PROCEEDINGS

GEOSEA XIV AND 45TH IAGI ANNUAL CONVENTION 2016 (GIC2016)

The Trans Luxury Hotel, Bandung, October 10 – 13, 2016

**PROCEEDINGS OF GEOSEA XIV AND 45th IAGI ANNUAL
CONVENTION 2016**

"ASEAN Earth Resources and Geoscientist Role in AEC Era".

10-13 October 2016, Bandung, Indonesia

IKATAN AHLI GEOLOGI INDONESIA (IAGI)

Indonesia Association of Geologist

Ikatan Ahli Geologi Indonesia (IAGI)

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PREFACE

The 45th Annual Scientific Convention of the Indonesian Association of Geologists (IAGI) this year has been held in conjunction with the GEOSEA Congress XIV (abbreviated as GIC-2016). The GEOSEA is a communication forum for the geologists in Southeast Asia countries.

The main theme of the event which is the ASEAN Earth Resources and Geoscientist Role in AEC (ASEAN Economic Community) Era has made the papers submitted and presented in the event covering a wide range of variety. The main theme covering two main topics, i.e. earth resources and geoscientist development in ASEAN countries has also been represented by the papers presented in this event.

Although since several years ago, the earth resource industry situation has not been that bright, triggered by the declining of commodity prices, regulation uncertainty, and also other issues related to the local stakeholders; this GIC 2016 event has attracted significant numbers of participants including industry geologists, faculty staff from the universities, government agencies, contractor companies, and other experts. It is the IAGI's pride to present this GIC 2016 event for the benefit of geological society in both Indonesia and ASEAN countries.

The proceedings contain all papers presented in the GIC 2016, covering various topics including

1. Engineering Geology, Hydrogeology, Mitigation and Applied Geology
2. Geology and Geophysics Method and Application
3. Geotourism
4. Mineral And Energy Resources Management
5. Mineralogy, Petrology, Geochemistry
6. Sedimentology, Stratigraphy, and Petroleum Geology
7. Tectonic, Structural Geology and Geodynamic
8. Volcanology and Geothermal

They are written by experts from various geology background including industry, government institutions, and universities.

On behalf of IAGI, we would like to thank all authors, paper reviewers, editorial team, and also to all sponsors from industry and government for their contributions and involvements. Without all of them the GIC 2016 event and the publication of this proceeding will not happened.

Bandung, October 2016

Sukmandaru Prihatmoko

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Environmental Baseline Assessment In Oil And Gas Activities In Indonesia Using Remote Sensing

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Abstract

Oil and gas industry are an expensive industries, high risk and high technology. The exploration of oil and gas activities has not always been without some ecological side effects. Therefore the Environmental Baseline Assessment (EBA) needs to be done before the starts of oil and gas activities. An EBA helps to understand existing environmental conditions thus defining the focus of the environmental impact analysis and resources that need protection through appropriate and viable mitigation measures. The EBA consists both desktop studies and fields surveys. The desktop studies comprise the collection and evaluation of existing data, studies and reports already gathered and available through local government and non governmental organisations. The field surveys comprise observations and registration, collection and analysis of samples. The study process entails a scoping exercise by multi-disciplinary group of experienced specialists for the key environmental issues. Based on the valued ecosystem components, the study scope should cover, but not limited to issues such as climatic conditions, drainage and water resources, soils, flora, fauna, air quality, noise, land use, land tenure and socioeconomic aspects. The results of this study provide an overview of the condition of oil and gas areas both the physical environment, biological and chemical. Mapping land use and infrastructure will also be taken into consideration in the mobilization tool and emergencies. Another results are to provide an overview potential conflicts with other activities, spatial plans, conservation areas and population concentration. It can be used as a basis for good planning and mitigation. Impact arising from oil and gas activities could be physical, chemical, biological and socio-economic impacts. With such potential impacts, impact prediction can be analysis from the results of EBA. The other results of EBA is sensitivity area and called Environmental Sensitivity area. It is a reflection of ecological, social economic and sociocultural entities of certain area and comonly used to set response priority of environmental damage in oil and gas activities.

Keywords: Oil and Gas, Environmental Baseline Assessment, Water Resources, Soils, Flora, Fauna, Air Quality, Noise, Landuse, Sensitivity, Field Survey

Introduction

Recently, awareness to protect environment damage from any human activities is increase both in developing and under developing country. Environment condition is influenced by many aspects, include human activities and natural hazards. In oil and gas activities also has not always been without some ecological side effects. In order to predict and evaluate environmental impact, it is critical to understand the baseline environmental condition prior to exploration and or development. This achieved by carrying Environmental Baseline Assessment (called EBA) before oil and gas activities.

EBA is environmental condition at certain time. The environmental discuss about climate, hydrology, landcover, soil condition, socio-economic and culture at oil and gas areas. EBA is an obligation for every oil and gas company in accordance with production sharing contracts:

- a. "Contractor shall conduct an environmental baseline assessment at the beginning of contractor's activities" (PSC term - 2007 section V point 5.2.5).
- b. "Contractor shall conduct an environmental baseline assessment at the beginning of CONTRACTOR's activities; and thereafter conduct any obligation pursuant to applicable law requirements, such as analysis of environmental impact (AMDAL)" (PSC term – 2009 section V point 5.2.6 a).

A review of country and institutional environmental policies and regulatory frameworks indicate that all national regulations and multilateral financial institutions guidelines require an understanding of the existing environment that might be affected directly or indirectly by human activities, especially oil and gas activities (Hietter, 1995 in Kubo, et al., 2009)). In Indonesia, BP Migas has been made the Guideline of EBA, especially for oil and gas activities (Working Procedure Guideline No. PTK-045/BP00000/2011 on Environmental Baseline Assessment).

In EBA, remote sensing is ones tools to support the study. The benefit of remote sensing are:

- a. Wide coverage imagery so it is easy to obtain a comprehensive description of the surface conditions, both for geology, planning and other;
- b. Application of multi-spectral detection sensor and even hyper-spectral, thus enables the automatic

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application of computers to describe and unravel the characteristics of the observed material;

- c. Can use various types of data, such as optical sensor data and radar sensors, as well as combinations, so we can have a new solution in determining the nature and relationships of various phenomena on the earth's surface.

Consider the importance of remote sensing data as one element that can be utilized in oil and gas activities, it issued Decree of the Minister of Mines and Energy Number 1519.K/20/MPE/1999 on Utilization of Remote Sensing Technology in the Supervision and Monitoring Activities of Mines and Energy. Business activities in the mining and energy required to utilize remote sensing technology to:

- a. Provision of information early hue situation of the mining area before activity begins;
- b. Supervision and monitoring of mining activities and energy performance;
- c. Supervision and monitoring management performance and environmental areas of mining and energy;
- d. Supervision and monitoring of the environmental consequences of business activities in the mining and energy (RSGIS Group LEMIGAS, 2010).

The main objective of EBA are to assess the quality of existing environment condition and sensitivity area to understand that may occur as result of impact oil and gas activities; to collect and present information that identifies cultural, social, economic features and characteristics in the study area and to provide the basic information for determining the fulfillment of project. In this paper are focused on the role of remote sensing and enviromental sensitivity area of EBA.

Scope Work of EBA

EBA helps to understand existing environmental conditions thus defining the focus of the environmental impact analysis and resources that need protection through appropriate and viable mitigation measures. The EBA consists both desktop studies and fields surveys. The desktop studies comprise the collection and evaluation of existing data, studies and reports already gathered and available through local government and non governmental organisations. The field surveys comprise observations and registration, collection and analysis of samples. Based on Working Procedure Guideline from BP Migas (2011) on Environmental Baseline Assessment, scope work of EBA include:

- Area study is in oil and gas working areas and its surrounding

- Components of EBA include geophysic-chemist, biology, social economic, cultural and social health in oil and gas working area and its surrounding.
- All environmental aspects were studied to provide information including the environmental characteristics of ecosystem condition, social, economic, cultural and public health.
- EBA should describe the spatial planning of area study
- EBA should describe the sensitivities area
- EBA should be equipped with thematic maps to be more informative
- Report of EBA should contain suggestion and feedback to the company in conducting oil and gas operations

The Role of Remote Sensing for EBA

Satellite remote sensing has been recognized as a valuable tool for viewing, analyzing, characterizing and making decisions about environment. This is because: (1) satellite remote sensing uses sensors/detectors to acquire information about objects or phenomena from a distance, rather than in situ; the spectral range imaged through satellite remote sensing is greater than the visible range of electromagnetic energy that our eyes only sense; (3) viewing perspectives range from regional to global scale; and (4) satellite images can form a lasting record. To meet the needs of different users for remotely sensed data, there are many remote sensing systems offering a wide range of spatial, spectral and temporal parameters (Wei et al., 2009).

Remote Sensing image data are digital representations of the Earth. Remote sensors are made up of detectors that record specific wavelengths of the electromagnetic spectrum. The electromagnetic spectrum is the range of electromagnetic radiation extending from cosmic waves to radio waves. In remotely sensed image data, each pixel represents an area of the Earth at a specific location. The data value assigned to that pixel is the record of reflected radiation or emitted heat from the Earth's surface at that location. The data value is the measured brightness value of the pixel at a specific wavelength. Satellite imagery is generally used for landuse/landcover analysis and also used to assess (directly or indirectly) the terrain relief (Murali et al., 2010).

Landuse/landcover has become a central and important component for EBA. Landuse is a product of interaction between a society's cultural background, state and its physical needs on the hand and the natural potential of land on the other (Balak and Kolarkar, 1993 in Rawat et al., 2013). Landcover is defined by the attributes of the earth's land surface captured in the distribution of vegetation, water, desert and ice and the immediate subsurface, including biota, soil, topography, surface and groundwater and it also includes those structures created solely by

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human activities, such as mine exposures and settlement (Lambin et al., 2003 in Rawat et al., 2013). Landuse/landcover mapping can be extracted using remote sensing data, it also landuse/landcover changes.

Remote sensing for landuse/landcover has been used with different techniques and data sets. Recently several techniques have been developed that make use of remotely sensed images for landuse/landcover. Visual interpretation has become common method and used for complex region. Digital interpretation has been developing with variety of techniques and Algorithms. Unsupervised classification, supervised classification, PCA, Hybrid classification, Fuzzy classification are the most commonly applied techniques used in classification (Lu et al in Butt et al., 2015).

Visual interpretation or called manual interpretation is interpretation of remote sensing data based on the introduction of properties/characteristic of objects spatially. Characteristics of object can be recognized based on 9 elements of interpretation namely shape, size, pattern, shadow, color, texture, sites, associations and proof convergence. Digital interpretation is quantitative evaluation of spectral information presented in the images. Basis of digital image interpretation in the form of pixel image classification based on spectral values and can be done in a statistical way. The digital image classification has specific purpose to categorize automatically every pixel which has the same spectral information by including spectral pattern recognition, spatial pattern recognition and temporal pattern recognition which eventually form specific spatial class or theme.

Figure 1. Remote Sensing Data (ASTER) of Indramayu Regency with Natural Color Band Combination (Susantoro, 2005).

Remote sensing for environmental has been started in the 1970s when digital satellite borne imagery compented aerial photography. It is expected that through remote sensing technology, information that describes the latest

environmental conditions will be obtained. The information that can be extracted from remote sensing data includes land use/land cover, geological map, drainage pattern, slope, infrastructure and etc. Figure 1 is remote sensing data and Figure 2 is interpretation results of remote sensing for Landuse and landcover.

Figure 2. Landuse/Landcover Interpretation of Remote Sensing Data

Environmental Sensitivity Area

At the beginning, the oil and gas activities cover regional geological studies, geological evaluation, concession area, survey and analysis / evaluation of prospects and leads as well as analysis of feasibility and economy. The impacts resulting from these activities are unidentified because the nature of these activities is in the form of study. The oil and gas activities that have environmental impacts include seismic, drilling, exploration, delineation drilling, development drilling, constructing of facilities, pipelines and infrastructure and production. Identification of impacts resulted from oil and gas activities on environmental, social, economic or cultural aspect needs baseline data. Sensitivity area should be identify to avoid negative impact. Working Procedure Guideline from BP Migas (2011) has been made criteria of Sensitivity area, those are:

- Presence or absence of protected areas in WKPs which includes: the region that provides protection Region subordinates (protected forests, peat and water catchment areas), Protected Areas local coastal border, chance of the river, the area around the lake / reservoir, and around springs), Natural Reserve Area and Heritage, and Natural Disaster-Prone Areas (Decree 32 of 1990 on forest Protected Area Management).
- The intensity of social and economic activities, culture and health in the region, such as the existence

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of the settlement, the potential for conflict, fishing, cruise lines, plague / disease is endemic, indigenous / indigeous people and others.

- c. Environmental setting conditions which have special characteristics and ecological functions, such as the condition of river water quality has been classified as heavy polluted.

Another common method used to identify sensitivity area is Environmental Sensitivity Index (ESI). ESI developed by Research Planning, INCH (RPI), USA senior scientist in 1976 and has become an integral component of oil spill contingency planning and response in USA and other countries world wide (Saxena et al., 2012). ESI is description of biological, socio-economic and socio-cultural values in a particular ecosystem that is used as priority response to oil and gas pollution. ESI maps are essential components of oil spill contingency planning that indicate substrates demanding specific clean-up actions and response options considering ecological, recreational and commercial concerns (Halls et al., 1997). PPPTMGB LEMIGAS (2001) has been divided ESI into 5 classes, those are:

- a. **Very Sensitive.** Very sensitive environment means one which is very sensitive to changes in environment / pollution in which resources are perishable due to changes in environment (especially oil pollution) because in addition to having high productivity of resources, it has major contribution to the ecosystem and the surrounding community. In the event of damage, any part of the ecosystem namely biota may die and miss in the communities of the area
- b. **Sensitive.** Sensitive environments means one which is sensitive to changes in environment / pollution whose resources are perishable and require very long time to renew them and it socially and culturally is an area that requires special treatment that require high response in the event of environmental change (especially oil pollution). Here oil and gas activities should be avoided.
- c. **Quite Sensitive.** Quite sensitive environment means one when there is a change in environment / pollution may cause damage to its resources and may take quite long time to renew it so it is necessary to use caution in the area.
- d. **Less Sensitive.** Less sensitive environment means one when there is pollution / environmental changes does not require any high response because its influence on the ecosystem is low or on the ecosystems the species of which will not be easily lost (part of ecosystem) but socially still requires caution, where social conflicts can still occur if good approach is not taken.
- e. **Insensitive.** Insensitive environment means one when there is any change in environment / pollution will not remove any part of its existing ecosystem so that it can be used for activities directly related to oil and gas activities, but social conflicts may still occur because

there is no activity in the surrounding community although little.

Environmental sensitivity index (ESI) in shoreline area needs shoreline classification, biological and human-use resources, allowing shoreline habitats to be ranked according to the biological sensitivity, natural persistence of oil and ease of clean-up. Information on biological resources includes oil-sensitive animals and non-shoreline habitats such as submerged aquatic vegetation and coral reefs. Specific areas that incorporate added sensitivity and value to humans such as high-use beaches, parks, marine sanctuaries and water intake are grouped into human-use resources (Michel, 1998 in Carvalho and Gherardi, 2008). Ranking of coastal environments range from ESI 1, low sensitivity coasts, to ESI 10, high sensitivity coasts (Table 1) and expresses the relationships among physical processes, substrate type, and associated biota.

Table 1. ESI Shoreline Classification (Michel, 1998 in Carvalho and Gherardi, 2008).

No	Ranking of ESI	Description
1	1	Exposed rocky shores
2		Exposed solid man-made structures
3	2	Exposed wave-cut platforms in bedrock, mud or clay
4		Exposed scarps and steep slopes in clay
5	3	Fine to medium grained sand beaches
6		Scarps and steep slopes in sand
7	4	Coarse-grained sand beaches
8	5	Mixed sand and gravel beaches
9	6	Gravel beaches
10		riprap
11	7	Exposed tidal flats
12	8	Sheltered rocky shores and sheltered scarps in bedrock, mud or clay
13		Sheltered, solid man-made structures
14		Sheltered riprap
15		Vegetated, steeply sloping bluffs
16	8	Sheltered tidal flats
17		Vegetated low banks
18	10	Freshwater marshes
19		swamps
20		Scrub-shrub wetlands

Conclusions

EBA is an overview concerning environmental conditions in detail in an area, in term of physical, social, economic, cultural and public health aspect. The environmental baseline assessment is mandate of legislation in Indonesia.

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Remote sensing can support EBA for identification of landuse/landcover, drainage pattern, geology map, slope map and etc. EBA is essential for oil and gas activities. This is useful for companies that will engage in the region, especially with the environmental baseline they may understand and know the overview of the area comprehensively. Various activities will be easier to plan after understanding and knowing the environmental baseline of oil and gas activities that will be carried out. Overview on topography and land use can be used to understand the realm level of difficulty when oil and gas activities, such as seismic, drilling, field development and production will be carried out. Overview of Spatial Plan, location of protected areas, population concentrations can be used as basis for good planning, so that they do not violate spatial planning that has been designated. Overall environmental baseline provides huge advantages for all oil and gas activities. The advantages among others are as follows:

- a. Facilitating in planning of activities of oil and gas activities.
- b. Facilitating in preparing of EIA and UKL / UPL.
- c. Facilitating in estimating of land compensation
- d. Facilitating in licensing.
- e. Facilitating in supporting seismic activities, such as selection of seismic lines, compensation, mobilization of equipment, survey licensing and determining location of base camp.
- f. Facilitating in planning pipeline if location of oil and gas has been found economical.
- g. Knowing the sensitive area, so it should be avoided and can be used as disaster handling priority scale.
- b. Facilitating in determining the areas to be relinquished / returned to the government after a three-year exploration phase.

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