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Revitalizing Nigeria's Brownfields: Strategies to Increase Oil Production and Improve Local Refining Capacity

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ABSTRACT: Nigeria's oil and gas sector, which is central to its economy, faces declining productivity due to the underutilization of brownfields—previously active oil sites that have become dormant or inefficient. This paper explores strategic approaches for revitalizing these brownfields to enhance national oil production and local refining capacity. Through a combination of site assessments, economic feasibility analysis using Net Present Value (NPV), and technological evaluations, the study establishes the viability of redeveloping ten selected brownfields across the Niger Delta. All sites demonstrated positive NPVs, indicating strong investment potential. Fields such as Forcados, Oredo, and Batan emerged as top priorities due to their high returns and existing infrastructure. Even historically significant or politically sensitive sites like Oloibiri and Ogoni showed promise for redevelopment when supported by robust environmental and regulatory frameworks. Applying Enhanced Oil Recovery (EOR) techniques, infrastructure upgrades, and community-inclusive policies is critical for successful implementation. Beyond economic gains, brownfield revitalization offers significant environmental and social benefits, including pollution remediation, job creation, and improved local livelihoods. This study provides a comprehensive framework to guide policymakers, investors, and stakeholders in transforming Nigeria's brownfields into productive assets for sustainable national growth.

KEYWORDS: Brownfields, Oil, Production, Refinery, Revitalization, Strategies

1. INTRODUCTION

As Africa's leading oil producer, Nigeria faces significant challenges in meeting its domestic refining needs. Despite having vast oil reserves, the country's refining capacity remains inadequate, compelling a heavy reliance on imported refined petroleum products to meet local demand (NNPC, 2022). This dependency strains the national economy and compromises energy security and self-sufficiency.

Nigeria's refining infrastructure has not kept pace with its crude oil production. The nation's refineries, plagued by outdated technology and frequent maintenance issues, operate significantly below their installed capacities (Shell Nigeria, 2020). This inefficiency forces Nigeria to import a substantial portion of its refined petroleum products, including gasoline, diesel, and kerosene. This reliance creates a paradox where an oil-rich country faces fuel scarcity and high import costs, adversely affecting the overall economy and increasing vulnerability to global market fluctuations (Ministry of Petroleum Resources, 2021).

The importation of refined petroleum products in Nigeria has been linked to issues like fuel subsidy fraud. These subsidies drain substantial funds that could be better allocated to sectors like education, healthcare, agriculture, rural development, and infrastructure. With Nigeria consuming around 45 million liters of premium motor fuel daily, the country's refineries can only produce 12 million liters, leaving a significant gap in meeting domestic demand (Nathaniel, 2018).

Brownfields, previously exploited oil sites that have experienced a decline in productivity, offer a promising solution to Nigeria's refining challenges. These sites often retain significant untapped reserves and existing infrastructure, although in a degraded state. By revitalizing these brownfields, Nigeria can enhance its oil production and refining capacity, effectively addressing supply and demand issues (Chevron Nigeria Limited, 2021). This approach reduces dependence on imported refined products and bolsters the nation's energy security.

Countries like Canada and the United States have successfully revitalized brownfields through technological innovation and robust regulatory frameworks. Canada's approach to brownfield redevelopment stands out for its strong environmental regulations and adoption of innovative technologies. This strategy has successfully revitalized numerous sites, setting a benchmark for sustainable development (Natural Resources Canada, 2019). By studying Canada's experiences, Nigeria can gain valuable insights into effective regulatory mechanisms and technological solutions that can be applied to its brownfield projects.

2.0 METHODOLOGY

This study adopted a multi-step research approach integrating data collection, site assessments, analytical modeling, and validation techniques to evaluate the revitalization of brownfields in Nigeria's oil sector. The methodology is structured as follows:

(a) Research Design

The study employed a mixed-methods approach, combining qualitative and quantitative analyses. It involved a systematic literature review, case study evaluations, and economic feasibility assessments to derive insights into brownfield redevelopment strategies.

(b) Data Collection

Data for this study were obtained from primary and secondary sources:

Primary Data: Site assessments from oil brownfields, industry reports, and stakeholder interviews.

Secondary Data: Government reports (NNPC, Ministry of Petroleum Resources), academic journals, industry white papers, and company reports from Chevron, Shell, and Dangote Industries.

(c) Steps in the Analysis

Identification and Classification of Brownfields: Historical production data and infrastructure conditions were obtained and reviewed for classification.

Geological and Infrastructure Assessment: Information was gathered on the condition assessments of existing pipelines, drilling rigs, and refining facilities.

Economic Feasibility Analysis: A cost-benefit analysis (CBA) was conducted to assess the financial viability of brownfield redevelopment. Net Present Value (NPV) calculations were used to evaluate potential investment returns.

Technological Evaluation for Enhanced Recovery & Refining: Different Enhanced Oil Recovery (EOR) techniques (water flooding, gas injection, chemical injection) were analyzed to determine their applicability. Advanced refining processes, such as hydrocracking and catalytic reforming, were reviewed to improve local refining efficiency.

(d) Analytical Tools Used

This study utilized economic modeling tools for financial assessments (CBA, NPV) to ensure rigorous analysis. **Microsoft Excel** was also employed for cash flow analysis.

2.1 Primary and Secondary Data Sources for Brownfield Revitalization Study

Table 1 is a structured table displaying the primary and secondary data used in this study, categorized based on data type, sources, and their relevance to brownfield revitalization:

Table 1: Primary and Secondary Data Sources for Brownfield Revitalization

Data Type	Data Collected	Sources	Relevance to Study
Primary Data	On-site geological surveys and reserve estimation	Oil fields in Niger Delta (NNPC, Chevron)	Determines remaining oil reserves in brownfields
Primary Data	Infrastructure condition assessments	Inspections of pipelines, drilling rigs	Identifies assets that can be refurbished/replaced
Primary Data	Environmental contamination levels	Soil & water quality tests in brownfields	Assesses pollution levels and need for remediation
Primary Data	Community engagement surveys	Interviews with local communities	Evaluates socio-economic impacts of redevelopment
Primary Data	Economic viability studies	Investor feasibility reports	Determines financial feasibility of brownfield projects

Secondary Data	Historical production data	NNPC, DPR, Shell, Chevron reports	Tracks decline in oil output from brownfields
Secondary Data	Regulatory and policy framework	Ministry of Petroleum Resources reports	Identifies legal and policy incentives for redevelopment
Secondary Data	Case studies on brownfield redevelopment	International oil industry reports (Canada, USA)	Provides best practices and lessons for Nigerian brownfields
Secondary Data	Technological advancements in oil recovery	Research papers, industry white papers	Evaluates suitable Enhanced Oil Recovery (EOR) techniques
Secondary Data	Economic models and investment trends	World Bank, IMF reports on oil sector	Assesses global investment trends in brownfield projects

2.2 Identification and Classification of Brownfields

Nigeria, a major player in the global oil industry, has numerous oilfields, some of which have transitioned into brownfields due to reduced production and operational challenges. These brownfields present significant opportunities for redevelopment through modern technologies and strategic investment. Here are ten notable brownfields in Nigeria:

(a) **Oloibiri Oilfield (Bayelsa State):** The Oloibiri Oilfield holds historical significance as the site of Nigeria's first commercial oil discovery in 1956. Located in Bayelsa State, this once-thriving oilfield has long since become inactive. Despite its dormancy, Oloibiri remains a symbol of Nigeria's entry into the global oil market and has potential for historical and educational redevelopment. Figure 1 below is the Oloibiri Oilfield that has turned into a brownfield.

Figure 1: Oloibiri Oilwell

(b) **Ogoni Oilfields (Rivers State):** The Ogoni Oilfields encompass several fields, including Bomu, Ebubu, and Korokoro. Situated in Rivers State, these fields have not only seen a decline in production but have also been plagued by significant environmental challenges. The legacy of pollution and environmental degradation in Ogoni land highlights the urgent need for environmental remediation and sustainable redevelopment strategies.

(c) **Forcados Oilfield (Delta State):** Located in Delta State, the Forcados Oilfield is a critical asset within Nigeria's oil infrastructure. Despite its importance, the field has faced recurrent production issues and frequent shutdowns. Addressing these operational challenges and stabilizing production could greatly enhance Nigeria's oil output and economic stability.

(d) **Batan Oilfield (Delta State):** Batan Oilfield is part of the larger Oil Mining Lease (OML) 42 in Delta State. This field has experienced significant output declines alongside various operational challenges. Revitalizing Batan would require addressing these issues through advanced extraction techniques and investment in infrastructure.

(e) **Utorogu Oilfield (Delta State):** Situated in the Western Niger Delta, the Utorogu Oilfield has seen reduced production rates over the years. Known for its gas production, Utorogu represents an opportunity to boost Nigeria's natural gas output by implementing modern recovery technologies and optimizing existing operations.

(f) **Oredo Oilfield (Edo State):** The Oredo Oilfield, located in Edo State within OML 111, is another example of declining productivity. This onshore field's reduced output could be countered with enhanced oil recovery techniques and comprehensive field management strategies to maximize its remaining potential.

(g) **Ogharefe Oilfield (Delta State):** Known for its operational issues and production decline, the Ogharefe Oilfield in Delta State requires significant attention to reverse its fortunes. Strategic investments and technological upgrades could restore its productivity and contribute positively to Nigeria's oil industry.

(h) **Gbokoda Oilfield (Delta State):** Part of OML 49, the Gbokoda Oilfield has experienced reduced output and is in dire need of revitalization. By leveraging modern extraction technologies and improved field management, Gbokoda can be brought back to productive life, benefiting both the local economy and the broader oil sector.

(i) **Afiesere Oilfield (Delta State):** Located within OML 26, the Afiesere Oilfield is facing declining production. Redeveloping this field could involve targeted investments and the adoption of innovative recovery methods to boost its output and extend its operational lifespan.

(j) **Uzere Oilfield (Delta State):** Another mature field within OML 26, the Uzere Oilfield has similar challenges of production decline. Comprehensive redevelopment plans focusing on enhanced oil recovery and infrastructure upgrades could rejuvenate this field, making it a valuable asset once again.

Historical production data and infrastructure conditions were obtained and reviewed to classify brownfields based on production decline, operational status, and infrastructure integrity. Table 2 shows the summary of historical production data and infrastructure conditions of various brownfields in Nigeria.

Table 2: Historical Production Data and Infrastructure Conditions

Brownfield	Location	Year of Peak Production	Peak Output (Barrels/Day)	Current Output (Barrels/Day)	% Decline in Output	Infrastructure Condition
Oloibiri	Bayelsa State	1960	50,000	0	100%	Abandoned, degraded wellheads.
Ogoni	Rivers State	1985	70,000	5,000	92.8%	Severe pipeline corrosion, refinery inactive
Forcados	Delta State	1995	200,000	60,000	70%	Partially functional, damaged storage tanks
Batan	Delta State	1998	120,000	35,000	71%	Worn-out pumping stations, leaking pipelines
Utorogu	Delta State	2000	90,000	30,000	66.7%	Old gas processing plants, pipeline vandalism
Oredo	Edo State	1992	60,000	20,000	66.7%	Moderate condition, outdated processing units
Ogharefe	Delta State	1987	80,000	10,000	87.5%	Severely corroded pipelines, weak drilling rigs
Gbokoda	Delta State	1996	110,000	45,000	59%	Aging refinery units, intermittent operation
Afiesere	Delta State	1999	95,000	25,000	73.7%	Deteriorated pipeline network, inactive units
Uzere	Delta State	2002	85,000	40,000	52.9%	Requires facility upgrade, some usable equipment

2.3 Infrastructure Assessments

This includes evaluating the condition of drilling rigs, pipelines, storage facilities, and other relevant equipment (NNPC, 2022). Many brownfields have infrastructure that has deteriorated over time due to neglect or insufficient maintenance. Detailed assessments, as shown in Figures 2 and 3, help to identify what can be refurbished and reused, and what needs to be replaced entirely. This approach helps optimize costs and ensure that investments are directed towards the most critical areas that will enhance operational efficiency.

Figure 2: Assessment of Pipelines Facility at a Brownfield

Figure 3: Assessment of Oil Drilling Rig at a Brownfield

2.4 Economic Feasibility Studies

Economic feasibility studies are a critical component of the assessment process. These studies analyze the financial viability of redeveloping the brownfields by considering capital expenditure, operational costs, potential revenue, and market conditions (Ministry of Petroleum Resources, 2021). The goal is to develop a comprehensive financial model that includes cost-benefit analyses, risk assessments, and sensitivity analyses. These models help stakeholders understand the potential return on investment and the economic risks involved. A well-conducted feasibility study provides a roadmap for strategic planning and decision-making, ensuring that only the most economically viable projects are pursued.

(a) Production Decline Analysis

Production decline analysis is used in petroleum engineering to estimate reserves and predict future production performance. The most common models include Exponential Decline, Harmonic Decline, and Hyperbolic Decline.

Exponential Decline

$$q_t = q_i * e^{(-Dt)} \quad (1)$$

Where:

q_t : Production rate at time t

q_i : Initial production rate at t = 0

D: Decline rate (constant for exponential)

t: Time (usually in years)

Harmonic Decline

$$q_t = q_i / (1 + D_i * t) \quad (2)$$

Where:

q_t : Production rate at time t

q_i : Initial production rate

D_i: Initial decline rate

t : **Time**

Hyperbolic Decline

$$q_t = q_i / (1 + b * D_i * t)^{\frac{1}{b}} \quad (3)$$

Where:

q_t: Production rate at time t

q_i: Initial production rate

D_i: Initial decline rate (usually 0.24)

b: Decline exponent ($0 < b < 1$ for hyperbolic, usually 0.68)

t: Time

For this study, the Hyperbolic Decline Model is preferred for the following reasons:

- **Flexibility:** Captures early and late-time production behavior more accurately than the exponential model.
- **Realistic Tail Production:** Accounts for the slowing rate of decline over time, which is common in aging wells.
- **Reservoir Complexity:** Better models reservoir variability with mixed flow regimes or secondary recovery influences.
- **Decline exponent b** adds control over the curve shape, helpful when production doesn't decline at a constant rate.

(b) Net Present Value (NPV)

$$NPV = \sum_1^n [C_t / (1 + r)^t] - C_o \quad (4)$$

Where:

C_t: Net cash inflow at time t

C_o: Initial investment (cash outflow/CAPEX)

r: Discount rate or cost of capital

t: Time period

n: Total number of periods

Interpretation:

If NPV > 0, the investment is profitable.

If NPV < 0, the investment is unprofitable.

If NPV = 0, the investment breaks even.

Table 3: Parameters for the Cost Benefit Analysis and Cash Flow Calculations

Brownfield	Initial Production Rate, q_i(bpd)	Production Rate (final) at Time t, q_f (bpd)	Oil Price (USD/bbl)	Annual OPEX (USD)	Initial CAPEX (USD)	Key Peculiarity
Oloibiri	2000	471.42	80	1,500,000	15,000,000	Historic, legacy infrastructure
Ogoni	2000	471.42	80	1,800,000	14,000,000	Politically sensitive, reactivation potential
Uzere	1950	460	79	1,450,000	13,500,000	Delta-based, flare management needed
Gbokoda	1800	440	81	1,350,000	12,500,000	Marginal producer, small field
Ogharefe	1850	445	80	1,400,000	13,800,000	Inland with modest infrastructure
Forcados	2400	550	81	1,700,000	17,000,000	Export terminal access, ageing infrastructure
Batan	1900	480	78	1,450,000	14,000,000	Swampy terrain, logistics costlier
Utorogu	2000	470	79	1,500,000	15,500,000	Oil-gas mix, reliable terrain
Oredo	1700	440	82	1,300,000	13,000,000	Recently serviced, low OPEX
Afiesere	1850	450	80	1,400,000	14,500,000	Mid-sized, near processing hub

(c) Cash Flow Calculation

Based on the information gathered from the primary and secondary data sources, the parameters given in Table 3 are used for the cash flow calculations and NPV for each of the brownfields for 10 years to determine their profitability.

Annual production volumes using the hyperbolic decline model:

$$q_t = {q_i}\Big/{(1 + b * D_i * t)^{\frac{1}{b}}} \quad ------------------(3)$$

Annual production = $q_t \times 365$

Annual Revenue = Annual Production × Oil price ($/barrel)

Net Cash Flow at time, $t = 0$, NCF = - (CAPEX + OPEX)

Annual Net Cash Flow at time $t \geq 1$, NCF = Revenue−Annual OPEX (Operating Expenditure)

NPV is found using equation (4) at a discount rate of 10% over the 10 years

Where:

Operational Costs = Revenue × Operational Cost Ratio (%)

Microsoft Excel was used for all the calculations, and the results are as shown in the tables (4) – (13)

2.4 Technological Innovations

Utilizing advanced extraction technologies is essential for the successful revitalization of brownfields. Enhanced Oil Recovery (EOR), hydraulic fracturing, and horizontal drilling are among the techniques that can substantially increase production from mature fields. EOR methods, in particular, involve injecting substances such as water, gas, or chemicals into the reservoir to improve oil flow and recovery rates. Hydraulic fracturing, or "fracking," involves creating fractures in rock formations to release trapped oil and gas. At the same time, horizontal drilling allows for greater access to oil reserves by drilling horizontally through the rock layers.

2.5 Environmental Consideration

Addressing environmental contamination is paramount for the successful redevelopment of brownfields. Robust remediation plans must be implemented to ensure that sites are safe for further development and to minimize ecological impacts. Environmental remediation efforts are crucial for restoring the integrity of ecosystems and mitigating potential risks to human health.

3. RESULTS AND DISCUSSION

Figure 4 shows the peak production output distribution among the brownfields based on the historical production data in Table 2.

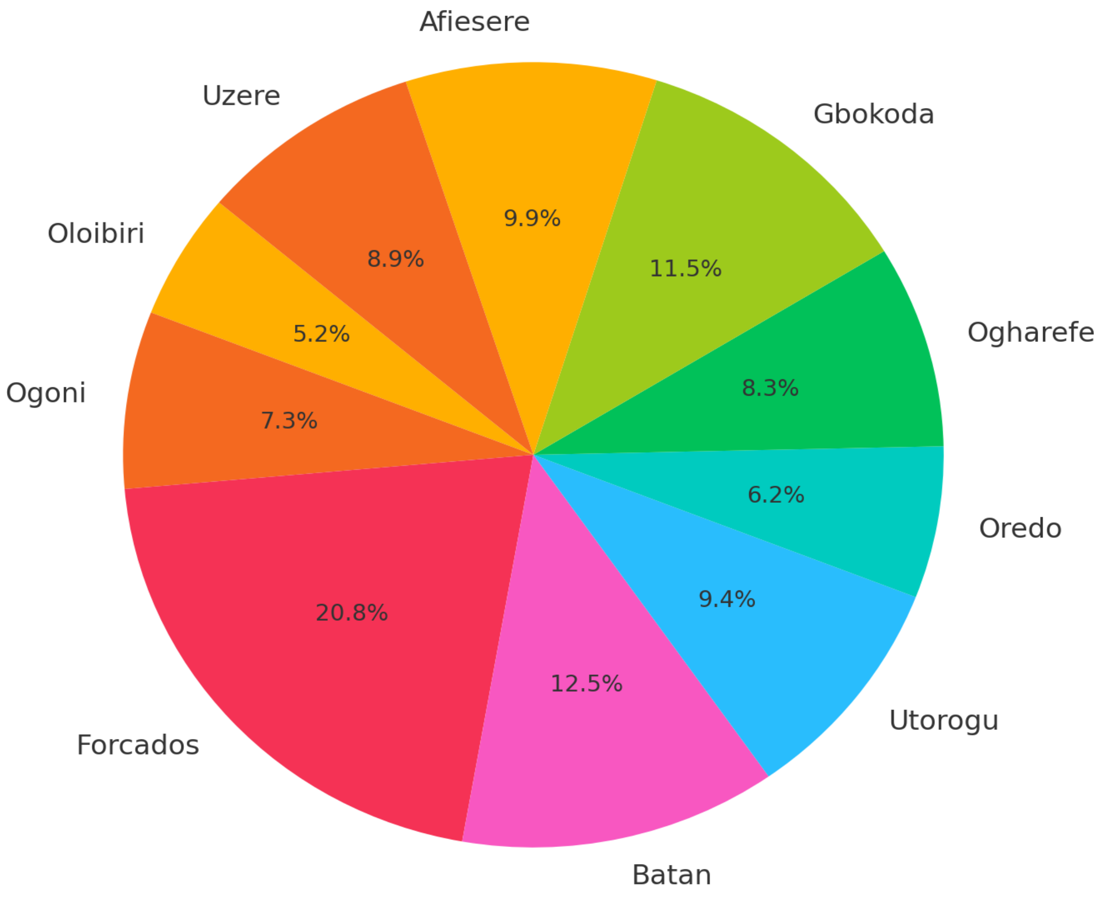

Figure 4: Peak Production Output Distribution Among Brownfields

The percentage decline in production among the brownfields is given as:

Percentage Decline = $\left[{(q_i - q_f)}/{q_i} \right] \times 100\% ------------ (9)$

q_i = Initial production rate (barrels per day)

q_f = Final production rate after a given time (barrels per day)

Result is expressed as a percentage (%)

Figure 5 represents the percentage decline in production of every brownfield listed in Table 2.

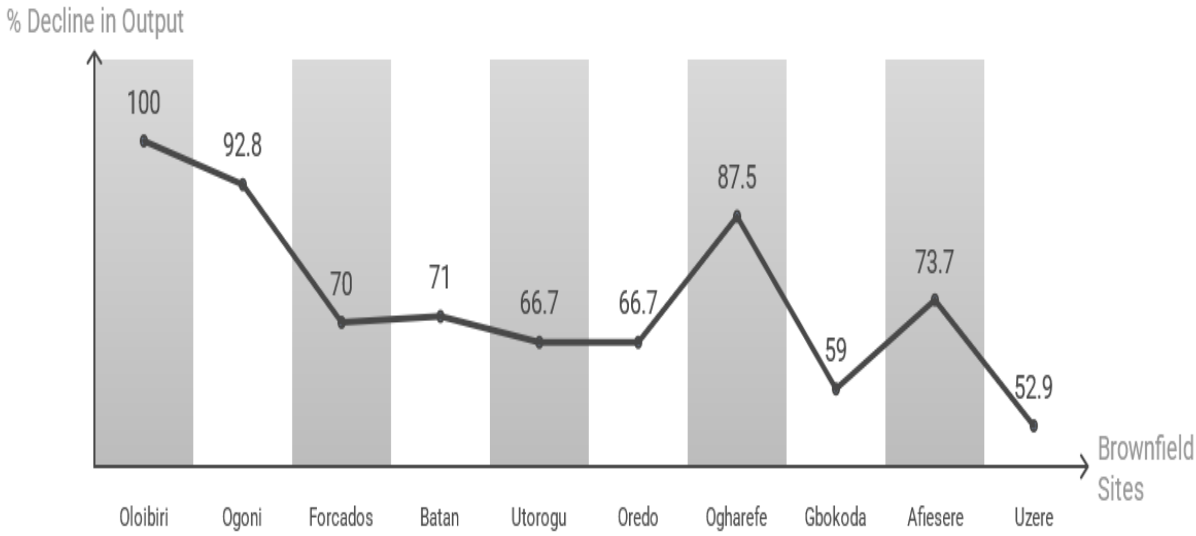

Figure 5: Percentage Decline in Production Among the Brownfields

3.1 Peak Production Output Distribution Among Brownfields

This chart in Figure 4 shows the historical capacity of each brownfield, identifying fields that once had high production. Fields such as Forcados, Batan, and Gbokoda had the highest peak production, indicating strong initial resource potential. Oloibiri and Ogoni had lower peak values, suggesting faster depletion or operational shutdowns.

3.1.1 Relevance to Revitalization

Prioritization: Fields with higher peak outputs may still have untapped reserves, making them prime targets for redevelopment.

Resource Allocation: Investment should focus on fields with significant past output, as they have the best chance for economic recovery.

Infrastructure Planning: Brownfields, which were major contributors, require upgraded facilities to restore production efficiency.

3.1.2 Percentage Decline in Production Among Brownfields

The chart in Figure 5 highlights the rate at which oil fields have declined. Oloibiri (100%) and Ogoni (92.8%) have experienced the highest decline, meaning they are either abandoned or severely underutilized. Forcados and Gbokoda, while still operational, have seen moderate declines (59%-70%), suggesting potential for recovery.

Relevance to Revitalization

EOR Application**:** Enhanced Oil Recovery (EOR) techniques (e.g., gas injection and hydraulic fracturing) can restore output in moderately declining fields.

Investment Justification: The most declining fields need a cost-benefit analysis before investing in complete redevelopment.

Policy & Regulation: Government incentives (e.g., tax waivers) should be provided for companies willing to rehabilitate heavily declined fields.

3.2 Cash Flow Analysis Among the Brownfields

Microsoft Excel analyzed cash flow among the brownfields, with input parameters obtained from Table 3. Tables 4 - 13 summarize the cash flow in each brownfield.

Table 4: Cash Flow Calculations on Ogoni Brownfield

Year	q(t) (bpd)	Annual Production (bbl)	Revenue (USD)	Net Cash Flow (USD)	Discount Factor (10%)	PV(USD)
0				-15,800,000	1.0000	-15,800,000
1	1791.1	653752.94	52300234.89	50500234.89	0.9091	45,909,763.54
2	1494.03	545321.37	43625709.56	41825709.56	0.8264	34,564,766.38
3	1270.32	463665.12	37093209.38	35293209.38	0.7513	26,515,787.92
4	1096.95	400387.83	32031026.2	30231026.2	0.6830	20,647,790.90
5	959.44	350194.4	28015552.2	26215552.2	0.6209	16,277,236.36
6	848.22	309598.66	24767892.6	22967892.6	0.5645	12,965,375.37
7	756.77	276222.14	22097771.21	20297771.21	0.5132	10,416,816.18

8	680.53	248392.77	19871421.99	18071421.99	0.4665	8,430,318.36
9	616.18	224904.62	17992369.27	16192369.27	0.4241	6,867,183.81
10	561.28	204868.47	16389477.61	14589477.61	0.3855	5,624,243.62

$$NPV = \sum_{1}^{n}[{}^{C_t}/_{(1+r)^t}] - C_o$$
$$= 188{,}219{,}282.44 - 15{,}800{,}000$$
$$= \$172{,}419{,}282.44$$

Table 5: Cash Flow Calculations on Oloibiri Brownfield

Year	q(t) (bpd)	Annual Production (bbl)	Revenue (USD)	Net Cash Flow (USD)	Discount Factor (10%)	PV(USD)
0				-16500000	1.0000	-16,500,000
1	1588.46	579787.39	46382991.14	44882991.14	0.9091	40,803,127.25
2	1302.68	475479.46	38038356.93	36538356.93	0.8264	30,195,298.17
3	1094.5	399492.65	31959412.32	30459412.32	0.7513	22,884,156.48
4	937.17	342066.16	27365292.99	25865292.99	0.6830	17,665,995.11
5	814.76	297386.36	23790908.67	22290908.67	0.6209	13,840,425.19
6	717.24	261794.31	20943544.72	19443544.72	0.5645	10,975,880.99
7	638.03	232882.64	18630611.55	17130611.55	0.5132	8,791,429.85
8	572.63	209008.5	16720679.81	15220679.81	0.4665	7,100,447.13
9	517.85	189015.86	15121268.6	13621268.6	0.4241	5,776,780.01
10	471.42	172069.83	13765586.29	12265586.29	0.3855	4,728,383.52

$$NPV = \sum_{1}^{n}[{}^{C_t}/_{(1+r)^t}] - C_o$$
$$= 162{,}761{,}923.70 - 16{,}500{,}000$$
$$= \$146{,}261{,}923.7$$

Table 6: Cash Flow Calculations on Uzere Brownfield

Year	q(t) (bpd)	Annual Production (bbl)	Revenue (USD)	Net Cash Flow (USD)	Discount Factor(10%)	PV(USD)
0				-14950000	1.0000	-14,950,000
1	1681.39	613707.71	49096616.93	47646616.93	0.9091	43,315,539.45
2	1386.17	505951.01	40476080.44	39026080.44	0.8264	32,251,152.88
3	1168.71	426577.5	34126200.26	32676200.26	0.7513	24,549,629.26
4	1003.01	366100.18	29288014.72	27838014.72	0.6830	19,013,364.05
5	873.31	318756.79	25500543.35	24050543.35	0.6209	14,932,982.37
6	769.49	280865.19	22469215.4	21019215.4	0.5645	11,865,347.09
7	684.86	249973.34	19997867.02	18547867.02	0.5132	9,518,765.35
8	614.77	224391.46	17951317.06	16501317.06	0.4665	7,697,864.41
9	555.95	202921	16233680.2	14783680.2	0.4241	6,269,758.77
10	506	184690.55	14775244.23	13325244.23	0.3855	5,136,881.65

$$NPV = \sum_{1}^{n}[{}^{C_t}/_{(1+r)^t}] - C_o$$
$$= 174{,}551{,}285.28 - 14{,}950{,}000$$
$$= \$159{,}601{,}285.28$$

Table 7: Cash Flow Calculations on Batan Brownfield

Year	q(t) (bpd)	Annual Production (bbl)	Revenue (USD)	Net Cash Flow (USD)	Discount Factor (10%)	PV(USD)
0	—	—	—	-15,450,000	1.0000	-15,450,000
1	1660.89	606223.66	48,497,892.52	47,017,892.52	0.9091	42,743,966.09
2	1457.64	532539.15	42,603,132.24	41,123,132.24	0.8264	33,984,156.48
3	1296.83	473332.64	37,866,611.24	36,386,611.24	0.7513	27,337,261.02
4	1168.74	426589.65	34,127,172.03	32,647,172.03	0.6830	22,298,018.50
5	1063.65	388234.76	31,058,780.77	29,578,780.77	0.6209	18,365,464.98
6	974.42	355648.22	28,451,857.44	26,971,857.44	0.5645	15,225,613.52
7	898.21	327854.81	26,228,384.56	24,748,384.56	0.5132	12,700,870.96
8	831.77	303596.74	24,287,739.14	22,807,739.14	0.4665	10,639,810.31
9	773.61	282352.54	22,588,203.27	21,108,203.27	0.4241	8,951,989.01
10	722.72	263792.37	21,103,389.57	19,623,389.57	0.3855	7,564,816.68

$$NPV = \sum_{1}^{n}[{}^{C_t}/_{(1+r)^t}] - C_o$$
$$= 199{,}811{,}967.52 - 15{,}450{,}000$$
$$= \$184{,}361{,}967.52$$

Table 8: Cash Flow Calculations on Afiesere Brownfield

Year	q(t) (bpd)	Annual Production (bbl)	Revenue (USD)	Net Cash Flow (USD)	Discount Factor (10%)	PV(USD)
0	—	—	—	-15,900,000	1.0000	-15,900,000
1	1572.30	573884.76	45,910,781.04	44,490,781.04	0.9091	40,446,569.04
2	1379.60	503554.47	40,284,357.54	38,864,357.54	0.8264	32,117,505.07
3	1232.00	449681.91	35,974,553.08	34,554,553.08	0.7513	25,960,835.72
4	1112.60	405099.04	32,407,923.37	30,987,923.37	0.6830	21,164,751.66
5	1013.52	369935.18	29,594,814.71	28,174,814.71	0.6209	17,493,742.45
6	929.02	339090.89	27,127,271.33	25,707,271.33	0.5645	14,511,754.67
7	855.06	312098.76	24,967,901.06	23,547,901.06	0.5132	12,084,782.82
8	789.53	288171.93	23,053,754.40	21,633,754.40	0.4665	10,092,146.43
9	730.98	266306.88	21,304,550.18	19,884,550.18	0.4241	8,433,037.73
10	678.36	247598.71	19,807,896.65	18,387,896.65	0.3855	7,088,534.16

$$NPV = \sum_{1}^{n}[{}^{C_t}/_{(1+r)^t}] - C_o$$
$$= 189{,}393{,}659.75 - 15{,}900{,}000$$
$$= \$173{,}493{,}659.75$$

Table 9: Cash Flow Calculations on Oredo Brownfield

Year	q(t) (bpd)	Annual Production (bbl)	Revenue (USD)	Net Cash Flow (USD)	Discount Factor (10%)	PV(USD)
0	—	—	—	-14,300,000	1.0000	-14,300,000
1	1712.60	625099.61	50,007,969.18	48,507,969.18	0.9091	44,098.594.78
2	1510.45	551315.09	44,105,207.52	42,605,207.52	0.8264	35,208,943.49
3	1346.09	491308.83	39,304,706.70	37,804,706.70	0.7513	28,402,676.14

Year	q(t) (bpd)	Annual Production (bbl)	Revenue (USD)	Net Cash Flow (USD)	Discount Factor (10%)	PV(USD)
4	1214.20	443182.82	35,454,625.80	33,954,625.80	0.6830	23,191,009.42
5	1106.48	403866.95	32,309,356.16	30,809,356.16	0.6209	19,129,529.24
6	1017.65	371443.80	29,715,504.01	28,215,504.01	0.5645	15,927,652.01
7	943.58	344398.34	27,551,867.19	26,051,867.19	0.5132	13,369,818.24
8	880.61	321431.87	25,714,549.59	24,214,549.59	0.4665	11,296,087.38
9	826.10	301526.47	24,122,117.81	22,622,117.81	0.4241	9,594,040.16
10	778.10	284038.30	22,723,064.08	21,223,064.08	0.3855	8,181,491.20

$$NPV = \sum_{1}^{n} [{}^{C_t}/_{(1+r)^t}] - C_o$$
$$= 208{,}399{,}842.06 - 14{,}300{,}000$$
$$= \$194{,}099{,}842.06$$

Table 10: Cash Flow Calculations on Ogharefe Brownfield

Year	q(t) (bpd)	Annual Production (bbl)	Revenue (USD)	Net Cash Flow (USD)	Discount Factor (10%)	PV(USD)
0	—	—	—	-15,200,000	1.0000	-15,200,000
1	1550.10	565286.26	45,222,900.61	43,802,900.61	0.9091	39,821,216.94
2	1346.62	491511.24	39,320,899.45	37,900,899.45	0.8264	31,321,303.31
3	1189.67	434223.32	34,737,865.36	33,317,865.36	0.7513	25,031,712.24
4	1068.76	390106.67	31,208,533.25	29,788,533.25	0.6830	20,345,568.21
5	971.22	354494.46	28,359,557.01	26,939,557.01	0.6209	16,726,770.95
6	890.58	325066.17	26,005,293.73	24,585,293.73	0.5645	13,878,398.31
7	821.67	299905.57	23,992,445.54	22,572,445.54	0.5132	11,584,179.05
8	761.56	277956.99	22,236,559.30	20,816,559.30	0.4665	9,710,924.91
9	708.08	258450.64	20,676,051.57	19,256,051.57	0.4241	8,166,491.47
10	660.49	240070.41	19,205,632.45	17,785,632.45	0.3855	6,856,361.31

$$NPV = \sum_{1}^{n} [{}^{C_t}/_{(1+r)^t}] - C_o$$
$$= 183{,}442{,}926.70 - 15{,}200{,}000$$
$$= \$168{,}242{,}926.70$$

Table 11: Cash Flow Calculations on Gbokoda Brownfield

Year	q(t) (bpd)	Annual Production (bbl)	Revenue (USD)	Net Cash Flow (USD)	Discount Factor (10%)	PV (USD)
0				-13850000	1.0000	-13,850,000.0
1	1537.72	561267.98	44901438.62	43501438.62	0.9091	39,547,157.85
2	1257.04	458818.66	36705493.08	35305493.08	0.8264	29,176,459.48
3	1055.19	385142.8	30811424.26	29411424.26	0.7513	22,096,803.05
4	903.94	329939.37	26395149.51	24995149.51	0.6830	17,071,687.12
5	786.95	287235.43	22978834.44	21578834.44	0.6209	13,398,298.30
6	694.1	253346.26	20267700.8	18867700.80	0.5645	10,650,817.10
7	618.86	225884.25	18070739.95	16670739.95	0.5132	8,555,423.74
8	556.82	203239.22	16259137.7	14859137.70	0.4665	6,931,787.74
9	504.9	184288.69	14743094.82	13343094.82	0.4241	5,658,806.51
10	460.9	168227.94	13458235.02	12058235.02	0.3855	4,648,449.60

$$NPV = \sum_{1}^{n} [{}^{C_t}/_{(1+r)^t}] - C_o$$
$$= 157{,}735{,}690.49 - 13{,}850{,}000$$
$$= \$143{,}885{,}690.49$$

Table 12: Cash Flow Calculations on Forcados Brownfield

Year	q(t) (bpd)	Annual Production (bbl)	Revenue (USD)	Net Cash Flow (USD)	Discount Factor (10%)	PV (USD)
0	0.00	0.00	0.00	-18,700,000.00	1.0000	-18,700,000.00
1	2400.00	876,000.00	70,956,000.00	69,256,000.00	0.9091	62,960,000.00
2	2102.10	767,266.50	62,148,586.50	60,448,586.50	0.8264	49,968,581.56
3	1871.35	682,038.84	55,246,145.96	53,546,145.96	0.7513	40,207,435.38
4	1691.54	617,405.56	50,008,850.36	48,308,850.36	0.6830	32,994,946.10
5	1546.28	564,388.57	45,717,476.29	44,017,476.29	0.6209	27,336,839.38
6	1424.37	519,891.12	42,111,181.00	40,411,181.00	0.5645	22,794,899.32
7	1320.63	482,032.95	39,044,671.00	37,344,671.00	0.5132	19,166,991.43
8	1229.77	448,859.05	36,358,584.89	34,658,584.89	0.4665	16,172,170.99
9	1148.61	419,235.48	33,958,072.19	32,258,072.19	0.4241	13,683,871.88
10	1074.72	392,261.80	31,773,201.62	30,073,201.62	0.3855	11,598,794.46

$$NPV = \sum_{1}^{n} [{}^{C_t}/_{(1+r)^t}] - C_o$$
$$= 296{,}884{,}530.50 - 18{,}700{,}000$$
$$= \$278{,}184{,}530.50$$

Table 13: Cash Flow Calculations on Utorogu Brownfield

Year	q(t) (bpd)	Annual Production (bbl)	Revenue (USD)	Net Cash Flow (USD)	Discount Factor (10%)	PV (USD)
0	0	0	0	-17,000,000	1	-17,000,000.0
1	1601.324753	584483.5349	46174199.25	44674199.25	0.909090909	40612908.41
2	1320.159179	481858.1004	38066789.93	36566789.93	0.826446281	30220487.55
3	1113.052846	406264.2888	32094878.81	30594878.81	0.751314801	22986385.28
4	955.2516217	348666.8419	27544680.51	26044680.51	0.683013455	17788867.23
5	831.7202657	303577.897	23982653.86	22482653.86	0.620921323	13959959.18
6	732.8511219	267490.6595	21131762.1	19631762.1	0.56447393	11081617.91
7	652.2461519	238069.8455	18807517.79	17307517.79	0.513158118	8881493.261
8	585.4963163	213706.1555	16882786.28	15382786.28	0.46650738	7176183.328
9	529.4742402	193258.0977	15267389.72	13767389.72	0.424097618	5838717.189
10	481.9062045	175895.7646	13895765.41	12395765.41	0.385543289	4779104.17

$$NPV = \sum_{1}^{n} [{}^{C_t}/_{(1+r)^t}] - C_o$$
$$= 163{,}325{,}723.51 - 17{,}000{,}000$$
$$= \$146{,}325{,}723.51$$

3.2 Key Findings

The analysis reveals that all assessed brownfields showed positive Net Present Values (NPVs), confirming their economic viability for redevelopment. With appropriate investment and management, these sites can significantly enhance Nigeria's oil production and energy security. Fields such as Forcados, Oredo, and Batan exhibit exceptionally high NPVs, signifying strong potential for return on investment. These should be prioritized for early intervention and redevelopment due to their favorable financial outlook and access to infrastructure. Additionally, brownfields like Ogoni and Oloibiri, despite being impacted by political sensitivities and infrastructural decline, still present promising economic prospects. With well-planned revitalization strategies, including environmental remediation, technological upgrades, and community engagement, these legacy sites can be transformed again into productive assets.

3.4 Broader Socioeconomic and Environmental Impacts

The paper emphasizes several key points beyond economics:

• Economic benefits: Job creation and increased government tax revenue.

• Social benefits: Enhanced quality of life, health, safety, and infrastructure.

• Environmental benefits: Remediation of polluted sites, reduced urban sprawl, and improved air quality.

This aligns closely with the Sustainable Development Goals (SDGs), particularly those focusing on clean energy, economic growth, and environmental restoration.

4. CONCLUSION

Revitalizing Nigeria’s brownfields presents a strategic opportunity to boost oil production, reduce dependency on imported refined products, and enhance national energy security. The study demonstrates that all analyzed brownfields exhibit positive Net Present Values (NPVs), underscoring their economic viability for redevelopment. Fields such as Forcados, Oredo, and Batan stand out as high-priority candidates due to their substantial return on investment. Even politically and environmentally sensitive sites like Ogoni and Oloibiri show potential when supported by targeted revitalization strategies. Nigeria can transform these dormant assets into productive resources by leveraging enhanced oil recovery technologies, improving infrastructure, and implementing supportive regulatory frameworks. A well-executed brownfield redevelopment program will also deliver broader socio-economic and environmental benefits, fostering inclusive growth and sustainable development.

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