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Abstract. Colombia began an expansion plan for oil exploration in the Caribbean Sea, this industry is recognized for the high impact it can generate, being necessary to identify mechanisms to improve management. This research presents a review of the experiences in the offshore oil industry, describes the case of oil exploration in the Arctic, a fragile ecosystem; methodologies and indicators used to strengthen the industry in order to achieve sustainability are identified. The results allow to conclude that it is necessary to strengthen the development plan from the institutional and political frameworks using a Strategic Environmental Assessment, also they indicate how this can improve the instruments and achieve improvement in the social, economic and environmental dimensions.

1. Introduction

The General Comptroller (2017) [1] presents a forecast of loss of oil self-sufficiency for the year 2021, to increase hydrocarbon reserves, the National Hydrocarbons Agency (ANH) has granted new exploration and exploitation blocks onshore and offshore [2, 3]. According to the Office of the General Comptroller (2017), it will not be enough to avoid the loss of national self-sufficiency if the prices of hydrocarbons are low in the market, or if policies are not formulated and adopted to encourage exploration and exploitation activities.

The drilling of an offshore well can cost on average $ 120MM, if it is a deposit in the Miocene and $ 230MM in the Jurassic one, while in an inner well it can range between $ 4.9 and 8.3MM, the production it is high and maintained for a period of 10 to 20 years [4, 5]. Offshore activities are highly sensitive and have a high impact on nature, due to the potential for spills and pollution that reaches a large scale, affecting marine ecosystems [6]; The regulations of the activities are much more rigorous and of permanent surveillance [7]. Oil activities on the high seas that are usually carried out are:

a. *Exploration* are carried out to locate areas with high potential, can use magnetic, gravimetric and seismic 2D and 3D, evaluates the seabed, winds and marine currents [8, 9].
b. *Drilling* involves the invasive activities to the maritime soil for the creation of a well that allows the extraction of the fluids from the deposit. For its proper operation, equipment is required that perforates the subsoil and controls the pressure of the fluids of the rock, fluids that are injected to lubricate the bit and remove the debris from the perforation [9, 10, 11].
c. *Production* is the extraction of the fluids contained in the previously drilled deposits, commonly the first years of production are oil or gas phase depending on the type of deposit, after a certain amount of time the production changes to the gas, oil and water phases; this last fluid will gradually increase its percentage of production, it will be necessary to install an

equipment for the treatment and its correct disposal [9, 12]. Other unwanted products that can be found within the production are the molecules of CO2 and H2S, corrosion generators in the equipment installed for the production management [9, 13, 14].

d. *Transport* is the activity where the fluids produced are transported to the coast, in order to give commercial value to the production. Large vessels called Tanker or by means of pipes are used depending on the distance to the coast and financial viability [9].
e. *Abandonment*, at the end of the productive life of the well or of some producing sands, the temporary or definitive closure is made; this operation installs expandable or inflatable seals (they are removable) or by means of pumping cement, plugs are created to seal the well and prevent the escape of reservoir fluids [15].

Offshore operations involve difficulties like land operations, added to others due to the wild environment and psychosocial risks, workers are isolated for long periods of time surrounded by water [16]. Among the risks of greatest occurrence are explosions, mechanical problems in the wells, equipment failures; which can have an impact on the ecosystem and implications for society and economy [9, 17].

To achieve viability and sustainability, Colombia must generate market conditions and implement policies that are attractive to foreign companies, giving greater confidence to investors due to the high investment values that are required, without neglecting the sustainability of the areas where develop the projects; so it is necessary to carefully evaluate the transformations that these projects will produce in the economy, society and the environment. This research presents a review of international experiences, methodologies and indicators used to carry out evaluations of oil activities, which can be the basis for formulating strategies, strengthening existing mechanisms and improving the growth of the offshore oil industry in the Caribbean Sea Colombian.

2. International experiences in the oil industry

The prevention of the different risks for the incursion in the projects is the motivation of the countries to adapt the policies and the guidelines of reference, to understand the actions carried out by other countries will allow to identify critical points for the later analysis and intervention. A review was made to identify aspects for the strategic planning in the oil industry.

Krupnick et al. (2014) [18] indicates that China's environmental standards are weak, ineffective or in non-existent cases, analysed the framework of the United States to develop shale gas exploitation projects to generate guidelines to strengthen China's framework. Aung (2017) [19] conducted a study in Myanmar; this is a region with petroleum resources, but backward on issues of environmental management; their policies and laws lack an administrative and legal structure. Its results propose the Environmental Impact Assessment (EIA) as an instrument to strengthen the prevention of risks and the preservation of the environment due to the activities of the oil sector. Shvarts et al. (2016) [20] proposes an instrument that can qualify as environmental responsibility of oil companies, with the purpose of generating motivation in Russia's oil and gas industry by disclosing information on its performance and economic and environmental impacts.

Ellis et al. (2017) [21] conducted a comparison of the instruments Environmental Risk Assessment (ERA), Environmental Impact Assessment (EIA) and Environmental Management Planning (EMP) in New Zealand in the offshore mining and oil industries, in the which results propose to carry out a Strategic Environment Assessment (SEA) to complement the instruments. Tait et al. (2014) [22] present the results obtained by the ExxonMobil company in the countries of Angola and Chad when using the Environmental, Socioeconomic and Health Impact Assessment (ESHIA), a variation of the EIA, its results exalt the success in identifying and assess the needs of the areas of influence.

The identification of risks and the integration of the social, economic and environmental dimensions are the basis of strategic planning, Rosenfeld et al. (1998) [23] conduct a study on the problems and challenges of an environmental and social nature, and what are the strategies to minimize the impacts that are generated in oil projects. Arora and Lodhia (2017) [24] use the case of the BP oil spill in the Gulf of Mexico and analyse how social and environmental relations can manage

the reputation, their results identify five key elements: Financial Performance, Quality Management , the performance of social and environmental responsibility, the quality of the employee and the quality of the goods / services.

Raufflet et al. (2014) [25] identifies four different areas: ethics and governance, environmental management, relations with the community and social health and safety problems in Corporate Social Responsibility (CSR); the work of Hilson (2012) [26] compares CSR from different countries and identifies a great difference between environmental regulations, where developed countries have more comprehensive regulations. Linnen et al (2015) [27] presents the experience of Apache Corporation, an onshore oil company in Egypt, and the key social aspects treated with the Bedouin tribe on issues related to political risks, benefits in education, consultations and socializations.

The identification of environmental and social constraints are other lines of research, Touzel (2012) [28] describes China's plans for unconventional gas extraction, the prospect areas have environmental and social restrictions, such as the availability of water for the hydraulic fracturing and its future disposition, access routes to the zones and the relationship with the inhabitants, indicates that the social and environmental management will allow to achieve a success in the development thanks to the acceptance of the project. Sun and Wang (2015) [29] establishes a model for evaluating shale gas projects and their impact on the environment, comparing the impacts before and after the project taking as a variable the impact on surface water in the water underground, on land and in the air. Le (2018) [30] analysed the development of gas extraction activity in shale rocks, the environmental implications mainly the need for a large volume of fresh water (around 12 to 20 million litres of water per horizontal well). Hasheminasab et al (2018) [31] present a review of economic, environmental and social indicators to generate metrics and evaluate refinery projects in terms of sustainability.

The literature presents the SEA as an instrument that can improve the instruments and improve social, economic and environmental aspects; highlight the importance of CSR as a key instrument for companies to achieve communication channels with society and the need to identify indicators to assess the impacts generated in different dimensions by the activities carried out.

2.1. Oil exploitation in the Arctic

In the investigations carried out in [32, 33, 34, 35, 36] they present experiences in the Arctic area, an area belonging to eight (8) countries and considered a fragile ecosystem. Hasle et al (2009) presents a study on the management of environmental risk through the Matrix Risk Assessment (MRA) instrument for requests for block allocation and well drilling under the criteria of possible oil spills and contingency plans. Harsem et al (2011) reviews the capacities and activities carried out to improve oil policies and infrastructure in countries with arctic terrain and the challenges they have to face, such as market conditions, strong winters and little infrastructure The work of Noble et al (2013) presents the results of an SEA for the offshore hydrocarbon extraction activities in the Arctic in areas belonging to Canada, they conclude the process must be continuous and adaptive to changes in policy conditions, environmental, social or economic; whereas Dale (2016) shows the work of Norway for the promotion of the extractive activities of oil in the seas of Barent and Lofoten, historically dedicated to fishing, indicates that the implementation of instruments for the management of political, environmental and social networks allows for a change and approval in the change in the use of these areas, but these changes must be accompanied by techno-scientific knowledge to change political decisions.

Gulas et al (2017) presents the market conditions that have affected the industry such as the low prices of hydrocarbons and the political restrictions of the West; compares frameworks to prevent pollution in the Arctic of Canada, USA, Denmark, Norway and Russia, and only Norway uses the SEA as a risk management instrument, where there is a participation of the different stakeholders and an improvement of the response teams. From the USA highlights that the responsible for responding to a spill is the coast guard, in 2015 the regulation for drilling in Alaska was published, but the impacts and mitigation plans are not clear; Canada has a more complex system because it has national and state regulation, where specific EIA are requested for each project. Denmark is conducting a SEA by the government of Greenland and where EIA are additional requirements. Finally, it recommends that

countries should be better prepared to control spills, improve well intervention and legal frameworks based on the SEA.

The investigations by Noble et al (2013) and Gulas et al (2017) highlight the SEA as an instrument that identifies the strong need of the oil sector to generate greater care for the environment and its effectiveness in establishing guidelines for the industry to generate greater security to the ecosystems where these activities are carried out.

3. Promoting sustainable development in the extractive industry

Talk about sustainable development in the extractive industry, such as the mining and oil sector, has a complex connotation to be defined due to the environmental and social impacts caused, due to changes in the traditional activities of society, the modification of the ecosystems and damages generated by process failures; seeking regulation and balance among the three dimensions proposed by sustainable development [37] creates a dilemma for the lack of compliance with the project. Wang et al (2014) [38] defines the concept of green image, where companies act in such a way that their corporate image delivers a concept of sustainable development through social and environmental responsibility. From a low index in its social and environmental dimensions, the companies carry out actions to increase it, among them there are actions such as the support of communities, improvement of access roads, creation of schools, among others [23, 24, 25, 26].

Table 1. Methodologies for the evaluation of environmental impacts.

Methodology	Remark
Strategic Environment Assessment (SEA)	It is the process by which environmental considerations are integrated completely into the preparation of plans and programs before their final adoption, its main objective is to provide a high level of environmental protection and promote sustainable development [39].
Environmental Impact Assessment (EIA)	It is a methodology for environmental management by forecasting the consequences that an activity can have on the environment, from the initial phase to the final phase. Its approach is practical and is guided in accordance with current legislation, allowing the adoption of preventive, corrective or compensatory measures [40].
Environmental Impact Statement (EIS)	It describes the effects of the proposed activities, considers and describes the positive and negative impacts, and the alternatives to mitigate the impacts. Laws and regulations require the federal government to evaluate the effects on the environment and consider alternative actions [41].
Risk Assessment	It used to characterize the nature and magnitude of health risks for humans and ecological risks of factors present in the environment; Data are collected to characterize the nature and extent of contamination, and thereby assess the frequency and magnitude of exposures that may occur as a result of contact. Its development is an iterative process [42].
Ecological Risk Assessment	It allows to evaluate the probability that the environment is affected by the agent exposure. Its evaluation starts from the collection of a characterization of the agent, then a determination of the effects and finally an estimation of the exposure risk, the results provide information to interpret the risks and identify a level of harmful effects [43].
Environmental Audit	It is a systematic, documented, periodic and objective process in the evaluation of the activities and services of an organization in relation to compliance with legal and internal requirements, promotion of good environmental management, maintaining credibility, sensitizing staff to compliance of environmental policy and create opportunities for improvement [44].
Regional Risk Screening	It generates standardized levels of detection for pollution levels. Detection levels are presented in tables with parameters and exposure conditions [45].

Identifying the mechanisms to guide the sustainable development of the projects is vital, to determine the baseline and evaluate the impact over time. The following subsections present

methodologies used for the evaluation of impacts and a categorization of the indicators according to the dimension of sustainable development.

3.1. Methodologies for the evaluation of environmental impacts

Table 1 presents methodologies used for the evaluation of environmental impacts, ordered according to their management capacity.

These methodologies allow to evaluate and forecast the situation in the social, environmental and economic dimensions generated by a project, regardless of the business sector. The SEA was designed by Directive 2001/42 / EC of the European Parliament or SEA Directive as a legal evaluation procedure, to introduce the systematic evaluation on the environmental effects of the plans and programs related to the use of the territory. The SEA is not applied in all countries, instead the EIA applies whose purpose is totally different. The SEA must be carried out before carrying out a plan and will allow a global vision, while the EIA is focused on the prevention of impacts in the area of influence [46].

The SEA is used to estimate the medium and long-term consequences of the execution of investments of different types [36]; and it is internationally recognized for its potential to fill gaps by incorporating considerations of environment and sustainable development into strategic decisions, such as policies, plans and programs in different sectors such as mining, agroindustry, environmental health and fuels [47, 48].

3.2. Categories of indicators used in project management

Table 2 presents the category of indicators according to the dimensions of sustainable development.

Table 2. Categories of indicators according to dimension.

Environmental Dimension	Socio-environmental	Social Dimension	Socio-economic	Economic Dimension	Economic-environmental
Environmental compliance	Health and security	Impact to the communities	Employment and unemployment	Economic benefit	Resource efficiency
Biodiversity	Management of biodiversity	Equality in opportunities	Local economy/ entrepreneurship	Exploration and production	Energy efficiency
Strategies for the climate	Climate change	Human capital development	Development and training	Risk management	Demand for energy
State of the environment	Risk management	Retention of human talent	Sponsorship	Business governance	Sustainability
Emissions to the environment		Working practices		Attractive to the investor	

Source: [49, 50, 51]

The indicators allow the SEA to have a greater vision and provide better standards for the protection of the environment and promote sustainable development; these are based on some category of table 2. The integral selection of the indicators will allow a better follow-up of the projects and achieve greater control in the aspects to be improved.

4. Conclusions

A review of international experiences in the oil industry was presented for the evaluation of environmental impacts and the case of oil exploitation in the Arctic; the results indicate that comparisons must be made of the frameworks of other countries to strengthen management mechanisms, there must be collaborative work between the different state entities and the countries that make up the Caribbean Sea.

Performing an SEA is an excellent option to establish a route for sustainable development in offshore oil exploration and exploration activity in the Colombian Caribbean region, because it will allow institutions to be evaluated and processes to be improved, dialogue and participation structures to be established In the stakeholders for decision making, identify relevant policies and propose reforms or policies that contribute to decision making. The SEA will allow to have information that helps to make key decisions, and that the different actors can participate formally, opportunely and sufficiently for social, economic and environmental development in a sustainable manner.

This work is part of an ongoing doctoral research. The research development is expected to provide strategic energy planning and guidelines for the sustainable growth of the offshore hydrocarbons sector.

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