Ghana's Quest for Oil and Gas: Ecological Risks and Management Frameworks

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Abstract

Ghana discovered commercial oil and gas in 2007, and, subsequently, commenced production in the last quarter of 2010. In the light of the potential economic boost that will accompany petroleum production, its discovery was welcome news for Ghanaians. However, oil exploration and production involve several activities that can have detrimental impacts on the ecosystem. In this paper, the potential sources of pollution in the upstream sector of the oil and gas industry and their effects on the environment are discussed. Also discussed are existing national environmental management legislations in the extractive industry, and the implementation and enforcement challenges these regulations face. Strategies to curtail the effects of oil and gas development on the ecosystem are also put forward. These include the need for government to formulate petroleum industry-specific environmental protection guidelines and appropriate regulatory frameworks. Such regulations in managing the environment should employ an integrated approach involving (i) prescription of environmental codes and setting of standards by government to be met by operators, and (ii) the need for oil companies to develop environmental management system (EMS) to ensure that they operate within the environmental standards for the industry. Administrative and institutional restructuring and reforms, as well as the provision of the necessary financial and human resources for the various environmental agencies, should be encouraged to ensure effective implementation, enforcement and monitoring.

Introduction

The global economy relies heavily on oil and gas to fulfill majority of its energy demands, and it is a key indicator of the economic well-being of both developed and developing nations. The International Energy Agency (IEA) predicts that global oil demand will reach 90 million barrels/day in 2010 and about 104 million barrels/day by 2020 (World Energy Outlook, 2009). The continued increase in the world's energy demands is due, in part, to robust economic growth in China and India and an uncertain political climate in the Middle East (Mane, 2005; BP, 2008)

The west central coast of West Africa along the Gulf of Guinea is reported to be endowed with rich hydrocarbon reserves, a source of oil and gas. Production of oil and gas in this region, which is estimated to have over 547 offshore oil and gas structures, has the potential to meet the energy demands of the European Union and the United States of America (Ayoade, 2002; IMF, 2005). Angola, Nigeria, Equatorial Guinea and Gabon are already producing crude oil in this region.

Apart from the huge hydrocarbon reserves, countries along the Gulf of Guinea, including Ghana, are now of global interest

due to the geopolitical and geographical locations (ease of shipping, less prone to pirate attacks, immune to ground political instability and wars), as well as the quality of crude oil. This is in sharp contrast with other areas, such as the Middle East, which is noted for wars, uprisings and other unfavourable activities.

Ghana's oil and gas exploration dates as far back as 1896, and the commercial discovery in the Jubilee Field in June 2007 (GNPC, 2009) was, without doubt, welcome news, as it can enhance revenue generation and job creation, and significantly improve the national economy. The Jubilee Field is located 60 km off the coast of Cape Three Points in the Western Region of Ghana (Fig. 1). It is situated in the Deepwater Tano and West Cape Three Points blocks of the Tano Basin (Fig. 2), which is one of the three offshore sedimentary basins in Ghana. The Field is jointly owned by a consortium of companies named the Jubilee Joint Venture and managed by Tullow Ghana Ltd. Water depth within the Jubilee Field Unit area ranges from 1,000 m to 1,700 m, and the discovered hydrocarbon is a 36.5° API Sweet Crude having a 1,000–1,200 gas-to-oil ratio and little sulfur content by international standards (Sunu-Attah, 2009). The reserve is estimated to hold about 800 million to 1.5 billion barrels of oil (Adjaye, 2009).

In spite of the socio-economic benefits that oil and gas production can bring to the nation, oil exploration and production involve several activities that can have detrimental impact, either directly or indirectly, on the environment and, therefore, require special attention in striking a good balance. Though commercial production started in the last quarter of 2010, pre-production activities required stringent environmental measures to ensure that the ecosystem is not damaged.

There are some existing laws in Ghana with relevance to the mining and oil industries. However, there are no comprehensive environmental laws directed at the oil industry (Darko-Mensah, 2009). Unregulated activities by the oil industry can potentially destroy habitats and damage biodiversity, and this requires that Ghanaian policy makers take a closer look at national sustainability strategies that will ensure sustainable exploitation of the hydrocarbon without adverse effects on the ecosystem.

This paper, as a contribution to the upstream sector of oil development in Ghana, highlights most of the upstream activities in oil and gas operations, the sources of pollution and the inherent environmental issues, and their potential negative impact on ecosystems. It also discusses existing national management practices to protect the environment, and recommends legislations and management frameworks that could be employed to minimize ecological damage.

Materials and methods

The ecology of Cape Three Points coastal areas

There are more than 90 lagoons along the entire coastline of Ghana, most of which are located in the central and western coastline, including the Cape Three Points area. These lagoons serve as habitats and nursery sites for a variety of fish, shrimps, mollusc, and crabs species (Armah *et al.*, 2004). The ecology of the Cape Three Points area is broadly divided into two, namely offshore and onshore (Armah *et al.,* 2004), which are described in detail below.

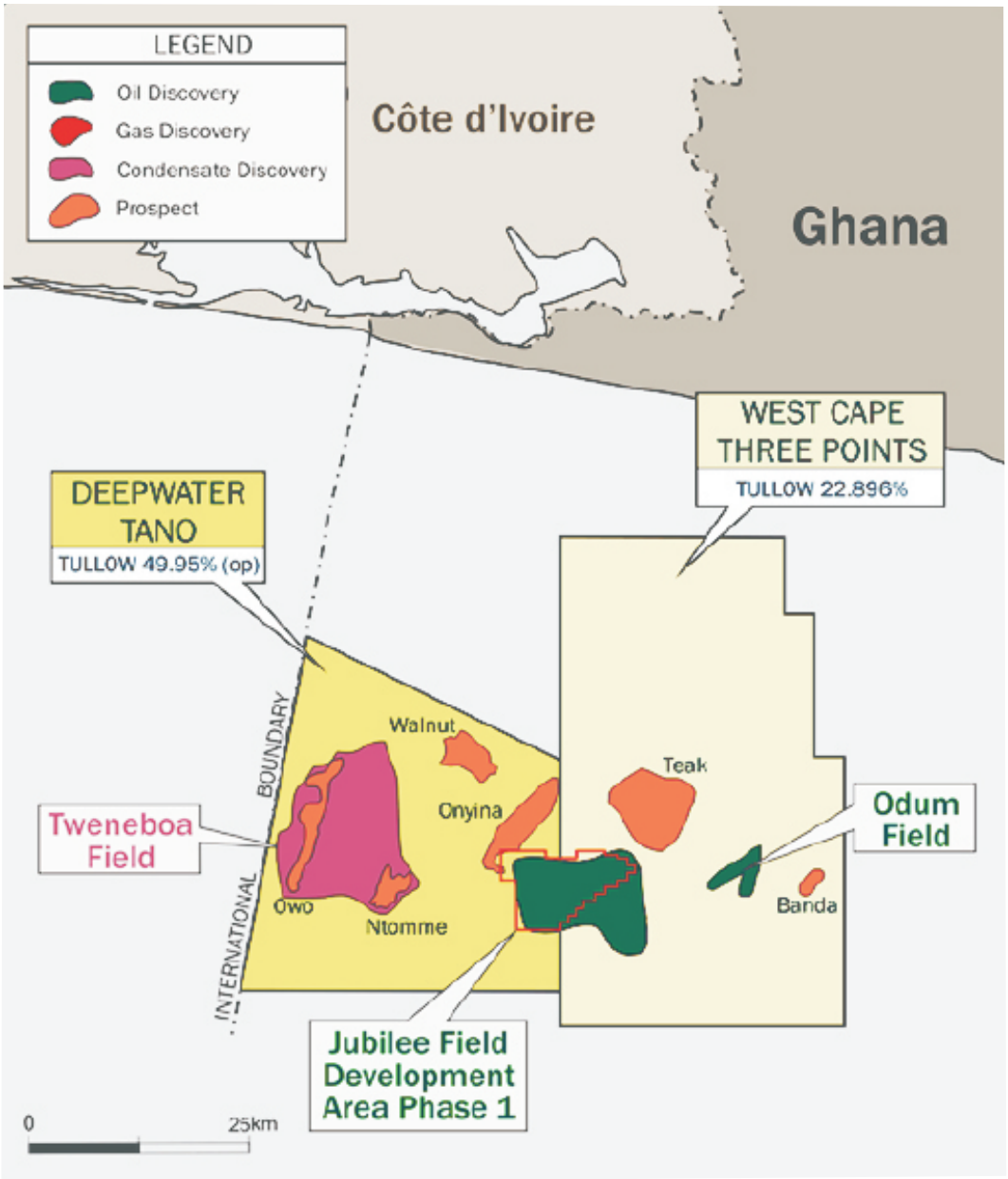

Fig. 1. Offshore map of south-western Ghana, showing the location of the Jubilee Oil Field in the Deepwater Tano and West Cape Three Points blocks (Source: Asafo-Adjaye, 2011).

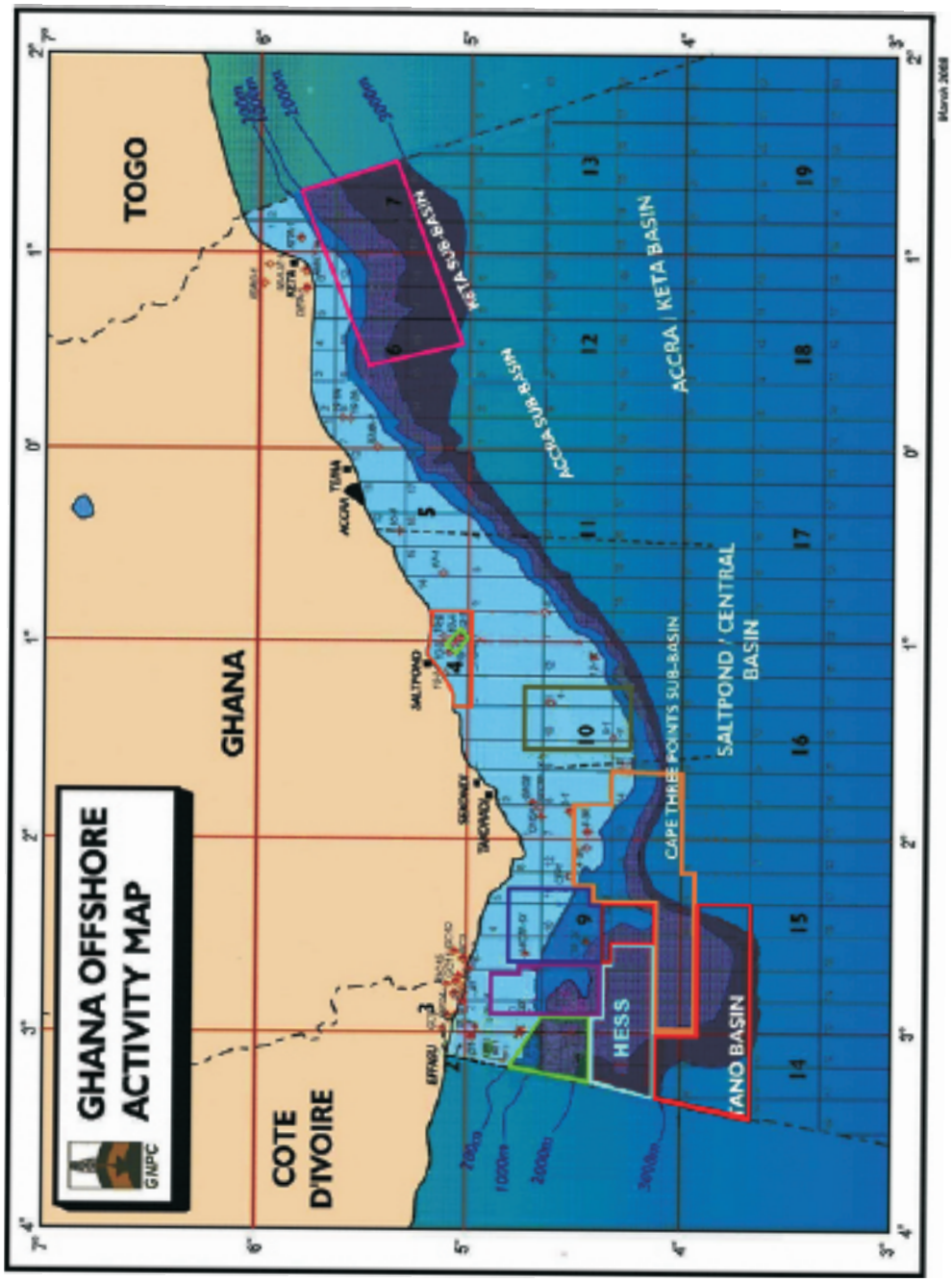

Fig. 2. Ghana offshore activity map, showing the three offshore sedimentary basins in Ghana, namely the Tano Basin, Central (Saltpond) Basin and the Accra-Keta Basin (Source: Asafo-Adjaye, 2011).

The Offshore ecology. An estimated total of 89 species of aquatic organisms are found in the 1,100–1,700 m water depth in the Jubilee Field. These include pelagic stocks and demersal species, which are the most abundant fish species offshore the Cape Three Points area. The pelagic stocks include sardinellas anchovy and chub mackerel (Boely & Freon, 1980). The distribution and abundance of the small pelagic species are affected by seasonal coastal upwelling in the area (MFRD, 2003). Bottom living demersal species in the area include red fishes, croakers, snappers, goatfish, groupers and threadfins. Other food species include shell fish, shrimps and prawns. Organisms of biomedical importance in this area include phytoplanktons, zooplanktons, pelagic fish, offshore benthic invertebrate fauna communities, marine mammals and sea turtles (MFRD, 2003).

Among the invertebrate fauna found in the coastal waters are polychaete worms, ribbon worms, amphipods, bivalves, gastropods, and decapod crustaceans (MFRD, 2003). In the Gulf of Guinea, the seasonal major and minor upwelling, occurring from June to September and December to January, respectively, each year, brings cold, nutrient-rich water to the surface, causing blooms of phytoplankton, which is dominated by diatoms such as *Leptocylindrons* sp., *Nitzchia* sp., *Chaetoceros* sp., *Rhizosolenia* sp. and *Skeletronema costatum.*

The onshore ecology. According to Armah *et al.* (2004), the sandy shores around the Cape Three Points region are known to serve as nesting places for sea turtles and habitats for species such as the ghost crab, isopods, amphipods, mysid, and mole crab. Others are the polychaetes, bivalves and gastropods. The sandy shores are also characterized by strand vegetation, including creepers and grasses, and changes further inland to dwarf palms, coconut palms and shrubs. The rocky shores, on the other hand, serve as important habitats for macro algae, barnacles and littorinid snails, all of which use the rocks as substrates (Armah *et al.,* 2004).

Along the coast of the Cape Three Points, which also hosts a forest reserve, rain forest fringes the Ehunli and Akpulu lagoons, and an estuary, where the Yile and Kpani rivers meet long the western coastline. A total of 141 species of 58 diverse plant families, made up of trees, shrubs, grasses and sedges, occur in this area (Armah *et al.,* 2004). In the forest are 263 species of birds, elephants, bongo, turtles and primates, including the endangered Diana monkeys. Because of the ecological importance of all the above-mentioned species, it is important to regulate the activities of oil companies to ensure that they do not damage habitats and breeding grounds of the fauna and flora, which could cause them to be extinct.

Oil and gas development activities

The oil and gas industry has three main sectors, namely the upstream, midstream and downstream. The upstream involves the exploration and production; the midstream covers the transportation of oil and gas, and the downstream deals with refining and processing of crude oil and gas products, as well as the distribution and marketing of the products (E&P Forum/UNEP, 1997).

The major stages of the upstream oil activities are briefly described below (E&P

Forum/UNEP, 1997; Kloff & Wicks, 2004). 1. Aerial and seismic surveys are carried out to identify favourable geological structures such as faults and anticlines in the subsurface. 2. Exploration drilling and appraisal involve drilling of oil wells to confirm the presence or otherwise of hydrocarbon and the internal pressure of such a reserve, all aimed at evaluating the nature, size and extent of the hydrocarbon reservoir to enable confirmation of its economic viability. 3. Development and production wells are drilled into hydrocarbon reservoir to extract the produced fluids, comprising oil, gas and water. 4. Decommissioning and rehabilitation involve the closure and removal of production installations and other structures at the end of the commercial life span of an oil reserve, followed by the restoration of the site to environmentally sound conditions.

Potential environmental impact arising from hydrocarbon exploitation in the Jubilee Oil Field

As may be the case elsewhere, oil and gas exploration and production in the Jubilee Field involve the various stages that could be accompanied by intrinsic environmental challenges. The environmental impacts arising from oil and gas production activities can be broadly grouped into two, namely (i) ecosystems, and (ii) human, socio-economic and cultural (E&P Forum/UNEP, 1997). Of particular interest in this paper is the potential negative environmental impact on ecosystems. Accordingly, our discussion is focused on the ecological damage accompanying the upstream activities.

Noise. During oil and gas development, noise disturbances associated with aircraft, bulk vessels and drilling operational activities are likely to impact negatively on the ecosystem. This may arise from prospecting and survey activities already mentioned above. At certain levels, noise affects the functions of marine organisms. Fish and marine mammals, including whales and dolphins, are particularly affected mostly by sound elevation because of their dependence on sound for reproduction, feeding, and avoiding hazards such as predators and navigation (McCauley, 1994; Tyack & Miller, 2002; Popper, 2003). There have also been reported death, reduced growth, impaired hearing and stress, as some of the possible impact of noise from oil and gas operation (Fernandez *et al.*, 2005).

Atmospheric emissions. Atmospheric emissions are increasingly becoming the subject of concern to both industry and national governments due to its negative effect on climate. Sources of emissions associated with oil development activities, can be grouped as follows (E&P Forum/UNEP, 1997): (i) Flaring, venting and purging of gases; (ii) Combustion processes from diesel engines and gas turbines; (iii) Fugitive gases from loading operations and losses from process equipment; (iv) Airborne particulate from burning sources, such as well testing and soil disturbance during construction and vehicular traffic

Of these gas emissions, flaring is the most alarming, and has been a source of major conflict in Nigeria and elsewhere (Sala-i-Martin &Subramanian, 2003; ERA/CJP, 2005). The principal emissions accompanying flared gas contain toxic byproducts such as methane and benzene, and also generate carbon dioxide, carbon monoxide,

volatile organic carbons, sulphur dioxide, nitrogen sulphide and nitrogen oxide. Some of these gases (e.g. carbon dioxide), contribute to global warming, whereas the sulphur gases and carbon dioxide contribute to the formation of acid rain, which is detrimental to soil fertility and vegetation upon interaction with water (Patin, 1999). Consequently, gas flaring has the potential to damage the Ankasa Forest Reserve and the surrounding vegetation and farmlands located offshore the Jubilee Field.

Current agreements between the Ghana Government and operators of the Jubilee Field emphasize on zero gas flaring. However, according to the GNPC and Tullow Ghana Ltd, there are no existing infrastructure to convert the natural gas into LPG to meet part of the country's energy demands (Ghana Oil Watch, 2011). On the other hand, re-injection of the gas back into the oil wells is not encouraged since that can damage the wells and reduce oil recovery, which, therefore, leaves the nation with the only option of flaring (Think Ghana, 2007). Currently ongoing is the Natural Gas Transportation and Processing Project (NGTPP), which is aimed at bringing natural gas from the Jubilee and the shallow water Tano fields and future discoveries for processing and further distribution to the Effasu Power Barge, the Takoradi Thermal Plant and for export (EDM/GNPC, 2009).

Aquatic pollution. Discharges from oils and gas installations include produced water, process water, sewerage, sanitary and domestic wastes, and spills and leakages (E&P Forum/UNEP, 1997). These discharges arise from the drilling of exploration wells and, subsequently, the production of crude oil. Produced water is a combination of formation water from the reservoir and injection water, containing a complex mixture of inorganic and organic compounds, trace and heavy metals, drilling fluids and drill cuttings, and well treatment chemicals (E&P Forum, 1994; Sadiq *et al.*, 2002). The composition of produced water makes it potentially toxic to marine waters.

Organic compounds in discharged waste water, when released into marine waters, rivers or lakes, react with and consume dissolved oxygen, thereby, depleting the water of oxygen and rendering it uninhabitable for aquatic organisms (Harremoës, 1998). Similarly, excess supply of nutrients to water bodies also stimulates excessive plant growth and causes reduction in water quality and a decrease in the population of fish and other aquatic organisms (Harremoës, 1998; WHO/EC, 2002). Anti fouling paints on ships also contain potent biocide such as tributyltin (TBT), which causes reproduction failure of female marine snails and a decline in population (Kloff & Wicks, 2004).

Oil tankers, underwater pipelines, offshore oil drilling rigs and coastal storage facilities can accidentally release crude oil into the ocean, and a significant portion of the ecosystem, both offshore and onshore Cape Three Points will potentially be at risk. The negative effects of oil spillage on marine organisms include damage to digestion tract of marine species through digestion, absorption of oil in contaminated food, contamination of eggs leading to poor hatchery, and trapping of turtles and birds leading to death. Over the years, the petroleum industry has witnessed oil spills that have caused considerable ecological damage.

Notable among these spills were the Amoco Cadiz, which spilled about 227,000 tonnes of oil in 1978 (Patin, 1999) and the Exxon Valdez, which spilled 40,000 tonnes of oil in 1989, resulting in the death of about 250,000 seabirds, nearly 3,000 sea otters, 300 harbour seals, 250 bald eagles and up to 22 killer whales (BBC, 1989). Similarly, in 1999, the Erika oil vessel spilled about 20,000 metric tonnes of oil that affected 400 km of coastline, and killed over 100,000 birds (BBC, 2000). The explosion, in 2010, of the Deepwater Horizon, owed by British Petroleum (BP) in the Gulf of Mexico killed 11 people, and resulted in the spillage of 4.9 million barrels of oil, polluting hundreds of miles of coastline and killing 491 birds, 227 turtles and 27 mammals within the first 40 days after the spill (Reuters, 2010; BBC, 2011).

Terrestrial pollution. During oil and gas exploration and production, potential impacts on soils arise from physical disturbances due to construction, deforestation and contamination, resulting from spillage and leakage or solid waste disposal. These activities result in land degradation, transformation and fragmentation of natural habitats, and can disable the vital ecosystem processes that support growth (Barnard & Newby, 2009). In the Niger Delta region of Nigeria, three main sources of oil pollution have been identified, namely oil spills, gas flares and waste discharges (Pyagbara, 2007). Rivers, streams and ponds have been the receiving bodies for oil spills and waste discharges, with their accompanying negative environmental impacts.

Available data show that between 9 and 13 million barrels of oil have been spilt in the Niger Delta region in the past 50 years (NCF/WWF/IUCN, 2006). These spills, which occurred both on land and offshore, destroyed crops and damaged the quality and productivity of soil that the communities use for farming (UNEP, 2011). The spills have also caused the death of birds and mammals, damaged fisheries and contaminated water, that the inhabitants use for drinking and other domestic purposes (Amnesty International, 2009).

Oil spills and other oil-related pollution have also seriously damaged the Niger Delta's mangroves, which are an important fish breeding area. The damage has resulted in a severely impaired coastal ecosystem, and compromised the livelihoods and health of the region's impoverished residents (NCF/WWF/IUCN, 2006; Amnesty International 2009), thus, negatively affecting economic activities. The reasons assigned to the frequent oil spills in the Niger Delta include corrosion of oil pipes, poor maintenance of infrastructure, spills or leaks during processing at refineries (World Bank, 1995), human error and the consequence of deliberate vandalism or theft of oil (Steiner, 2008). The damage to the ecosystem has caused the Ogoni people, who think their lives are intrinsically bound up with the survival of the environment, to stand up against the denigration of their environment (UNEP, 2011).

Ghana is likely to suffer from the above-mentioned potential sources of pollution and their accompanying negative environmental impacts, if the environment is not well managed. Since the Jubilee Oil Filed is located offshore, the ecosystems of utmost concern are the ocean, beaches, and the atmosphere. The inhabitants of towns and communities dotted along the coast of the

Gulf of Guinea in the Western Region of Ghana traditionally engage in fishing, as their means of livelihood. Consequently, protecting the sea from any potential environmental damage is very paramount.

Past environmental management performance in Ghana – Case study of the mining industry

Selected mine-related pollutions in Ghana. Ghana has comprehensive legislation and regulations on environmental protection and supporting institutional infrastructure, like ministries, bureaus or agencies, all focused on the mining industry. These laws, notwithstanding, Ghana has experienced mining-related pollution of the aquatic and terrestrial ecosystems. Between 2001 and 2009, several mining communities in Ghana recorded more than nine cyanide spillages, most of which were caused by the collapse of tailings dams and holding ponds (e.g. EPA, 2004, 2005; GNA, 2009; Kosich, 2010). Notable among these occurred at the Newmont Ghana Gold Limited (NGGL) Ahafo Mine in 2009, which cost the company an amount of GH¢7 million in the form of fines and compensation to the Government of Ghana (Myjoyonline, 2010). The spillages damaged farmlands and polluted rivers, and, consequently, resulted in the death of thousands of fishes, crabs and shrimps, and posed health and environmental hazards to the people and wildlife in the respective communities.

In Ghana's oil and gas industry, besides the reported spillage of low toxicity oil-based mud by Kosmos Energy in the Jubilee Field in December 2009 and March 2010 (EPA, 2010), there are no documented incidents of spillages related to oil development in the coastal communities located offshore Saltpond and Cape Three Points, where oil is currently being produced. It is, therefore, important that the necessary measures are taken to ensure effective and efficient exploitation and production of oil and gas, thereby, minimizing or avoiding its attendant environmental consequences on the ocean and aquatic life.

Challenges in implementation, compliance, enforcement and monitoring. Even though Ghana has well-formulated national policies and legal frameworks that regulate the operations of mining companies, most of the legislations on environment are not strictly enforced, and this has been attributed to several factors. Among these are weak institutional capacity to manage the environment, inadequate resources, and lack of political will, all of which have resulted in the lack of proper mechanisms for coordination, monitoring and enforcement. Furthermore, economic concerns, absence of effective sanctions to serve as deterrent to potential polluters, community dissatisfaction, and duplication and overlapping of institutional functions add up to the other foreseeable challenges (UNEP, 2002). Finally, inadequate remuneration and lack of commitment on the part of staff members of the regulatory and enforcing agencies, often serve as good grounds for bribery and corruption. Consequently, mining companies find it cheaper to pollute than to prevent environmental degradation, and the consequence is the documented mining-related pollution and land degradation in the mining communities.

Management frameworks for minimizing oil-related ecological risk

Legislations, conventions and regulatory

frameworks. Major environmental issues related to oil and gas development have been addressed through countless global and regional treaties, national laws and a number of administrative regulations and management frameworks, promulgated by individual countries and multinational organizations such as UN agencies, the World Bank, and International Finance Corporation (IFC) (Gao, 1998) to promote natural resource conservation and pollution control. Ghana is signatory to a number of United Nations and Regional Cooperation Conventions and multi-lateral agreements, which will help in managing environmental impacts. These international conventions are binding on national governments and serve as a baseline or guide in drafting national policies, legislations and regulations.

Notable among these treaties and conventions, that have been ratified by Ghana and of particular importance to the environment and oil and gas operations, include (e.g. Kloff & Wicks, 2004) 1. International Convention for the Prevention of Pollution of the Sea by Oil, 1962; 2. International Convention on the Establishment of an International Fund for Compensation of Oil Pollution Damage, 1971; 3. The International Convention for the Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region, 1981 (Abidjan Convention); 4. International Convention on Civil Liability for Oil Pollution Damage, 1969; 5. Convention on Wetlands of International Importance, especially as Waterfowl Habitats,1971; 6. Convention on the Conservation of Migratory Species of Wild Animals, 1979; 7. International Convention for the Conservation of Atlantic Tunas, 1966; 8. Montreal Protocol on Substances that Deplete the Ozone Layer, 1989; 9. Convention on Biological Diversity, 1992; 10. International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties; 11. United Nations Convention on the Laws of the Sea, 1982; 12. The International Convention for the Prevention of Pollution from Ships (MARPOL Convention 73/78); 13. International Convention on Oil Pollution Preparedness, Response and Cooperation, 1990; 14. The Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention); 15. Convention on the Ban of the Import into Africa and the Control of Transboundary Movement of Hazardous Wastes within Africa (Bamako Convention).

Nationally, Ghana has no comprehensive environmental legislation targeting the oil and gas industry. Existing legislation for ecosystem protection include Wild Animals Preservation Act 1961 (Act 43), Oil in Navigable Waters Act, 1964 (Act 235), Wildlife Conservation Regulations 1971 (LI685), Wild Reserves Regulations 1971 (LI 740), Maritime Zones (Delimitation) Law (PNDCL 159 of 1986), Environmental Protection Agency Act 1994, The Wetland Management (Ramsar sites) Regulation, 1999, and Environmental Assessment Regulation 1999.

Other legal frameworks that target the oil and gas industry are Oil and Mining Regulations, 1957 (LI 221), Mineral (Offshore) Regulations 1963 (LI 257), Mineral (Oil and Gas) Regulations 1963 (LI 256), Ghana National Petroleum Corporation

Act (Act 64 of 1983), Petroleum (Exploration and production) Law 1984 (PNDCL 84), and National Petroleum Authority Act (Act 691 of 2005). Some of these legislations were formulated for both the mining and oil and gas industries, and are, therefore, more generalized. Consequently, they have not been effective in the mining industry, and are, therefore, destined to face a number of challenges in the oil sector.

Recommended measures to address environmental concerns in the Oil and Gas industry

Guided by the various international treaties and conventions, there is the urgent need for the Government of Ghana to formulate an all-inclusive oil and gas development policy with environmental issues at the centre stage. The policy framework should integrate environmental legislations and management systems, and also mandate stakeholders to develop an environmental value culture at every stage of their business processes to supplement government's efforts in a cost effective manner. Consequently, the policy should be tailored along two main approaches to regulating the environmental performance of an industry, namely the 'prescriptive' and 'performance based' approaches (Technical Meeting Document, 1998).

The prescriptive approach

The prescriptive or "command and control" approach is based on legislations indicating specific requirements made by government, to be met by operators. The regulations clearly spell out structural, technical, and procedural requirements to address environmental, health and safety hazards. This makes it relatively easy for government to determine, via an inspection procedure, whether an operator is meeting the requirements. Thus, it is convenient for the Government of Ghana to adopt this approach by setting mandatory environmental codes and standards to regulate and monitor the activities of companies in the oil and gas industry. These standards must include general guidelines for the preparation of an environmental impact assessment and detailed guidelines for the preparation of an environmental action/management plan to be submitted by firms before the commencement of operations. It is very important that environmental impact assessment be undertaken prior to the commencement of oil exploration and development, and, when discovered that it can potentially impact the environment negatively, the companies involved would be required to indicate what mitigation measures would be employed to contain the situation. The standards must also include acceptable limits of concentrations of compounds and chemicals in effluent discharges generated through the operations of the various companies. Equally importantly should be the application of the "polluter pays" principle to ensure that producers of wastes that cause environmental damage are made to pay compensation and the cost of remediation.

In line with this, a solid foundation has been laid to effectively manage the negative impact on the environment. First was a national forum held to discuss potential problems and solutions, including the environmental management of oil development. Also formulated is the Fundamental Petroleum Policy for Ghana, which requires all players in the oil industry

to recognize that "achieving excellence in environmental management, health and safety, and relating well with the community in which a company operates not only contribute to business results by safeguarding people and conserving resources, but also serve as useful indicator of effective management systems".

Additionally, the National Oil Spill Contingency Plan (2010) has been formulated to respond to oil spills of any size in Ghanaian waters. The Plan provides the framework for coordination of an integrated response, definition of responsibilities, reporting and alerting procedures and means of communication, training and exercises, equipment, etc. Plans are far advanced in the preparation of Ghana Petroleum Development Master Plan, which is intended to provide the framework for rational and systematic allocation of resources to address the potential impacts of the development of petroleum resources on the population and the environment. Also being prepared is the National Environmental Policy (NEP), which has the ultimate aim to ensure sound management of the environment and the avoidance of exploitation of resources in ways that may result in irreparable damage to the environment.

Performance-based approach

In the performance-based or "self-regulation" approach, which is based on agreements made between government and operators, greater emphasis is placed on setting environmental goals or standards to be met by operators in the industry. This requires the operators to define strategies and plans in order to achieve the overall objectives and criteria set by the regulator. Accordingly, the operators are responsible for providing evidence, assuring that they are complying with the agreements. An example is a legally binding Environment Action Plan (EAP) that is formulated by the operator and subject to reporting and auditing requirements (Technical Meeting Document, 1998). The self-regulation approach focuses on self-inspection (internal audits) by company experts, in consultations with skilled external auditors, in order to check compliance and report to the regulator.

It, thus, removes some of the burden of auditing and inspection from government, while allowing the operator flexibility in choosing practical measures to meet the environmental objectives (Technical Meeting Document, 1998). This approach could, therefore, be adopted by the operators in the industry, who will be presented with the opportunity to find other ways of meeting the goals or targets set by government. Thus, the oil companies could be mandated by government to develop Environmental Management Plan (EMP) or Environmental Management System (EMS) to ensure that they operate within the environmental standards for the industry. EMS is a tool which involves continual cycle of planning, implementing, reviewing and improving the processes and actions that will effectively and efficiently enable an organization meet its business and environmental goals (Five Wind International, 2004). This means that there is a review of the system after each cycle to identify areas for further improvement to meet the national environmental standards for the industry.

The EMS, if well implemented, offers a lot of benefits including improved environmental performance, enhanced

compliance, pollution prevention, reduction in emissions, resource conservation and reduction in environmental pollution. As part of operational measures, oil companies should develop innovative environmental technologies to be employed in their operations, and develop a proper disposal of generated solid waste. The two types of approach could be achieved through the collaborative efforts of the Ministry of Environment, Science and Technology, the Environmental Protection Agency (EPA), the Ghana Standards Authority (GSA), the oil and gas companies, and other stakeholders in the industry.

Recommended administrative and institutional support. A perfect blend of both prescriptive and performance-based approaches could serve a good purpose in pursuing environmental management in the oil and gas industry. In many countries, performance-based approaches are increasingly being adopted to complement existing prescriptive regulations. Classical examples exist in Norway, the Netherlands and Australia, where the offshore oil industry has been moving to a regime based on goal-setting approach, supplemented by the prescriptive system of regulation (Technical Meeting Document, 1998). However, the mere prescription of environmental codes and setting of standards, as well as the development of EMS, cannot provide the much needed panacea for pollution emanating from the oil and gas industry. Guided by the drawbacks encountered in Ghana's mining industry, it is important that an improved and sustainable strategy be put in place to ensure that oil companies strictly adhere to regulations guiding their activities in the industry, and are not spared any documented punishment if they violate any of the legislations. Accordingly, it is recommended that the following be considered by government in its quest to safeguard the ecosystem whilst exploiting the oil and gas resources: 1. Government should ensure strict control and enforcement of environmental policies; 2. Strengthening existing regulatory framework for environmental protection; 3. Regular and effective monitoring of oil development activities; 4. Periodic update of environmental guidelines; 5. Periodic upward review of fines/penalties to deter potential polluters; 6. Periodic review of the effectiveness of local environmental agencies; 7. Availability of resources for staff development in the regulatory and enforcing agencies; 8. Improved remuneration to prevent violations of legislation by companies and discourage bribery; 9. Tax and duty exemptions on the importation of technologies related to environmental control to encourage firms in both industries to transfer pollution control technology to their establishments; 10. Regular inspection and maintenance of oil installations.

In addition, Ghanaians should be equipped with the necessary knowledge, skills, attitude and motivation for the prevention of pollution and resource deterioration. Furthermore, establishment of conservation pressure groups, with requisite expertise should be encouraged to serve as an appropriate watch dog, providing public education and making sure that the environment is conserved. Environmental education, both formal and informal, should be embarked on to inculcate environmental

values and the habits of preservation and conservation among the entire citizenry.

Conclusion

The exploration, development and production of oil and gas in the Jubilee Oil Field could be associated with ecological degradation, but these effects can be minimized if the Government of Ghana takes steps to develop petroleum industry specific environmental protection guidelines and appropriate regulatory infrastructure including monitoring equipments, compliance enforcement networks and also a deterrent sanction regime. This should employ an integrated approach, involving both prescriptive and performance-based approaches in managing the environment. Thus, the sustainable development of the Jubilee Oil Field has the potential to bring a positive change to Ghana through the preservation of the marine environment and ecosystems, and improvement of the welfare of communities to be impacted by the oil and gas industry, while enhancing the economic prosperity of the nation.

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