

Maintenance, Security, and Environmental Implications of Pipeline Damage and Ruptures in the Niger Delta Region.

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ABSTRACT

The Niger Delta is one of the world's most important wetland and coastal marine ecosystems, and the region has attracted the attention of environmentalists, human rights activists, and fair trade advocates around the world due to oil exploration and production activities carried out there. The pipeline network is constructed at strategic locations for effective distribution of gas and petroleum products from the Niger Delta region to other parts of Nigeria. In ensuring the safety of the grid of oil and gas pipelines, the government acquired a 3.5 m right-of-way on each side of the pipelines before they were laid and the pipes were buried a meter deep to prevent accidental contact.

However, recent events have shown that the integrity and safety of the pipelines has been compromised by vandals who tap into them resulting in damage and ruptures. This paper therefore assesses and offers recommendations on the maintenance, security, and environmental implications of pipeline damage and ruptures in the Niger Delta region.

The drawbacks of pipeline damage and ruptures include high costs of maintenance and security, reduction in fuel supply for electricity generation, environmental degradation and pollution of waterways due to oil slippage, reduction in revenue for the government, and threats to the socio-political stability of the nation.

Therefore, to sustain and improve the integrity and safety of the pipelines, there is the need for a complete overhaul of aging pipelines, frequent checks for pipeline integrity, improved surveillance and introduction of aerial/satellite monitoring of pipeline installations, effective tracking by the Naval force of the inflow of arms

and combating oil bunkering and sea piracy, quick response to oil spillage and pipeline vandalism, minimizing restiveness and unemployment through capacity building for the host communities by the provision of education, social infrastructures and small/medium scale enterprises, and increased enlightenment on the adverse consequences of pipeline vandalism.

(Keywords: maintenance, security, environment, pipeline damage and ruptures, Niger Delta)

INTRODUCTION

Nigeria is not only the most populous country in Africa, with a population approaching 140 million citizens, but is also a major supplier of petroleum to the United States and European markets. The country is Africa's leading oil producer and ranks among the top ten oil producers in the world. Most of the oil and gas are produced in the Niger Delta region; a region measuring about 70,000 sq. km in geographical area and lying in the southern-most part of Nigeria. It stretches from the Nigeria-Cameroon boundary in the east to the Ondo-Ogun boundary in the west. The area is bounded in the north by Enugu, Ebonyi, Anambra, Kogi and Ekiti States, with the Atlantic Coast forming the general boundary in the south. The whole area is traversed by a large number of rivers, streams, rivulets, and creeks, and consists of a number of ecological zones, sandy coastal ridges barriers, saline mangroves freshwater, permanent and seasonal swamp forests and lowland rain forests.

A few states in the South-South geo-political zone, namely Akwa Ibom, Balyesa, Delta, and Rivers States, which possess varying degrees of the deltaic features fit into the classical

description of the Niger Delta. However, presently the political boundary of nine oil producing states, of about 16,000 communities with more than 20 million people, is used in defining The Niger Delta region. The states are Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, and Rivers. However, Delta and Rivers states are the dominant oil producers, producing about 75% of Nigeria's petroleum (World Bank, 1995).

The people of the Delta are predominantly fishermen and farmers who depend on the ecosystem for survival. The region is made up of four main ecological zones, harboring a high diversity of flora and fauna: coastal barrier islands, mangroves, fresh water swamp forests, and lowland forests. The Niger Delta is one of the world's largest wetlands and has the largest mangrove forest in Africa. The region has attracted the attention of environmentalists, human rights activists, and fair trade advocates around the world due to oil exploration and production activities carried out there.

About 5,284 oil wells, 7,000 km of pipeline, 10 gas plants, 275 flow stations, and 10 export terminals constitute the assets and infrastructures employed in Nigeria's oil and gas operations (Smith, 2006). All of these are connected by pipelines. The pipeline network is constructed at strategic locations for effective transportation and distribution of gas and petroleum products from the Niger Delta to other parts of Nigeria. There is a total network of 5001 km of oil pipelines; this consists of 666 km of crude oil pipelines and 4,315 km of multi-product pipelines. The pipeline network forms a mesh that interconnects the 22 petroleum storage depots, the four refineries at port Harcourt (I and II), Kaduna and Warri, the offshore terminals at Bonny and Escravos, and the jetties at Atlas Cove, Calabar, Okrika, and Warri (Onuoha, 2008).

The Pipeline and Product Marketing Company (PPMC), a subsidiary of Nigerian National Petroleum Corporation (NNPC), uses this pipeline network to transport crude oil through distances of about 719 km of to the Port Harcourt (I and II), Kaduna and Warri refineries. The multi-product pipelines are used in transporting products from the refineries and import-receiving jetties to the 22 petroleum storage depots all over the country. These depots are connected by pipelines of 6 to 8

inches range and have combined installed capacities of 1,266,890 of PMS, 676,400 DPK, 1,007,900 AGO, and 74,000 ATK metric tonnes (Special Committee on the Review of Petroleum Product supply and Distribution 2000).

In ensuring the safety of the grid of oil and gas pipelines, the government acquired a 3.5 m right-of-way on each side of the pipelines before they were laid and the pipes were buried a meter deep to prevent accidental contact. However, recent events have shown that the integrity and safety of the pipelines have been compromised by vandals who tap into them resulting in damages and ruptures. This paper assesses and offers recommendations on the maintenance, security, and environmental implications of pipeline damage and ruptures in the Niger Delta region.

METHODOLOGY

Assessment of Pipeline Damages and Ruptures in the Niger Delta

Pipeline breakage and oil spills are caused by two major phenomena: damages and ruptures. Ruptures occur due to diminished pipeline integrity and the aging process of the pipes. However, pipeline damages are caused mainly by sabotage. Oil spills in Nigeria occur due to a number of causes which include corrosion of pipelines and tankers, sabotage, oil production operations, and insufficient or non-functional production equipment.

Pipeline Ruptures

The largest contributor to the oil spill total, corrosion of pipes and tanks, involves the rupturing or leaking of production infrastructure that are describe as "very old and lack regular inspection and maintenance". Corrosion plays the major role in oil spills because of the small size of the oilfields in the Niger Delta; there is an extensive network of pipelines between the fields as well as numerous small networks of flowlines allowing many opportunities for leaks. In onshore areas, most pipelines and flowlines are laid above ground. Pipelines, which have an estimate life span of about fifteen years, are old and susceptible to corrosion. Many of the pipelines are as old as twenty to twenty-five years.

Pipeline Damages/Sabotage

In Nigeria, interfering with oil pipelines and installations has assumed huge dimensions and a variety of forms. There are three major identifiable forms, namely oil bunkering, oil pipeline vandalization/fuel scooping, and oil terrorism. Compared to oil bunkering and pipeline vandalism, oil terrorism is a new vocabulary introduced by security analysts and scholar to describe the deliberate attack on pipeline systems in Iraq and elsewhere in the world by militias, freedom fighters, and insurgents.

Oil Bunkering: Nigeria's most profitable illegal private business in the petroleum industry is oil bunkering. 'Bunkering' is a term used to describe the process of filling a ship with oil (or coal). 'Illegal oil bunkering' is, therefore, a euphemism for theft of oil (Human Rights Watch, 2003), which involves tapping crude oil directly from the pipelines. Illegal oil bunkering is a dangerous process that persists in the creeks of the Niger Delta where oil pipelines form a grid. Stealing oil from pipelines in the creeks involves building a temporary enclosure around a small portion of underwater pipe, pumping out water from the enclosure, drilling a hole into the steel casing of the pipe through which the crude passes, and fitting the hole with a pipe and control valve. The creek water is the allowed to flow back and fill the enclosure so that the set-up is underwater and therefore hidden from oil company inspectors (Junger, 2007). When crude oil is being pumped through the pipelines, sometimes at a pressure of 600 psi, the thieves are able to fill up to a 1,000 metric tonne barge in a matter of hours. The barge is then moved offshore to a transport ship and the oil is sold on the high seas (Onuoha, 2008).

Oil bunkering was also reported to involve tapping directly into pipelines at a site removed from oil company facilities, and connect the pipes to barges that are hidden in small creeks under cover of mangrove forests (Human Rights Watch, 2003). It is estimated that over 10 per cent of the oil exported from Nigeria every year has actually been bunkered.

Oil bunkering is now an activity that does not necessarily require the assistance of oil company staff to operate equipment at

wellheads or allow access (though there are reports of conspiracy from company staff).

Pipeline Vandalism/Oil Scooping: In the 1990s, vandals, mainly unemployed youths operating in remote areas and communities through which oil pipeline pass, punctured the pipes or took advantage of ruptured or leaking pipes to siphon fuel or other petroleum products into drums, plastic containers or storage cans for sale on the black market. The technology employed was quite rudimentary, involving the use of funnels, drilling tools and plastic hoses to siphon the products. Also, only few cases of vandalism occurred. For instance, in 1995 there were only 7 reported cases of vandalism and in the next three years 33, 34, and 57 cases were recorded (Special Committee on the Review of Petroleum Product Supply and Distribution, 2000).

Towards the end of the military rule in Nigeria, the vandalism of oil pipelines, especially the pipelines for premium motor spirit (PMS), came into the limelight. But in recent times it has assumed an alarming rate, because of the increase in the frequency of attacks on these pipelines, increased sophistication in the technology used, and concentration on the three axes that are crucial to petroleum products distribution in the country (Onuoha, 2008).

Oil Terrorism: In Nigeria, oil terrorism includes such acts as the blowing up of oil pipelines, installations, and platforms with explosives, and the seizure of oil barges, oil wells, flow stations, support vessels, and other oil facilities in order to prevent the exploitation and/or distribution of crude oil or its refined products.

The first act of oil terrorism in Nigeria can be traced to December 2005, when the Movement for the Emancipation of the Niger Delta (MEND) blew up Shell's Opobo Pipeline in Delta State (Ibinabo 2007). After the arrest of Alhaji Asari Dokubo, the leader of the Niger Delta People's Volunteer Force (who is widely regarded as a leader of the Ijaw nation) in September 2005, militant groups in the Delta region instructed all multinational oil companies to leave the region, as they were preparing for a war with the Nigerian government. Since then militants in the region, seeking to control a greater share of the nation's oil wealth, have adopted a terrorist

strategy to impair the capacity of the petroleum industry to export crude oil. By doing so they hope that the federal government will lose the substantial revenue needed to sustain the machinery of government, and so be forced to their political, economic, and environment demands (Okafor and Olagoke, 2007).

Some of the reported cases of the militants' attacks include the following:

(i) On January 16th, 2005, a major pipeline supplying crude to the Forcados export terminal was blown up, cutting supplies by about 100,000 barrels per day.

(ii) On March 18th, 2005, militants blew up an oil pipeline operated by an Italian company, reducing flow by 75,000 barrels per day.

(iii) On October 3rd, 2006, militants struck at an oil vessel at Cawthorowe Channels, killing five soldiers who were escorting the vessel, and later sinking the vessel.

(iv) On May 8th, 2007, MEND attacked three oil pipelines; two of these pipelines were in the territory of Akassa and the third in Twon-Brass.

These acts showed that the militants have developed both the tactics and weaponry that have enabled them to launch devastating attacks on onshore oil installations and near offshore rigs (Onuoha, 2008).

Maintenance and Economical Implications of Pipeline Damages and Ruptures

When diminished pipeline integrity and the aging process of the pipes cause pipeline ruptures, and/or sabotage (in form of oil bunkering, pipeline vandalism/oil scooping, and oil terrorism) cause pipeline damages, there is usually an urgent need to repair and regularly inspect/maintain the pipeline networks and keep the environment clean of any oil spill. Repair of the pipelines and cleaning up of oil spills in the environment involves huge capital expenditure. Therefore, pipeline damage and ruptures require that the oil companies and the Federal Government spend more money on improving the integrity and safety of pipelines and the environment by overhauling aging pipelines, frequently checking pipeline integrity (e.g., using cathodic protection devices to monitor steel

pipes for corrosion), improving surveillance and introduction of aerial/satellite monitoring of pipeline installations, effectively tracking by the naval force of the inflow of arms and combating oil bunkering and sea piracy, and quickly responding to oil spillage and pipeline vandalism.

On the part of the oil companies, the money that could have been spent on other areas of oil exploration and production are used for pipe repair/maintenance and cleaning oil spills. Since most oil companies operate on joint venture contractual agreements (and of recent production sharing contracts), the Federal Government also bears part of this burden because of the negative impact on the scarce resources available for investment in other sectors of the economy and the statutory duty of the government to render diverse socio-economical responsibilities to the people.

Security Implications of Pipeline Damages and Ruptures

Governments all over world, particularly those of developing countries, are increasingly recognizing that threats to national interests/security are more likely to stem from internal than external sources. Such threats can assume different forms in different countries at different times. In terms of strictly national security considerations, oil pipelines and facilities are sensitive strategic assets that must be protected at all times. Oil pipeline sabotage, regardless of whether it is perpetrated by nationals, foreigners, or terrorist groups, is a serious threat to national security, particularly for a country that depends heavily on oil exports for survival. This is essential because in a situation of war with another country, pipelines are usually one of the first targets of an enemy and preserving them could be the difference between victory and defeat (Adeniyi 2007).

For this reason, countries will expend enormous financial and material resources on safeguarding the integrity of their strategic assets. In 2002, for example, Colombia announced plans to train and arm special troops to protect a key oil pipeline. The United States government supported the initiative and requested that Congress allocate US\$98 million in the 2003 budget to train, arm, and provide air support for Colombian troops to defend the

pipeline, which is jointly owned by the Occidental Petroleum Corporation and the Colombian state oil company, Ecopetrol (Adeniyi 2007).

Given that Nigeria has a mono-cultural economy that depends on oil exports for survival, oil pipelines and installations are the arteries and veins that supply the lifeblood of Nigeria's economic wealth (i.e., crude oil and its refined products) to various parts of the country. It follows that attacks on them, both in peace and war situations, could strangle the Nigerian state and render it incapable of defending itself against internal subversion or external aggression. More so, in view of the strategic position these facilities occupy in the political economy with regards to security and development in Nigeria, there is no doubt that Nigeria's oil pipeline network and facilities still remain vulnerable to both militants and terrorist attacks.

Another major implication of oil pipeline sabotage for national security is the huge loss of government revenue. Oil pipeline sabotage undermines the capacity of the government to generate resources needed to fulfill its responsibilities, of which the security of its citizens is a primary consideration. In February 2007, for instance, the NNPC estimated that the nation lost about 10 billion Naira to pipeline vandalism. The figure includes losses incurred because of damage to equipment and losses of products and equipment (Bello, 2007). Indeed, the loss to the Nigerian government from illegal oil bunkering amounts to about US\$14 billion a year (Ikoku, 2007).

Such funds represent lost opportunities for funding initiatives to provide basic and quality services to citizens, better equip the security forces to ensure the security of life and property, strengthen institutions that promote human rights, and undertake infrastructural development, among others.

In addition, oil pipeline sabotage in the form of illegal bunkering is one of the factors such as poverty and unemployment that adds to criminality, cult clashes, communal violence, proliferation of small arms, and political instability in the region. In Nigeria, the sabotage of pipelines conveying crude oil or gas to power plants has resulted in power cuts. Reliable electricity supply is critical for national

development, and by extension, national security.

Environmental Implications of Pipeline Damages and Ruptures

Degradation of the environment is one of the worst disasters that have befallen the areas where pipelines have been vandalized. Raging fires have destroyed farmlands and forests thereby reducing arable land for farming. Spills into waterways destroy marine and aquatic life, flora, fauna, resort centers, and result in the pollution of potable water (Badejo and Nwilo, 2007). Pipeline vandalism compounds oil spillages from other sources and exacerbates the problems of environmental degradation and pollution of waterways (Ogbuefi, 2007).

Oil spill effects are so alarming that an oil spill is considered to be serious environmental catastrophe. Annually, millions of gallons of oil are discharged into the oceans due to careless handling, offshore oil drilling, and terrorist activities. In addition to having disastrous effects on the environment, an oil spill is often lethal to wildlife. Short term oil spill effects include tarred coastlines and seashores, dead or injured flora and fauna, and contaminated water. With the passage of time, oil spills that are not cleaned can ultimately destroy the surrounding ecosystem.

Leakage of oil into a body of water, like a river or stream, has very unpleasant ramifications. The surface of the water becomes coated with very thick layers of crude oil, preventing oxygen from getting to the fish and other marine life in the water. Also, aquatic wildlife and their habitats are affected by oil spills by means of physical contact, ingestion, absorption, and inhalation. The oil spill causes damage to the entire aquatic food chain. Plankton, algae, larvae, and fish eggs which are consumed by small fish species are contaminated. This contamination is then passed on to larger fish, aquatic birds, and even humans. The growth and germination of marine plants are affected by oil spills as well.

When exposed to oil spills, some species of marine algae and seaweeds may even perish. Oil spills can cause marine invertebrates to choke. They can also alter their metabolic activities. These invertebrates may accumulate

high levels of toxins in their bodies, which get passed on to their predators when they are eaten. Fish tend to ingest large amounts of oil through their gills, which seriously affects the health of their eggs and larva. In adult fish, an oil spill may cause damage like reduced growth, improper heart and respiration rates, fin erosion, and reproductive mutilation. Oil spills can even destroy the insulation capacity of a marine bird's feathers or a mammal's fur, which leads to death by hypothermia. When oil is ingested by these species, it leads to damage of the lungs, liver, and kidneys, followed by death.

In areas where oil spills result from pipelines vandalism, some of the spills seep into the ground and contaminate ground water. Many people in the Niger Delta region have complained that water from freshly sunk boreholes show evidence of oil contamination. This makes the water undrinkable even after some treatment. Also, some natives have been known to use or drink polluted water out of frustration and the negative effects cannot be overemphasized.

Another problem of oil spills is that areas that have been known to be fertile for farming in the past have suddenly become barren or are getting closer to being so. The mangrove forest is slowly withering away and the agricultural industry is suffering. This is particularly sad because the natives, who used to make their living through subsistence farming, have to look elsewhere for their livelihood. Oil spills on farms and grassy lands can also lead to the die-off of plant life. Plant life is so detrimentally affected because the soil will lose its ability to absorb water. Light oil seeps into top soil quickly, rapidly percolates, and then contaminates ground water. On the other hand, heavier oil with a high viscosity penetrates slowly. Terrestrial oil spills seriously affects the soil fertility, often making it unfit for vegetation.

DISCUSSION

Steps Towards Improving the Integrity and Safety of Pipelines

Frequent Checks for Pipeline Integrity and Complete Overhaul of Aging Pipelines: There should be frequent checks for pipeline integrity in the Niger Delta to prevent pipeline rupture. The goal of any pipeline integrity program is to

prevent structural integrity problems from having a significant effect on public safety, the environment, or business operations by identifying and performing the most effective inspection, monitoring, and repair activities.

Pipeline integrity methods include visual inspection, depth of cover survey, external non-destructive testing (NDT), cathodic protection monitoring, coating disbondment and damage survey, hydrostatic testing, geometry in-line inspection (ILI) tools, and ultrasonic in-line inspection tools.

The pipeline network today must be rigorously tested to ensure they meet safety guidelines. Before they can be put into service, hazardous liquid, oil, and gas transmission pipelines must be hydrostatically pressure tested. The hydrostatic pressure test helps to discover any defect that might threaten the pipeline's ability to sustain its maximum operating pressure.

Pipelines are designed to have a certain strength based on the appropriate operating pressure. The hydrostatic pressure test fills the pipeline with water while increasing the internal pipeline pressure to a specified level above the intended operating pressure. If there are any critical defects in the system, the system will leak or fail. When detected, these defects can be repaired. The pipeline pressure testing is conducted again until it passes the certification.

Other testing methods are used to detect pipe and pipe membrane defects. These procedures help identify specific types of defects, such as:

- (i) corrosion (the wastage or thinning of the pipe wall due to a chemical or electrochemical attack),
- (ii) gouging (the mechanical removal of metal from a local area on the surface of the pipe),
- (iii) metallurgical anomalies like hard spots, laminations, slivers, scabs and inclusions, and
- (iv) cracks due to fatigue stress corrosion and weld defects.

However, hydrostatic testing is the predominant pipeline testing method for ascertaining the strength and reliability of a pipeline section that may be put into active service.

Aging pipelines are easily amenable to defects; hence, there should be complete overhaul of aging pipelines both in the downstream and upstream sections of Nigeria oil industries.

Improved Surveillance and Introduction of Aerial/Satellite Monitoring of Pipeline Installations: There should be an improved surveillance and introduction of aerial/satellite monitoring of pipeline installations to prevent and control pipeline vandalism by responding quickly to any act of oil bunkering, pipeline vandalism/oil scooping and oil terrorism. Security agencies in collaboration with youth and community leaders should be deployed to patrol oil and gas pipeline right of way, although it is sad that some of these security men and trusted allies are also working in consonance with the vandals.

Pipelines play a critical role in the world economy, therefore, the integrity and efficiency of pipeline systems should be given serious consideration. Pipelines and pipeline transport must be designed and monitored in real time using Global Positioning System (GPS) communications. Oil and gas pipeline projects in Nigeria should be granted only when pipeline construction companies can assure pipelines have efficient reporting systems on the integrity of its operations.

The threats from a poorly monitored, inspected, and maintained pipelines can result in legal action, financial losses, and bad publicity that can cause cancellation of future projects. Therefore, it is essential that pipeline management firms have the very best software applications and upgrade modules to perform the best pipeline inspections.

Effective Tracking by the Naval Force of the Inflow of Arms and Combating Oil Bunkering and Sea Piracy

Despite the advances in global maritime security, attacks by pirates have been on the increase. Reported maritime terrorist attacks are rare by comparison, although they may well be contributing to the increase in piracy. A maritime attack on the Northern Arabian Gulf Oil Terminal (NAGOT) in April 2004 was thwarted because of the vigilance of U.S. Naval and Coast Guard

units monitoring vessel traffic in the restricted areas surrounding the facility (Snoddon, 2008).

In the Niger Delta, sea piracy has become a major threat and creates fear among travelers along the various waterways that cascade the region. Vessels are equally not spared, as most often the unescorted ones are hijacked; the items therein are vandalized and at times run aground. The situation is further compounded by the terrain and thousands of creeks, which not only makes effective policing difficult but also provides safe havens for the criminals. Therefore, to effectively track the inflow of arms and combat oil bunkering and sea piracy in the Niger Delta region, the Federal Government must equip the Nigeria Navy and make them battle ready for the security of the coastline.

Quick Response to Oil Spillage and Pipeline Vandalism

When oil spills after pipeline rupture or damage, there should be a quick and effective clean up to prevent the oil from being mixed or buried in the sediment. This can be done with the use of Geographic Information Systems (GIS). A quick and effective response minimizes oil spill damage and institutes effective and practical plans for all types of oil spills clean up. Hence, a contingency plan for oil spills clean up must be made. A contingency plan is a strategy that is prepared in anticipation of an oil spill. A typical contingency plan comprises the following:

(i) identification of authority and chain of command, listing of persons and organizations that must be informed immediately of an oil spill, and recording of available trained oil spill personnel and spill response equipment,

(ii) listing of jobs to be done in order of priority, organizing a communication network to coordinate response and identify probable oil movement patterns under different weather conditions, assessing information sensitive maps and compiling other technical data, and

(iii) knowing important physical and biological resources within or near the region such as marshes and vital habitat areas required by particular species for spawning, feeding or migrating, and gathering information about tides, currents and local climate conditions, weather patterns and shoreline characteristics.

To make these tasks feasible, more funding must be provided by the stakeholders of the oil industry

Minimizing Restiveness and Unemployment through Capacity Building for the Host Communities

The Niger Delta crisis is a culmination and expression of built-up anger and frustration by a people from whose lands and rivers the bulk of Nigeria's revenue is exhumed in the form of oil and gas, which translates to billions of dollars yearly, but with the people of the area left in squalor, neglect, abject poverty, and in a general state of underdevelopment. Therefore, to address the issue of restiveness and unemployment in the host communities where oil and gas exploration and exploitation take place, capacity building through provision of education, small and medium scale enterprises should be put in place.

Also, the host communities should be developed into satellite towns using the sustainable community development (SCD) option as proffered by the Nigerian National Petroleum Corporation. There should also be provision of welfare facilities and access to health care. There should be provision of cheap source of energy to stimulate industrial and technological development in the region. The Niger Delta Development Corporation (NNDC) should be adequately funded to enhance performance towards developing the Niger Delta region. There should also be an increased enlightenment on the adverse consequences of vandalism on our economy, environment and the disaster of fire outbreaks when scooping fuel from vandalized pipelines.

CONCLUSION

Recent events have shown that the integrity and safety of the pipelines in the Niger Delta region have been compromised by vandals who tap into them resulting in damage and ruptures. The maintenance, security, and environmental implications of pipelines damage and ruptures in the Niger Delta region are assessed. The drawbacks of pipelines damages and ruptures were found to include high costs of maintenance and security, reduction in fuel for the national electricity supply, environmental degradation

and pollution of waterways due to oil slippage, reduction in revenue for the government, and threats to socio-political stability of the nation.

RECOMMENDATION

To sustain and improve the integrity and safety of the pipelines, there is a need for the complete overhaul of aging pipelines, frequent checks for pipeline integrity, improved surveillance and introduction of aerial/satellite monitoring of pipeline installations, effective tracking by the Naval force of the inflow of arms and combating oil bunkering and sea piracy, quick response to oil spillage and pipeline vandalism, minimizing restiveness and unemployment through capacity building for the host communities by the provision of education, social infrastructures and small/medium scale enterprises, and increased enlightenment on the adverse consequences of pipeline vandalism.

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