners, businesses, householders, tourism operators, environmental agencies such as REO and PEO, and non-government and civil society organisations) (v) Restore and rehabilitate forests in the reservoir catchment areas to slow water flows during extreme precipitation, and to increase absorption of water into soil and underground aquifers		
	13.3: Conduct adaptation planning and actions in the agricultural sector The following agriculture and food security measures should be implemented at the provincial level: (i) Map agriculture areas that are at risk from climate related natural hazards (particularly flood and drought); (ii) Define adaptation measures linked to various climate change hot spots and for the main agricultural cropping patterns – especially rubber plantations and emphasising nature based solutions (iii) Enhance agricultural resilience to climate change through application of Thailand's new theory agriculture;[121] promotion of organic farming practices and certification and participatory processes to develop action plans for dealing with floods and droughts. (iv) Enhance early warning mechanisms so that farmers have more time to prepare for natural hazards; (v) Establish a natural hazards inventory and online decision support system for farmers on extreme weather events and other natural hazards	National Parks Authority, Department of agriculture, REO, PEO,	
	13.4: Conduct adaptation planning and actions for public health responses to climate change Climate change impacts have strong ties to human health through climate sensitive diseases, through influencing pollution concentrations and dispersal, and by direct impacts of natural hazards.[122] Measures to address these issues in Rayong include: (i) Developing a network of early warning systems for climate related disease prevention: (ii) Diseases of concern for Rayong should include (i) dengue, (ii) malaria, (iii) food and water borne diseases (e.g. gastroenteritis); (iii) Enhancing and improving health insurance systems, including to ensure coverage for vulnerable populations including unregistered and illegal migrants;	DoH, REO, PEO, RPAO, Town and Country Planning	Next 2 – 5 years

[121] For detail about new theory agriculture, and how it integrates with Thailand's sufficiency economy principles, see: https://www.chaipat.or.th/eng/concepts-theories/sufficiency-economy-new-theory.html#:~:targetText=The%20New%20Theory%20is%20a,cut%20down%20on%20labor%20expenses.
[122] For a World Health Organization examination of the links between climate change and health, see: http://iris.wpro.who.int/handle/10665.1/12401

	(iv) Working with local communities to identify and eliminate climate sensitive disease risk factors (e.g. eliminating mosquito breeding areas, addressing weaknesses in existing septic and sewage treatment arrangements, running public awareness raising sessions on hygiene and sanitation); (v) Encouraging health sector personnel to collaborate and coordinate with other sectors to address health risk factors that are not within the strict mandate of health authorities (e.g. environmental health factors); (vi) Developing a climate-sensitive disease database to map disease hotspots		
	13.5: Conduct adaptation planning and action for forests and terrestrial biodiversity	National Parks Authority, Department of agriculture, REO, PEO,	Next 3 – 10 years
	Forests and biodiversity will be impacted by climate change. Also they play an important role in reducing climate change impacts through ecosystem services. To ensure that ecosystem services are restored and maintained: (i) Protect and maintain existing forested areas in Rayong, with high-biodiversity areas a priority; (ii) Restore and rehabilitate degraded forests in reservoir catchment areas; (iii) Support and encourage reforestation, including with community and enterprise economic and financial incentives; (iv) Promote and encourage eco-villages, including implementing a certification system (v) Increase areas of mangrove forests in coastal areas to help protect against sea-level rise and storm surges; (vi) Monitor the province for deforestation, and apply penalties for encroachment and clearing. These measures are described in more detail in the Forests and Biodiversity chapter of this report.		
	13.6: Conduct adaptation planning and action for urban areas	Rayong Governor's Office; Town and Country Planning;	Next 3 – 5 years
	Rayong is prone to droughts and floods, with both types of natural hazard projected to become more frequent and intense. To proactively address flood and drought issues Rayong should: (i) Define and enforce urban and industrial planning zones and controls on development in flood prone areas; (ii) Designate Rayong as a "sponge city" - one that can hold, clean, and drain water in a natural way - using ecological approaches[123] (iii) Reform design standards and development control conditions to require in all proposals application of a. water infiltration and attenuation systems b. permeable pavement, sidewalks, parking areas, government allotments and gardens – replace impermeable surfaces with permeable materials allowing the rainwater to drain into the soil		

[123] https://www.wavin.com/en-en/News-Cases/News/10-measures-to-prevent-urban-flooding

	c. roof gardens, rainwater gardens, bioswales and minimum percentage vegetation cover in all building plots and estates d. flood retention and water storage areas e. building design and orientation controls to ensure drainage patterns and natural flow is not impeded. (iv) Conduct a detailed GIS survey and field assessments of landforms, buildings and other infrastructure to analyse how they impact on water runoff, so that affected areas can be adjusted to improve drainage patterns (v) Conduct annual end of dry season audits/surveys of Rayong's canal systems to ensure that obstructions are removed, so that water is able to flow freely during heavy downpours; (vi) Establish early warning systems to provide advance warnings of impending storms and floods		
Supporting national mitigation	**13.7: Establish a provincial greenhouse gas inventory** As per measure 3.1 in the Industry chapter, Rayong is a major industrial and energy hub, and responsible for a significant portion of national greenhouse gas emissions.[124] However, along with pollution more broadly, greenhouse gas emissions are not well monitored or standards enforced. In order to support national efforts to curb greenhouse gas emissions, Rayong should be supported to: (i) establish a greenhouse gas inventory as part of installing more effective pollution monitoring and reporting systems: (ii) conduct a greenhouse gas audit of the industry and energy sectors to determine greenhouse gas sources and hotspots; (iii) focus standards enforcement on high greenhouse gas emissions sources identified in the audit, and on industries, enterprises and sector in hot spot locations identified in the pollution audit	Industrial Estate Authority of Thailand (IEAT), Pollution control Department, Department of Industrial works, Rayong.	Next 5 years
	13.8: Coordinate use of wastes from development projects to reduce greenhouse gas emissions		

[124] For example, in the United States, the electricity and energy sectors account for 50% of total national greenhouse gas emissions (https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions)

	Urban greenhouse gas emissions can be reduced through reuse of waste materials in parallel developments. (i) Link construction projects that produce soil and rock waste, with projects that require aggregate and other materials. In a case-study example,[125] a reduction of 2,360 tons of GHG emissions was achieved (in conjunction with reductions in other pollutants such as NO_x, SO_x, VOCs and CO) through reduced transportation of earthworks materials (ii) Coordinated practices to be promoted include: a. Crushed rock re-used instead of transported elsewhere for disposal; b. Excavated soil re-used for landscaping instead of being transported elsewhere for disposal; and c. A dis-used pond was refurbished, instead of the earthworks that had accumulated inside it being removed and transported elsewhere for disposal. As outlined in the urban development chapter (Measure 6.4), adaptation measures relating to wastes include: (iii) Improved source separation of waste; (iv) Encouragement of waste-to-energy systems; (v) Recovery of methane from landfill sites for use to generate electricity – this reduces emissions of a powerful GHG, and supports self-sufficiency	Municipal Planning Authorities; Town and Country Planning;	
	13.9: Introduce and strictly apply controls on building energy consumption for greenhouse gas emissions reductions		
	As outlined in the urban development chapter (Measure 6.4), there should be (i) Application of design standards to reduce energy consumption in government, commercial and industrial buildings (ii) Annual energy audits of existing government and commercial buildings and facilities to prioritise upgrades such as: a. replacing inefficient air conditioning units; b. improving insulation and lighting c. replacing inefficient street lighting d. raplacing inefficient appliances from washing and vending machines to dishwashers and refrigerators. (iii) Provide incentives for installing solar systems on government and commercial building rooftops and above carparks;		

[125] See: "GHG Emissions Reduction through Urban Planners' Improved Control over Earthworks: A Case Study in Finland", available at: https://dx.doi.org/10.3390/su10082859

13.5 Conclusion

The impacts of climate change in Thailand, including in Rayong, are already observable. Temperatures are on average about 1°C hotter than 60 years ago, monsoons are becoming shorter and more intense, and droughts are becoming more frequent as dry seasons lengthen.

Rayong should focus its efforts on developing provincial and sectoral adaptation plans to address key issues picked up in this chapter as well as in chapters on other thematic areas in this SEA. Actions to adapt to a changing climate include establishing a comprehensive science evidence base relating to water resources and the effects of climate change on water availability and quality. The management of water resources in the province need to be founded on that assessment, including ensuring the maintenance of environmental flows and ecosystem services. A key element in Rayong's response to climate change involves reforestation programs, particularly for reservoir catchments, mapping agricultural areas at risk from climate change impacts and developing early warning systems for natural hazards, and enhancing climate sensitive disease surveillance.

Mitigation actions will be directed from the national level, however, there are a number of initiatives that can be implemented in Rayong to support national efforts. Adoption of climate change mitigation measures in Rayong province are likely to enhance its competitiveness and productivity in the medium term, in line with the aspirations of Thailand 4.0 and EEC development goals. This will become all the more imperative as developed country markets are forced to adopt a border tax on embedded carbon in imported goods to ensure their low emission economies remain competitive. Mitigation actions for Rayong include establishing a greenhouse gas inventory, taking a stronger approach to urban planning, as outlined in the urban development chapter, as well as improving waste management and building efficiencies in the province.

The measures included in this chapter for adapting to climate change impacts, as well as for limiting and reducing greenhouse gas emissions, are supported through national level planning and legislation, including through the NAP planning process, Thailand's climate change master plan and national plans, in particular, the 12th National Economic and Social Development Plan.

14 CONCLUSIONS

14.1 Factors influencing the shape of the SEA

This SEA of the Rayong Province Development Plan was conducted as a demonstration of Thailand's draft national SEA guidelines. It was commissioned by the National Economic and Social Development Committee in collaboration with the Rayong Governor's Office. One SEA cannot possibly pilot all approaches to strategic assessment. The process, methods and tools used need to be molded to the subject matter and scope of the assessment. The funds and time available and the capacities of the SEA team are also determining factors in shaping an assessment. SEAs of a river basin, of a national development sector such as energy, a new trade agreement, or of a special economic zone will all look different. They will require different tools and may vary in terms of cost and expertise on the SEA team. SEAs of provincial plans are particularly valuable because they bring in all sectors and potentially cover development throughout the country if all 73 provincial plans are assessed on a regular basis. They have the potential to change the entire course of national development to a more sustainable track.

In this case, the geographic boundaries of this SEA were those of the province – although it was necessary to assess upstream influences in Rayong's two main rivers which have their origins in neighbouring provinces. Regional and national institutions and plans had to be considered because of their significance in driving development within Rayong. The goal of the SEA was to define a sustainable pathway for development which all actors would need to abide by and respect when working in the province. That meant all sectors operating in the province had to be involved in the SEA process and the subject of analysis. The SEA ran for some six months with a budget close to USD200,000. The overall project was extended because it had other critical components, in particular, the review and revision of the national SEA guidelines and the preparation of linked SEA training materials and associated consultations.

14.2 The SEA context

Rayong's economy has grown impressively over the last thirty years, now having the highest gross provincial product per capita of any province in Thailand. Yet, on its own economic growth has been insufficient to secure livelihoods and well-being of residents with benefits unevenly spread. The traditional agricultural and fisheries sectors are suffering while industry, new commercial activities and tourism are expanding, leading to problems of structural adjustment. A variety of social equity issues have arisen linked to environmental quality, employment, access to public services and diminishing cultural heritage. Land ownership and land use is changing. Environmental degradation is associated with large scale heavy industry, uncontrolled urban expansion and agricultural runoff, impacting most on those least able to respond. Industry is attracting highly skilled and educated workers, while educational attainment within the province remains below standard. For Rayong's long term viability, the province needs to resolve these socio-economic and environmental problems stemming from its rapid development.

This final volume of the pilot SEA has detailed measures to address the central issues that are inhibiting sustainable development in the province – issues that have been identified by SEA stakeholders as of greatest concern. Some of the primary areas that the measures address include the growing demand for water, land and other natural resources, lack of integrated spatial planning and development controls, and the limited framework and enforcement of environmental standards. The measures address water shortage issues, environmental performance of the industry and tourism sectors, adjustments in agriculture, improved monitoring and generation of information to support better management, and nature based solutions to environmental quality problems across all sectors. Implementing the sustainability measures included in this volume will be essential to ensuring Rayong's long term vitality and development because of the close links between its attractiveness and liveability, and its economic viability.

To help promote and guide implementation of the measures included here, the next section outlines the steps needed to build a strategic support base as well as to oversee, monitor and evaluate performance against the SD objectives as part of the overall RPDP. Implementation, monitoring and evaluation is an iterative process, where measures are assessed for effectiveness over time, and modified as necessary on the basis of feedback. Also, the framework of indicators for monitoring performance can be adjusted based as needed and capacities are adequate.

The SEA was conducted taking cumulative impacts and cross-sectoral linkages into account. The iterative implementation and monitoring process must ensure that modifications or additions to measures take into account their likely effects on other sectors, groups and geographic areas, over the short, medium and long-term.

The final section provides a summary of substantive and process-oriented lessons learnt during implementation of the SEA. The lessons provide a reference for future SEA practitioners and supplement the national SEA guidelines.

14.3 Next Steps

SEAs are intended as a valuable supplement to guide decision making. While the strategic assessment process has value in its own right, ultimately, the intention is for SEA recommendations to be implemented. In large part, the success of an SEA can be measured by the number of its recommended actions which are implemented and have the intended outcomes.

The draft national SEA guidelines require that an SEA have a proponent agency (s), a review agency or committee. In this case, the proponent is the NESDC in collaboration with the Rayong Governor's Office. The review body is NESDC, ONEP and a special SEA technical committee involving other agencies such as the Department of Water Resources. When it comes to implementation of the SEA measures the proponent agency (s) need to take the lead. Because SEA's are strategic in nature, implementation is likely to require concerted actions across many sectors – so cabinet endorsement and facilitation will be required. That high level involvement and commitment will be needed in support of the Rayong SEA next steps. The SEA's sustainable development pathway, intended for integration within the RPDP should provide a road map and direction for any government agency and private sector with development and resource management interests in the province. They all have a key role in adhering to a common set of sustainability principles and measures when working in Rayong to be set out in the RPDP.

14.3.1 NESDC & ONEP planning meeting with Governor's Office and the RPDP working group

The NESDC, ONEP and the Rayong Governor's Office need to form a tight collaborative partnership to plan and facilitate implementation of the SEA. An initial meeting in the Governor's Office should lead to a day-long session with the RPDP working group, which is set up to review and revise the current RPDP and then prepare its next iteration. The objectives of the meeting will be (i) to present and discuss the SEA SD pathway and to decide on the most appropriate process for integrating the SEA findings into the current and next plan; and (ii) to agree on how best to build a constituency for SD pathway implementation within relevant local, regional and national agencies.

As a start, the roles and responsibilities of NESDC, ONEP, the Governor's Office and the RPDP working group should be defined – and a work program and schedule of activities and events with associated budget and source of funding prepared.

14.3.2 Workshop for SEA stakeholders to present and discuss the SD pathway

Three workshops with SEA stakeholders have been conducted. A final two day workshop is desirable to present and discuss the SD pathway and its implementation. The workshop would be convened jointly by the NESDC and Rayong Governor's Office and held in Rayong. Workshop participants should be similar to those attending the third SEA workshop to prepare the SD pathway, supplemented by

representation of key regional and national agencies which will have an essential role in implementation, such as the EEC Office, Regional Environment Office and Ministry of Industry and the Ministry of Transport. The output would be supplementary recommendations on the "who, what, where and when" of SD pathway implementation.

Another output would be the establishment of a stakeholder advisory group to help monitor progress and provide feedback on ways to improve implementation during the next five years of RPDP implementation.

14.3.3 Meetings on sector agency obligations and implementation strategy

NESDC would need to take responsibility for arranging round tables with sector agencies to discuss their specific roles in RPDP implementation, and to sharply define the priorities and schedules to be recorded in sector development plans and budgets. The implementation strategy should include arrangements for the cross-sectoral action and collaboration on the SD measures. Many measures nominate several responsible agencies because of their overlapping or complementary mandates. In those cases, the agencies should define ways of working together, including the sharing of information, and the establishment as needed of joint task forces.

ONEP and the Rayong Governor's Office should be involved in each of those meetings. The discussions should commence with a round table at NESDC bringing together all relevant agencies, followed by a program smaller one to one meetings with individual ministries and departments. Each agency should identify a senior focal point with authority to direct and guide agency action on SD pathway measures within their respective mandates. Focal points would need to come together on a regular basis to assess progress and address obstacles. Those meetings would best be convened each quarter in the first year of implementation and every six months thereafter. NESDC with the Governor's Office would be responsible for ensuring the program of sector agency meetings proceeds effectively with recording of points of agreement and reporting on progress as part of the overall RPDP monitoring and evaluation framework.

The intention is for NESDC and the Rayong SEA oversight committee to continue treating the SEA as a pilot – and shifting attention to the constraints, obstacles and prerequisites to effective SEA implementation through well-coordinated action at all levels and sectors of government.

14.3.4 The special role of the EEC office in SEA implementation

Because of the large-scale development plans under the EEC scheme, and the influence of EEC planning processes on sustainability in Rayong, the EEC Office needs to play a central role in ensuring the SD measures are implemented. Because the focus of EEC development planning in Rayong is on transforming and expanding provincial industry and infrastructure, the areas where EEC Office involvement is particularly important are: [126]

- *The industrial sector measures* - particularly in relation to industrial pollution and effluent as well as treatment of hazardous waste from industry;
- *Water resources measures* - industry is the largest single water user in the province, and industrial water usage will grow significantly under EEC planning;
- *Energy sustainability* - industry is the largest consumer of electricity in Rayong, and maintains a large number of Small Power Producers attached to industrial estates and factories;

[126] In 2017, Thailand's Board of Investment (BOI) released a presentation on key aspects of EEC development plans, including elements relating to the seven sectors detailed in this list. The presentation is available at: http://www.boi.go.th/upload/EEC%20pack%20for%20BOI%20fair_Rev4%203%201.pdf

- *Spatial planning and urban development*, - the EEC development planning includes elements focusing on increasing urbanization and enhancing community life.
- *Transport sustainability* - a major component of EEC planning is to support and improve transport infrastructure.
- *Tourism sustainability* - EEC plans include expansion of tourism.
- *Social equity* - many new migrants will be attracted to the region, which will influence the socio-demographic characteristics and benefit sharing in Rayong.

Building on the Rayong SEA, the EEC Office should work with NESDC and ONEP in supporting the two other EEC provinces - Chachoengsao and Chonburi - in conducting SEA's of their provincial development plans as a means of helping shape the EEC plan in its future iterations.

14.3.5 Establishment of an inter-provincial committee

A key concern raised by Rayong authorities during the SEA was the lack of a forum for regular consultations and exchanges between the three EEC provinces as a way of shaping their collective development. Many SD pathway measures require collaborative responses from the three provinces - for example, concerning water resource management, hazardous and solid waste management, river basin management, the creation of forest corridors and enhancement of biodiversity, and monitoring, analysis and reporting on environmental quality conditions. The Ministry of Interior with NESDC and the EEC Office would need to agree on how best to set up the provincial committee and then work with the three provinces in defining the mode of operations and budgeting of meetings and follow up support.

14.3.6 Integrating the SD pathway measures into Klong Yai and Prasae river basin plans

Thailand has a legislative commitment to preparing and implementing plans for all 25 river basins in the country. Important SD pathway measures for Rayong Province require a river basin approach so that upstream development does not negatively affect downstream activities and resource use. The Klong Yai and Prasae rivers have been grouped with the other rivers in the Eastern Seaboard region in their management planning. Because of their significance to sustainability in Rayong, they require individual management plans which are founded on the SD pathway prepared through this SEA and which are to be integrated into the RPDP. The National Office of Water Resources should take the lead in supporting the existing river basin committee in preparing those plans and in their implementation as an integral part of overall RPDP implementation.

14.3.7 A monitoring and reporting framework for SEA measure implementation

Establishing the monitoring and reporting framework for the RPDP is a crucial activity in ensuring the SD pathway is effectively implemented against the sustainable development objectives defined by SEA stakeholders. The initial framework of SD objectives and indicators is set out in the introductory chapter to this SEA volume. The objectives and indicators will need to be reviewed with recommendations for adjustment made along with the first year of application and reporting to reflect growing capacities in local government and changing conditions within the province – and then with every 2 years of reporting. The Rayong Governor's Office should lead in the monitoring and reporting of RPDP implementation progress, and its SD pathway measures. The reporting should be transparent and openly identify areas of achievement as well as naming agencies which have not met their obligations or have taken actions in the province contrary to the SD objectives.

All agencies working in Rayong should be required to report to the Governor's Office against relevant indicators. The NESDC would need to support the Governor's Office in the process, as part of its responsibilities to assess implementation of the national development plan and its central role in promoting use of SEAs as an essential strategic planning tool in Thailand.

14.3.8 Updating and improving SEA training in Thailand

The pilot SEA in Rayong was used to test Thailand's Draft National SEA Guidelines developed by the SEA Sub-committee, and facilitated by NESDC. The NESDC needs to build on the current first phase of SEA training by updating and improving the training program with the lessons learnt from the Rayong pilot SEA, and using the Rayong SEA as a case-study and standard. A set of training materials has been prepared as part of the overall project in which the Rayong SEA was one component. The training materials were based on the revised national SEA guidelines prepared during the SEA implementation, and the Rayong case-study.

The training program should take on board the lessons learned during the SEA implementation. The lessons are set out in the next section. In particular, trainees should be exposed to lessons relating to (i) stakeholder engagement, (ii) selecting and defining themes and sustainable development objectives, (iii) working in data scarce environments, and (iv) in defining and assessing alternatives and advising on steps to support adoption and implementation of SEA SD measures.

14.3.9 Building on the Rayong experience to enhance sustainability in other provinces

The process of conducting a provincial wide SEA focusing on provincial development planning highlighted the limited role provinces play in guiding sustainability within their borders. It also demonstrated how important that role can be in defining a framework of sustainability principles and actions which all arms of government need to follow. NESDC and ONEP should plan to replicate the Rayong SEA in other provinces around the country. One of the most important lessons from the Rayong SEA, which needs to be incorporated into the national SEA guidelines, is the value of provincial SEAs as a foundation governance level for reorienting the way in which development is planned and managed in Thailand.

14.4 Lessons learnt from the SEA

The pilot Rayong SEA demonstrated a staged process for strategic assessment of a provincial plan. The SEA led to the definition of sustainability measures for inclusion in the current and next iteration of the plan. The process worked collaboratively with key stakeholders from the province and with national and regional organisations. It was overseen by an SEA coordinating committee chaired by NESDC and including ONEP and DWR as members. The SEA received the full support and engagement of the Rayong Governor's Office and various provincial agencies such as the Town and Country Planning Department responsible for preparing the comprehensive spatial plan for Rayong and its municipalities.

The pilot SEA highlighted opportunities and constraints in development planning, particularly in terms of cross-sectoral integration for sustainability. The sections which follow outline lessons from the process arranged in four categories: (i) stakeholder engagement, (ii) structuring of SEA thematic areas, (iii) collecting data, and (iv) reporting SEA results.

14.4.1 Stakeholder engagement

Strong engagement and support from the Governor's Office is essential to a successful SEA at provincial level. At this earliest stage in the SEA a series of meetings were held with the Rayong Deputy Governor and senior representatives of the Governor's Office to explain and discuss the purpose of the SEA and the proposed process. The Office was influential in shaping the nature of stakeholders to be involved and in facilitating meeting and workshop arrangements. In general local government officers were uncertain about the potential scope of their provincial plan to have real influence on the most significant forces shaping development in the province. But they were aware of the commitments within the 12th national development plan to decentralisation so keen to explore the extent to which this could be promoted and achieved through the SEA process.

National sector agencies do not give adequate credence to provincial plans or priority to their involvement in the consultative process for defining them. In Rayong, national sector agencies dominate the development agenda and can be dismissive of the role of provincial agencies and stakeholders in development decision making. They tend to regard provincial plans as dealing only with local parochial concerns. In Rayong, there were reports of national sector agencies just not turning up to consultative meetings with the Governor's Office and RPDP working group to discuss their projects and budgets as an input to the provincial plan. That dismissive attitude of some central agencies is a significant obstacle to integrated planning for sustainability at provincial level which needs to be overcome. SEAs provide a vehicle for breaking down the centralised and sector based institutional culture which exists in some national agencies. The EEC planning process is an important opportunity to support the spatial foundations of sustainability in Rayong and its two sister provinces, but great emphasis is needed on involving provincial and local government in the planning process. That is where SEAs have an important role to play.

Provinces which share resources and a regional planning contexts need to be supported in forming inter-provincial consultative committees to discuss and resolve shared issues and to define concerted action. As indicated earlier, Rayong, Chachoengsao and Chonburi provinces would greatly benefit from having the capacity and authority to convene their own consultative meetings to discuss shared concerns and arrive at common positions on their linked development in an independent and transparent fashion. The current arrangements within the Ministry of Interior for encouraging cross provincial consultation on the initiative of neighbouring provinces is inadequate and centralised, inhibiting the kind of strategic spatial planning across borders which is promoted through SEAs. Inter-provincial forums facilitate implementation of SEA recommendations which have trans-boundary implications and solutions. For that reason it is also desirable to involve neighbouring provinces in province specific SEAs as they progress.

Consistent commitment from local stakeholders in the SEA process is nurtured by (i) a highly participatory workshop format with practical outputs and (ii) the involvement of high level national agencies with potential to support implementation of SEA outcomes. Stakeholders from Rayong were keen to be involved in the SEA aimed at building environmental and social sustainability into development of their province. Participants were asked to take a "hats off" approach to their involvement functioning as informed experts rather than sector representatives. The working sessions with all participants were designed to have well defined inputs to the SEA reports and recommendations. Also, it was made clear at each workshop that NESDC was the engine behind the SEA working closely with the Governor's office. In other words the SEA had authority and credibility with national government backing and was in a position to make a difference. .

The stakeholder selection process needs to be strategic: SEAs are not EIAs – they function at a strategic level and therefor need to be strategic in engaging stakeholders. Because SEA's have a broad geographic, substantive and temporal scope they have the potential to affect many hundreds and possibility millions of people. It is not feasible or desirable to attempt to involve them all. Stakeholder engagement needs to be highly selective targeting interest group "gate keepers" and influential agencies and organisations which are key to change and innovation in the development process.

In the Rayong SEA, the first major workshop to scope out the SEA attempted to involve too many participants – close to 100 were invited. That number made working sessions difficult to manage and reduced the depth of discuss and usefulness of the outputs. It led to frustration among some participants that they had not been given adequate opportunity to share the views and have their interests well reflected in discussions. Subsequent workshops were more strategic limiting participants to around 50 to much greater effect.

At the same time, it is important that all sectors or strategic themes identified by stakeholders as central to the SEA are represented. At the first workshop participants were concerned that some sectors such as tourism and health were not represented. That gap was remedied in the ensuing

workshops. The issue of representativeness in SEAs is always a challenge, especially in cases such as this one where all sectors are covered. The final composition set for participants is a balance of resources available, the duration of the SEA and the need to get the most out of participatory exercises – so they are fruitful and satisfying.

If consistency in participants is achieved from the beginning, they develop a good understanding of the SEA processes and outputs, and form a core group of "champions" who can communicate SEA results to their peers and to other groups, as well as being able to support implementation of SEA measures and monitoring of their effectiveness.

A stakeholder consultation and communications plan should be prepared at the earliest stage of an SEA: There needs to be a stakeholder consultation and communications plan developed for each SEA, and this plan must be used as a road map for participation throughout the conduct of the SEA. The plan should be based on a stakeholder analysis identifying the groups affected and the nature and extent of their involvement at the various stages of the SEA process. It should identify the methods to be applied in providing regular feedback of findings and progress to the stakeholders, and the opportunities and events for stakeholders to have input and comment on outputs progressively.

The stakeholder consultation and communications plan must take into account the available budget and SEA timeframe, and define the key stakeholder issues of concern and target groups in a realistic manner.

SEA workshops need to be thoroughly prepared and rehearsed by the SEA team: SEA teams should spend 2 – 3 days prior to a 2 day workshop working through the approach, participatory exercises and materials, as well as ensuring that everyone on the team has a good understanding of the types of outputs to be gathered and their roles in facilitation. SEA workshops should not be editing sessions where stakeholders go through draft reports line by line. Instead the events need to be forums for identifying strategic issues, illustrating concerns, sharing opinion and new information and defining responses to enhance sustainability. SEA teams should introduce fresh analysis of the issues of concern, and present new and innovate approaches and solutions to stimulate discussion. If resources and time allow, it is desirable to conduct at least one workshop at each stage of an SEA – scoping, baseline, impact assessment and sustainability solutions. For SEAs with broad geographic scope it may become necessary to conduct workshops in different regions to capture the views and input of groups unable to participate in events in capital cities.

14.4.2 Achieving the strategic focus for SEAs

SEAs should progressively focus on the most important issues of concern to the development in the area, sector or community under assessment. The need to focus down is one of the most challenging imperatives for any SEA team. It is not possible to resolve the many issues of concern to all stakeholders. Another key finding from the Rayong SEA was that a provincial wide assessments provide significant benefits in explicitly identifying links between sectors and in breaking down the silos between them in order to define inter-sectoral working relationships that are needed for sustainability.

Scoping should continue throughout an SEA so that they continue to sharpen their focus on the most important strategic issues: Usually SEAs begin with many issues of concern to stakeholders. In the Rayong SEA close to 100 issues were identified by stakeholders. The participatory process should facilitate discussion and exercises to group and narrow the range of issues which are the primary target for detailed analysis. That priority setting or scoping needs to happen at each stage of the SEA as information is gathered and understanding advances. The number of strategic issues should be reviewed during the SEA process with less important issues removed from consideration to enhance the strategic focus of the SEA.

In the Rayong SEA the full set of thematic areas selected during the initial scoping phase were retained for the whole SEA, however the number of issues under each theme were reduced to two or three

priorities. That filtering was achieved through groups working sessions and voting exercises. There continued to be significant overlap in the issues and findings between the development sectors and the environmental quality themes. Retaining the strategic scope of thematic areas still meant that analysis was conducted several times on priority issues such as solid waste and wastewater management, but from differing perspectives.

14.4.3 Operating in data scarce environments

Emphasis should be placed on the baseline assessment phase of the SEA in terms of time and resources to allow for the collection of data and creative analysis: In Thailand baseline data can be difficult to source, and often spread among a variety of agencies in different formats. SEA teams should allow sufficient time for baseline data collection and analysis. They should anticipate that data collected from different agencies may be conflicting and allow time for analysis to understand and resolve differences. Also, SEA teams should anticipate gaps in the availability of data, and should have methods in place to deal with these gaps (e.g. through analytical techniques or through acknowledging limitations in data and how this has affected the analysis and recommendations). Where gaps cannot be filled, expert judgement and stakeholder opinion and historical recollection is needed. Normally, SEA's do not have the capacity to undertake original research – but if budget and time allow, studies to fill gaps and resolve critical issues may become necessary. SEAs in Thailand may find, for example, that development planners have not adequately considered alternatives or supported research to better inform strategy decisions. In those cases, SEAs may need to identify the critical gaps and conduct original research and survey to fill them.

The Rayong SEA baseline assessment phase took a month longer than was initially planned. For example, Rayong did not have comprehensive monitoring and reporting data or analysis of the environmental situation, and the census data for the province was lacking because the previous national census was conducted nine years before the SEA. The dearth of reliable data and trend analysis caused additional expenses and had knock-on effects for later stages of the SEA, as the team searched for information to fill the data gaps that challenged analysis. In response, the SEA team continued the baseline data assessment and analysis in parallel with beginning the sustainability analysis phase of the SEA. The team remained open to new "baseline" insights to inform the sustainability analysis. SEA recommendations include addressing data gaps such as enhancing environmental monitoring networks and conducting interim "rapid" provincial censuses every two or three years.

Build awareness and understanding of the SEA process and objectives from the earliest stage: SEA teams should approach the baseline assessment phase as an opportunity to build awareness and understanding in stakeholders about SEA processes, and about the importance and nature of their contribution. Many government agencies, are still unclear and unsure about the purpose and value of SEAs, and this can lead to resistance to the process.

The SEA team in Rayong found that the lack of clarity about the SEA process among staff in a variety of government agencies formed an obstacle to obtaining data. This was not because of active blocking, but rather because staff interviewed generally did not have a clear understanding of why the SEA team was asking for information, and therefore were not sure exactly what information and data the team was trying to locate. The SEA team found that during data gathering interviews, it was valuable to allow time at the beginning of interviews to clearly explain what the overall goals of the SEA were, and to allow the interviewees to ask questions to clarify their understanding. This facilitated better data collection overall, but often required repeated visits to agencies and a formal process for arranging meetings and requests which was time consuming.

14.4.4 Reporting on SEA results

SEA reports should be formatted to enhance communication: In line with the high level of engagement from stakeholders in sharing information, it is important that the SEA reports are

engaging, colourful, and representative of the energy and input from the stakeholders. Reports should be divided into a series of communications briefs so that become more digestible for the reader. They should include graphs and figures to communicate and highlight the information content most effectively. The Rayong SEA reports were prepared in this way with a report documenting each phase of the process and being presented in the form of stand-alone briefs on each of the strategic themes. The team prepared thematic chapters in each report as individual briefs, complete with graphs, illustrations, photographs and other figures, to bring the information alive and highlight the critical findings.

Content should focus on analysis of trends and avoid stuffing reports with irrelevant data and statistics.

In the Rayong SEA an attempt was made to share draft reports at each stage with the technical coordinating committee members through NESDC. That desirable process of having draft reports reviewed and completed at each stage did not work perfectly as time constraints required the SEA to move to the next phase before the review and commentary process was completed. Also draft findings and analysis were presented to SEA stakeholders through the scoping, sustainability analysis and sustainable development pathways workshops. Ideally, every SEA should take a stage approach to reporting and not move to the next phase until review and comment by stakeholders is complete. In practice, this approach is not always feasible. SEAs need to remain relevant to the decision making context – if the process continues too long its relevance and the interest of stakeholders can be lost.

All reports and participatory events should be in Thai to optimise their uptake and engagement: The Rayong SEA team comprised of national and international specialists. They worked in English. Interviews with local stakeholders were conducted in Thai, with interpreters supporting the SEA team. The outputs of the SEA were all delivered in English. While this worked for NESDC and ONEP, it tended to exclude opportunities for line agencies and local government to comment and provide feedback. Some outputs were translated into Thai during the SEA, including all materials for stakeholder workshops. However, the language barrier did present some challenges to SEA participatory ideals. In this case, the SEA did not have the resources and time to translate all the SEA reports into Thai, but to be successful in influencing decisions and the RPDP that will be necessary.

15 REFERENCES

Bangkok Post (2019) Cabinet Gives Green Light to Water Master Plan https://www.bangkokpost.com/thailand/general/1697576/master-water-plan-given-green-light retrieved 03 August 2019

Bennett, G., and N. Carroll (2014) Gaining Depth: State of Watershed Investment www.ecosystemmarketplace.com/reports/sowi2014.

Bennett, G., and N. Carroll. 2014. *Gaining Depth: State of Watershed Investment 2014.* Online: www.ecosystemmarketplace.com/reports/sowi2014.

CATSPA (2017) Catalyzing Sustainability of Thailand's Protected Area System: Final Report. GEF/UNDP/DNP Thailand.

CATSPA (2017) Catalyzing Sustainability of Thailand's Protected Area System: Final Report

Chalamwong, Y. S. Mongkolsomlit., S. Paitoonpong., K. Ngaosri., K. Thanadkah., R. Prasomsup., A.Tunmuntong. and S. Sae-Khoo. (2018). *A Research Synthesis on: Attitude of native population and concerned government agencies towards migrant workers in Thailand in the context of Public Health, Economic Impact and National Security*. http://kb.hsri.or.th/dspace/handle/11228/4963?show=full;

Chantapong, S. and P. Thepkham. (2018). *Agricultural innovation: the solution to the inequality of Thailand, part 1.* https://www.bot.or.th/Thai/ResearchAndPublications/DocLib_/Article_11Apr2018.pdf

Decharut Sukkumnoed. 2018. Youth and Agri-Entrepreneurship on Thailand, Faculty of Economics, Kasetsart Univesrity, FFTC Agricultural Policy Articles, FFTC Agricultural Policy Plaform (FFTC-AP), Food and Fertilizer Technology Centre for Asian and Pacific Region. http://ap.fftc.agnet.org/ap_db.php?id=924

Eastern Special Economic Development Zone Act (2018)

Ministry of Agricultural and Cooperatives (2016). Agricultural and Cooperatives Strategic Plan 20 2017-2036. (https://ssnet.doae.go.th/wp-content/uploads/2017/09/25600922_แผนยทุ ธศาสตร์ส่งเสริมการเกษตร-ระยะ-20- ปี.pdf;

Nabangchang, O. (2014) A Review of the Legal and Policy Framework for Payments for Ecosystem Services (PES) in Thailand. CIFOR, Bogor, Indonesia. https://doi.org/10.1016/j.ecoser.2015.10.010

Nabangchang, O. (2014). *A Review of the Legal and Policy Framework for Payments for Ecosystem Services (PES) in Thailand.* CIFOR, Bogor, Indonesia. https://doi.org/10.1016/j.ecoser.2015.10.010

Pagdee, Adcharaporn, et al. 2015. *Developing REDD+ Strategies in Thailand: A Case Study of Drivers of Deforestation, Forest Degradation, and Possible Countermeasures in the Phu Wiang National Park Area in Khon Kaen Province.* Institute for Global Environment Strategies, Kanagawa, Japan.

PCD (2017) Environmental situation in eastern region 2016 https://drive.google.com/file/d/0Bws-qTXZ5yY2aDB1RHh5MWY4Rm8/view"

Sarnek, J.H., et al. 2011. Inpang carbon bank in northeastern Thailand: A community effort in carbon trading from agroforestry projects. Pp. 263-280 in Kumar, B. Moran, and P.K. Ramakrishnan Nair (eds.). *Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges.* Springer, New York

Suksawang, S and McNeely, J.A. (2018) *Protected Areas and Ecosystem Services in Thailand: Using Economics to help support conservation* (Draft in prep.)

Tapanapunnititkul, O. (2014). *Entry of Young Generation into Farming in Thailand.* FFTC-RDA International Seminar on Enhancing Entry of Young Generation into Farming in Thailand, October 20-24, Jeonju, Korea. http://ap.fftc.agnet.org/ap_db.php?id=330.

UNDP (United Nations Development Programme). 2017. *Payments for Ecosystem Services.* United Nations Development Programme, New York. www.undp.org/content/sdfinance/en/home/.../payments-for-ecosystem-services.html

UNEP (2014). *Building Natural Capital: How REDD+ Can Support a Green Economy: A Report from the International Resource Panel.* United Nations Environment Programme, Nairobi, Kenya.

Win, H. E. (2017) *Organic Agriculture in Thailand* Centre for Applied Economics Research Thailand. Available online at: http://ap.fftc.agnet.org/index.php

Win, H.E. (2016) *Crop Insurance in Thailand* Centre for Applied Economics Research Thailand available online at http://ap.fftc.agnet.org/index.php

icem

Climate Change | Biodiversity
Water | Integrated Assessments

Correspondence:
6A/49 To Ngoc Van Street,
Tay Ho District
Hanoi
Vietnam
(t) +84 24 3823 9127
(f) +84 24 3719 0367
info@icem.com.au
www.icem.com.au