



## Marine ecosystem impact assessments of offshore petroleum production in the EIA process of Thailand: Principles, practices, and suggestions for improving effectiveness

Sarawuth Chesoh\* and Burachat Sripitak

Department of Science, Faculty of Science and Technology, Prince of Songkla University, Pattani Campus, 94000, Thailand.

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### Abstract

An Environmental Impact Assessment (EIA) is a formal tool used in controlling, preventing, and reducing the environmental effects caused by any project operation. Field experience reveals that such report always largely varied in scope and quality of implementing. Offshore petroleum production is becoming an increasingly crucial part of global energy development. The principles and suggestions for improving effectiveness the practice in current marine ecosystem impact assessments, in the EIA process in Thailand were analyzed. Marine ecosystems are highly fragile, complex and diverse. Investigation of existing abiotic and biotic components of ecosystem, human use value, and quality of life value, together with measures to prevent and mitigation of adverse impacts then to compensate for the damage incurred, are assigned in Thailand's law. Key potential marine ecosystem, environmental impact issues to be prioritized are proposed. The insufficiency of site-specific baseline information and ineffective of follow-up monitoring are major current issues. Challenging issues in the procedure of EIA system are also discussed. Precise and updated information shared by multidisciplinary networking are necessary. Thus, the development of guidelines for the Best Professional Practices for marine environmental risk assessments and for public participation is strongly recommended.

**Keywords:** Aquatic conservation, Ecological monitor, Energy industry, Gas and oil, Transboundary pollution

### 1. Introduction

Production and exploration of natural gas and petroleum show clearly highly significant associated with our daily lives; in the house, on the road, and anywhere. It is a key factor in the socioeconomic growth and has had linkage effects to the public welfare improvement globally. Since the dawn of the industrial age, global exploitation of offshore petroleum has rapidly expanded to ever more remote areas due to developments in technology [1]. Petroleum, commonly known as natural hydrocarbon and paraffin substances covers unprocessed crude oil, natural gas, condensate, and free-chemical form product in nature. Petroleum industry totally comprises the process of exploration, extraction, refining, transportation and distribution, petroleum products to the consumers and typically belongs to multinational corporations. Crude oil supply is a major domestic source of energy in Thailand. Since scarcity of the internal petroleum reserves, the huge volume of crude oil imports roughly 860 thousand Barrels per day constitutes an important portion of the nation's total energy consumption that almost 90% imported currently from the Middle East. Therefore, the Thai government has promoted megaprojects for petroleum development over at least four decades. The Petroleum Act and the Petroleum Income tax were established in 1971 for favorable promoting

terms and conditions of domestic petroleum exploration and production [2].

Presently, a petroleum exploration and production project needs the EIA report under the responsibility of the Office of Natural Resources Policy and Planning (ONPP). The Department of Mineral Fuel (DMF), Ministry of Energy, is currently the sole government agency overseeing the upstream petroleum industries. The first exploration of petroleum in Thailand started in 1921 in the northernmost parts of the country by the Department of Energy Defense under the ministry of Defense to provide fuel for the state railway operations. For promoting the petroleum exploration rights, concession agreements were modeled and launched in 1961. And then the first discovery of the offshore petroleum occurred in Pattani basin or named "Erawan" in the lower part of the gulf of Thailand by the Union, (which later became Unocal), in 1973. Thailand has currently announced natural gas reserves approximately over 14 trillion cubic feet that about 85 production areas have been approved. Almost of these volumes are situated in offshore regions of the Gulf of Thailand and Andaman Sea. Further, petroleum business companies are actively operating presently on 40 exploration fields, including 19 land-based petroleum exploration projects and 21 in the Gulf of Thailand covering 29 concessions over 225,893 square kilometers of the total area [3]. Chevron belongs to the largest of Thailand oil field in the north Pattani trough and shares the biggest oil producer

\*Corresponding author. Tel.: +6681 963 3775  
Email address: chesoh.s@hotmail.com  
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about one third of the whole country followed by the PTT Exploration and Production Company Limited (PTTEP) and Salamander Energy and Coastal Energy PLC.

Actually, Thailand is located between the two great civilizations of India and China and is the prominent maritime nation, with continental shelf areas included within its boundaries, and an exclusive economic marine zone of at least 314,000 square kilometers. Exploration and production of petroleum business in the gulf of Thailand have considerably enhanced the nation's economy over 40 years. However, there are serious concerns about the ecological impacts of these business operations on marine life biodiversity and productivity, which in their turn affect the coastal inhabitants' livelihoods especially in fishery and tourism industries [4]. Moreover, transboundary pollution from offshore oil and gas activities in the Southeast Asian seas, and issues with the decommissioning of offshore production platforms, are also serious problems [5].

Marine ecosystems are recognized as the world's dominant producers of valuable resources, but they are highly fragile, complex and diverse. In addition, approximately 33% of the world's population inhabits in coastal areas [6], these incomputable valuable resources may adverse impacts of above offshore business operations. Healthy seawater is very important to marine living organisms and to the coastal communities whose household income relies on fishing and tourism. Increasingly, such concerns of environmental deterioration and public well-being are addressed through Environmental Impact Assessments (EIA), which are environmental management tools used in project decision making. This review paper aims to examine the principles and the practices of marine ecosystem impact assessment of offshore petroleum production, in the EIA process in Thailand and suggestions for improving effectiveness. Finally, it may contribute to striking a sustainable balance between economic growth, environmental mitigation and protection, and public acceptance, in the activities necessary for offshore petroleum development projects.

## 2. The principles of the EIA of offshore petroleum in Thailand

Basically, the EIA process highlights the better alternative plan of policy makers to regulate the sustained natural resources, public interest and human health. Moreover, it reflects the efficiency indicator of the strategic development project based on their prediction. The first mandatory notification of EIA requirement on the economic development project screening approach in Thailand was issued in 1981 beneath the Enhancement and Conservation of National Environmental Quality Act 1992 [7].

The five steps and respective responsibilities in the EIA process are stated, and the participation of all stakeholders is legislated in every step. (1) **Screening**; this is a basic process to answer the question "Is an EIA required?" and "Are there significant environmental impacts probable?" Therefore, the answers are about the nature of project activity for categorizing the degree of risk level on fragile natural resources and vulnerable group in the sensitive area. To determine whether the preliminary assessment is necessary, the important question is why and what an EIA needed to be done, including background of the proposed project, preliminary location appraisal and the opinions of key community leaders or the local administrative organization. (2) **Scoping**; this is an important stage to answer the question "What should be included by the environmental

information?" Therefore, the answer similarly needs to identify the contents and scopes of an EIA report, including location selection from a number of alternatives, framework and boundary of local and public engagement particularly opinions of competent authority. Key issues and impact items must be identified and considered. (3) **Report preparation**; project owner together with consultant and specialist panel need to be assorted and well organized for each responsibility to design and accomplish the EIA report outlines, including information achievement and preparing draft documents, notices of all stakeholders' especially local opinions, independent entity and their complaints. (4) **EIA report examination**; all analyzed and proposed contents will be examined and rechecked by official expert committees and then submitted to the Cabinet for endorsement. (5) **Monitoring**; this procedure includes a follow-up mechanism in each step of construction, operational and post-operational phase by the permitting authority and the third party implementing. The official EIA guidelines determine the prioritizing the various ecological aspects of data collection that are required in the environmental impact statement process [8].

## 3. Practical topics in implementing the EIA process

The National Environmental Quality Act (NEQA) 1992, promulgated the requirement to prepare an EIA report for various project types and sizes. ONEP then established the guideline in the EIA preparation that an EIA report must describe the various impacts to the environment and surrounding areas from the activities of the proposed action or project. The environment usually represents physical, biological, social, human health and community livelihood characteristics in the proposed project area and the adjacent. The impact means a change from the baseline situation caused by the activity of the project, and then the preventing, mitigating and balancing the significant adverse impacts of proposed projects are integral considered. In characterizing the baseline situation, each environmental component, including terrestrial ecosystem, aquatic ecosystem, air quality and meteorological aspect is necessary to be involved. The most significant impact, both the positive (benefit) and negative (damage), principally needs to focus on initial assessment. An EIA process is concerned about all categories of the impacts and may be identified in a number of ways, namely intensity, direction, spatial extent, duration, frequency, reversibility and probability. To understand the various activities of the proposed project, primary activity and associated action, is the first key success of the EIA process based on what and why are those activities being proposed? Therefore, the EIA team must realize the objectives of the development project to recognize environmentally sound alternatives.

The EIA report should be prepared and cooperated in the same direction and purpose of all technical parties, including the consultant firm project proponent, EIA reviewer and permitting agency. The contents of an EIA offshore petroleum production report usually comprise 6 domains as follows [9];

(1) **Introduction**; this describes the background of the project, including the objectives of the EIA report, list of core activity and action program, the outlines of the initial assessment and the characteristics of the study area.

(2) **Project description**; this describes the rationale and purpose of the project activity and action plan. General geographic and physical oceanographic characteristics and components of shoreline are also defined. The preliminary

analysis of activity and action of project programs, alternative outcome, whether with and without the project implementing, work plan, project activities, platform preparation and installation phase, drilling phase, petroleum producing phase, (petroleum storage, transporting and distributing stage), decomposing phase. Employment, waste and waste management, mud and cutting, wastewater treatment, solid waste and hazardous waste, greenhouse gases, occupational health, safety, and environmental safeguard management, environmental policy, and emergency response plan.

(3) **Environmental information setting**; this describes and recognizes the details of physical environmental structures i.e. climate and meteorological conditions, geology, oceanographic characteristics, including sea water quality, water current circulation, wave and tide, thermal and salinity stratification, seabed and sediment quality, biological environment, marine ecology, marine living organisms (species composition and abundance of flora and fauna, habitat, population structure), key species and rare marine animals, human use value, fisheries use, marine protected area, navigation routes and archaeology, all above need to be described. Each element in this domain plays highly important for public consultation and decision.

(4) **Local participation and public consultation**; this describes the consulting on environmental information and the impacts to say what specific content is needed in the report or can express opinions on the quality of field information included in the report. Public involvement typically takes place at scoping and EIA review stages. Similarly, for accountability and transparency, it may also conduct at any stage of the EIA process. Moreover, this indicates the public involvement process, people concerned with the issues, opinions and suggestions for all stakeholder involvement. Transboundary consultation may require in some sensitive case.

(5) **Prediction potential impact and judge the significance of potential impact**; this determines potential impacts are likely to become actual and quantity these magnitude impacts to the extent possible, including baseline information of environmental features, socioeconomic, cultural, health care and community livelihood that are arranged into groups the items of significant impacts. In addition, preventing and mitigation measures of the negative impacts must be closely investigated under the periodic monitoring plan by the third party.

#### 4. Key potential marine ecosystem, environmental impact issues

Marine ecosystems are complex and require a multidisciplinary approach of high quality specialists to assess them, and then to establish management measures. Therefore, assessing the impact of offshore petroleum and its linkage businesses that affect the sustainability of marine ecosystems is vital to the approval process. The main crude oil and natural gas produced in Thailand originated from an offshore tertiary basin in the gulf of Thailand. This shallow and semi-surrounded Gulf is situated in the South China Sea, where is the one part of the Pacific Ocean. The Gulf is surrounded by Malaysia, Thailand, Cambodia and Vietnam covering roughly 320,000 square kilometers and average depth is about 45 meters, whereas the deepest is approximately 80 meters [10]. The majority of natural gas fields is dispersed all over the Pattani trough while oil fields are clustered in the shallower part of the basin margin of the

Gulf, these resulting of the diverse sediment seabed of the Gulf and geological periods of the Gulf formation [11]

In terms of marine ecological impacts concerning, four basically steps of oil and gas companies to explore and produce petroleum can be considered [12]; (1) Geographical survey to estimate the potential petroleum reserve by using seismic reflection techniques. (2) Drilling activity to approve probable natural gas and crude oil reserve. (3) Advanced well drilling to quantify hydrocarbon volume for established oil pool extension; and (4) Commercial producing; this step requires offshore platform installation and bulky construction for gas pipeline and field work facilitating etc. Marine ecological impacts may originate at all stages of such petroleum activities, including initial exploration, production, and final decommissioning, and the issues that relate to offshore pollution are as follows;

1. Exploration operations (Seismic survey and exploratory drilling)

- Noise and vibrations from seismic survey, underwater explosions, habitat destruction and acoustic emission, drilling fluid discharges (water based and oil based muds) and drill cuttings or particles of solid rock, atmospheric emissions, accidental spills/blowout and solid waste disposal.
- Chemicals effluents such as polycyclic aromatic hydrocarbons and heavy metals are also released during drilling.
- Ecosystem destruction and interference with land use to access onshore sites and marine resource areas; environmental pollution and safety problems.

2. Development and production (Development drilling, processing, separation and treatment, and initial storage)

- Physical disturbances from the presence of fixed or floating platforms and vessels involved. Influence of light, marine noise, and disposal of wastes.
- Discharges of solids, hydrocarbons and additive effluents, drilling cuttings and contaminated water discharges from operation, atmospheric emissions, accidental oil spills, deck drainage, sanitary waste disposal.
- Transportation, socioeconomic and cultural issues
- Marine ecosystem destruction, deterioration and interference, including contamination by petroleum-derived wastes; atmospheric emissions from fuel combustion and gas flaring.
- Discharge of oil and compounds from platforms and ships. Risk of petroleum hydrocarbon spills, blowouts, malfunctions and accidental discharges. Impact of particles on marine ecosystems via physical burial of organisms.
- Coastal local safety, including pollution related to onshore and offshore operations, hazards to fishing, tourism and navigation. Risks of extreme weather events and alien invasive species.
- Effect on fisheries and aquaculture as a livelihood for the community. Fishing effort loss due to some fishing ground closure, environmental degradation.
- Tourism and navigation impacts due to some water surface area closure.
- Urbanization trend and related problems.

3. Decommissioning and rehabilitation (Well plugging, removal of installations, equipment, and site restoration)

- Physical closure or removal, petroleum-contaminated waste disposal, leave in situ (partial or total), dumping at sea.

- Marine pollution and coastal local safety, including pollution related to onshore and offshore operations, hazards to fishing, tourism and navigation.
  - Positive impacts of a rig re-used as an artificial reef to shelter aquatic life.
4. Transportation and distribution (Pipelines, barges, ships, tankers and trucks)
- Emissions and accidental discharges, discharges from transporting vessels e.g. ballast, bilge and cleaning waters.
  - Marine pollution, contamination of soils and water. Risks to coastal local safety and family occupations.
  - Air emissions (hydrocarbons from loading racks and oil spills); accidental discharges and operational failures; disposal of sanitary waste.

Major marine ecological impacted issues briefly contain; (1) Physical and chemical environment i.e. marine pollution, change in sea water quality due to hazard chemical effluents, increase gaseous air emission, possible change in noise level, global warming and climate change of gaseous emission. (2). Biological environment; for example, ecosystem damage and disturbance, biodiversity loss, decrease primary production, fish larvae kill, and eutrophication. (3) Human use value, i.e. negative impacts of fisheries and aquaculture as livelihood of the community, tourism, navigation, loss of sport and recreation area, urbanization trend and related problems. (4) Quality of life value i.e. change of ways of life due to some must change traditional occupation, decrease family income of community households, negative human health risk, increase and unpredictable human risk and hazard for daily activity, marine accidents, increase health treatment cost. However, positive impacts of a platform re-used as an artificial reef to shelter aquatic life, a change of lifestyle to modernization or better well-being.

Analysis of marine ecosystem impact should be related to the activity of petroleum exploration and production process, potential associated risks, and issues of the environment, human health and safety. Nine domains of standard impact analysis should include the following indicators; (1) Type of the impacts i.e. physical, chemical or biological characteristics, socioeconomic or human health performance. (2) Nature of the impacts i.e. direct or indirect, accumulative. (3) Magnitude or severity, for instance, high, moderate, low, acute or chronic. (4) Extend of the impacts i.e. specific area, local, regional, transboundary or global. (5) Timing i.e. immediate, short run or long run. (6) Duration i.e. temporary or permanent. (7) Uncertainty i.e. low likelihood or high probability. (8) Reversibility i.e. reversible or irreversible. (9) Significance i.e. unimportant, important or very important. Checklists, matrices, network, GIS, expert team and professional judgments are the effective tool for those impacts analysis and making decision.

## 5. Challenging issues in the procedure of EIA system in Thailand

### 5.1 Qualities of the EIA report

Actually, the project owner employs a private consultant, agent to organize the EIA document under a limited budget and short period, keeping the cost of business, which might cause carelessness as indicated by the out of date baseline information especially site-specific data and insufficient public consulting. The environmental impact of any development projects often has a low priority in national policy. Several of the EIA reports are of slightly lower

quality and may also be hard to understand, regardless of the reader being well-educated. Some are too short and unclear about the relevant data. It seems that in particular short EIA reports are often of poor quality. The environmental impact of any development projects often has a low priority in national policy. Several of the EIA reports are of slightly lower quality and may also be hard to understand, regardless of the reader being well-educated. Some are too short and unclear about the relevant data. It seems that in particular short EIA reports are often of poor quality. Some are too small sample size in term of number of sampling location, number of represented species and population, uncovering seasonal data collection, level of marine habitat disturbance and destruction, limited information about marine rare, threatened and endangered species, a key species in marine protected area etc. Moreover, inappropriate and ineffective techniques are applied to classify and to evaluate the baseline situation and condition, particularly uncovering all stakeholder opinions. Thus, the scales of negative effects or local complaint on their well-being and change ways of life are not taken account in the assessments. Therefore, a professional EIA team with high experiences in the marine ecosystem survey is strongly required. And then to avoid biases, inaccuracies in analysis and the chosen best alternatives, public involvement in an EIA process is strongly recommend in developing countries [13].

### 5.2 Mismanagement of the EIA process

Even though the EIA law in Thailand was promulgated at least 32 years, misunderstand in the EIA concept and mismanagement of the EIA process is usually occurring among project developer, private consultant, agent and the official representative in charge of the EIA inspection authorization.

Some projects are decreased in size or capacity to avoid the EIA process. Moreover, in some cases the impacts of the project remain incompletely element identified or quantified and the local population is rarely consulted. Deficiency of transparency in the local participation in the decision-making process is also a serious issue. In cases like this anywhere the EIA has been ineffective, corrupt behavior of authorized agents and corporations may be suspected. An anonymous big petroleum company operator expressed views on how to speed up the EIA process, and how the operators can better understand the related concepts and academic principles. The intent is to minimize environmental impacts, not to let the operators avoid environmental responsibility. Thus, the full EIA report must consider real alternatives and the impacts also must be clearly assessed and honestly.

### 5.3 Follow-up mechanisms

The EIA report will be useless if inadequate follow-up mechanisms of implementing in the environmental monitoring program, which executes project operational and post-operational audits. To ensure that implementation of conditions attached to a decision and to confirm that mitigation measures are occupied as expected. Furthermore, it may take action to manage any unforeseen changes. Accordingly, the weak enforcement of environmental law and poor EIA follow-up may be due to experts that are poorly equipped with knowledge and material capacity. Thus, a properly implemented follow-up mechanism not only boosts the effectiveness of current projects, but also ensures the heightened effectiveness of future projects in providing them added value of learning and skill

development. That is information in this process contributes to effective EIA in the future.

#### 5.4 Establishing competencies

A large-scale development project always involves a large number of stakeholders, particularly in offshore petroleum production, which may generate environmental and socioeconomic adverse impacts and may even cause conflicts at local, national and transboundary scales. Individual countries must draw on the services of professionals with multidisciplinary knowledge of EIAs, and should collaborate internationally. However, a nontechnical summary should be done for all key players.

The petroleum development project operators in Thailand stated that the EIAs for those projects often came across problems, because there were not enough advisory companies with expertise in the field. Many EIAs were incomplete as a first draft and had to be revised many times. When the EIAs failed to get a green light within the operators' planned schedule; their businesses were affected by the delays and changes to concession conditions. However, ONEP already has joined hands with the relevant organizations to set up EIA manuals for petroleum exploration and production projects. The competency requirements for conducting an EIA should include knowledge of the scope of impact identification and related procedures, analytical methods used to generate the EIA, and technical and social skills. Finally, the EIA regulators should be empowered to carry out their responsibility faster and more effectively.

#### 6. Conclusions and recommendations

Rapid economic growth in Southeast Asia, offshore petroleum exploration and production has become or primary importance of energy security. However, our oceans face serious deterioration due to marine pollution, especially by hydrocarbon substances. The EIA is only the first step as a legal measure to protect our ocean environments. We must ensure that the quality of the baseline condition provided in the EIA report for decision-making purpose corresponds to the scale and significance of potential adverse impacts. Precise, updated information, clear access to all key actors, and multidisciplinary networking of various stakeholders in the EIA process to share data and information are necessary. Thus, guidelines should be proposed to support users to identify, avoid, prevent and/or mitigate potential adverse impacts and increase potential beneficial impacts. The Best Professional Practices for marine environmental risk assessments including (1) Key issues must be explained why the various issues outlined in EIA report are of concern. (2) Impact assessment should be summarized in the tabular format and summary matrices should also be constructed. (3) Significant adverse impacts must be clearly discussed. (4) Severity indicators (major, moderate, minor, negligible, no interaction and positive) must be categorized for ecological, socioeconomic and human health effects, stakeholder concerns and consequence for project developers. Moreover, optimism bias and planning fallacy can be a significant sources of limitation. Therefore, public participation and transparency in all EIA implementing steps must be strongly concerned.

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