RESEARCH ARTICLE OPEN ACCESS

Comparison of Mud and Chikoko Potential for Mangrove Regeneration in Bodo Creek, Niger Delta, Nigeria

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Abstract:

Bodo creek is a mangrove dominated area. Observed mangrove speciesinclude red mangrove, black mangrove,and white mangrove. The area, however, was exposed to heavy crude oil impact following two operational spill incidents from Trans Niger Pipeline operated bySPDC in 2008 and subsequent several spill incidents due to sabotage, most of the mangrove died as they could not survive the heavy impact of the spilled crude.Cleanup activities at Bodo creek beganin September 2017 and over two-million litres of crude oil have been recovered resulting in significant reduction ofsediment oiling especially in the top 30cm.Re-vegetation of the former mangrove areas forms part of the objectives of the ongoing cleanup and thousands of mangrove seedlings have so far been planted. However, owing to significant reduction in sediment oiling, regeneration of mangrove has been observed.Bodo creek is dominated by chikoko and mud sediment. This study assessed the potential of mud sediment and chikoko for mangrove regeneration to see if the discovery at Abel-Kiri applies to other mangrove areas in the Niger Delta such as Bodo Creek. The study concluded, based on its findings, that chikoko dominated area has higher potential for mangrove regeneration than mud dominated area.

Keywords **—Bodo creek, Bodo project, Mangrove regeneration, Chikoko, Niger Delta.**

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1.INTRODUCTION

Nigeria has extensive mangrove forests in the coastal region of the Niger Delta and is considered to be one of the most ecologically sensitive regions in the world situated within a deltaic depositional environment. The Niger Delta mangrove forest has approximately 80% of its vegetation distributed in three states namely Bayelsa, Delta, and River states [1].

Bodo creek is an intertidal mangrove dominated area situated in Rivers State. Observed mangrove species present in Bodo creek include red mangrove, black mangrove, and white mangrove but red mangrove is dominant. However, the mangrove area was exposed to heavy crude oil impact following two operational spill incidents from Trans Niger Pipeline operated by Shell Development Petroleum Company of Nigeria (SPDC) in 2008 and subsequent several spill incidents in the area due to sabotage, most of the mangrove died as they could not survive the heavy impact of the spilled crude. On March, 2012, Bodo community members filed a law suit against SPDC seeking for compensation for the two operational spills and requesting for remediation of the impacted area. In January 2015, SPDC accepted the responsibility to clean up impacted area in Bodo. Bodo Mediation Initiative was then established and sponsored by the Dutch government to oversee the cleanup activities. This brought a

hold on the ongoing litigation but the Bodo community reserved the right to resume the claim if the cleanup activity is not properly conducted [2].

The cleanup activities in Bodo creek began in September 2017 [3] with BMI as the project directorate and supported by SPDC. Following the cleanup, over two million litres of crude oil in form of liquid waste have been recovered and sediment oiling has significantly reduced especially in the top 30cm. Re-vegetation of the former mangrove areas forms part of the objectives of the ongoing cleanup and thousands of mangrove seedlings have so far been planted. However, owing to significant reduction in sediment oiling, regeneration of mangrove has been observed in many locations within the creek.

A study on natural regeneration of some mangrove species in a Melaleuca Leucodendron plantation at Abel-Kiri, Niger Delta, Nigeria [4] noted that mud having more nutrients and salinity is better for mangrove regeneration than chikoko soil. This study assessed the potential of mud sediment and chikoko for mangrove regeneration to see if the discovery at Abel-Kiri applies to other mangrove areas in the Niger Delta such as Bodo Creek, the study area. Bodo creek is dominated by chikoko and mud sediment, chikoko dominate the former mangrove areas while mud dominate the preserved mangrove areas. This paper, therefore, reports comparison of natural mangrove regeneration on mud sediment and chikoko within Bodo Creek.

1.1 Location and description of study area

Bodo creek is situated in Gokana Local Government area of Rivers state along the eastern part of the Niger Delta (fig. 1). It is an intertidal environment with little wave action and non-existence of strong tidal currents. The topography is flat to gentle slope and it harbours red mangrove, black mangrove, and white mangrovebut red mangrove specifically the tall red mangrove is dominant having expansive geographic coverage of about 90 percent of the mangrove biota. More of the red mangrove are found closest to river or channel edge while black mangrove and white mangroveare found within the platform area that receives shallow flooding during high tide. The red mangrove has prop roots, the white mangrove has no outstanding root structure while black mangrove has root projections called pneumatophores (fig. 1).

Crude oil spill incidents that happened twice in 2008 alongside subsequent spills due mainly to sabotage and transport of stolen crude oil killed most of the mangrove rendering affected areas completely deforested most of which mangrove seedlings have been planted as part of the ongoing clean up and revegetation project in the study area. Nypa palm (Nypafruticans) are also present in the study area, however, because they are not indigenous species and have overtime possessed a competitive advantage over the mangroves spreading rapidly within the creek and competing with the native mangrove for available nutrients and living space, their removal is part of the ongoing clean up and re-vegetation activities in the area. Sediment type in the study area include mud, sand, clay, and silt. The sediment may be found mixed with chikoko. There are also areas that the sediment is completely overlain by chikoko up to 0.3m depth and beyond.

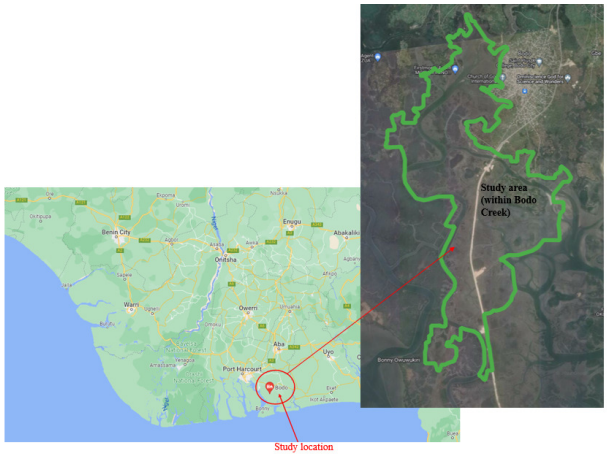

Fig. 1 Map of the Study area

Fig. 2 Red mangrove within Bodo creek

Fig. 3 Black mangrove within Bodo creek

Fig. 4 White mangrove within Bodo creek

2. MATERIALS AND METHODS

The study area covers an area of about 1000ha and as such was divided into 4 sections (fig. 5 - 9) to ensure that comparison is made between sediments that are subjected to same site conditions such as tendency of re-oiling by tidal influence. Other site conditions of concern that informed the decision to subdivide the study area into different sections include: salinity, soil anoxia, nutrient levels, pH, wave energy, temperature, impact levels, tides and wind distribution of propagules and seeds [5]. Observations were made in 80, 74, 57, and 57 different locations in sections 1, 2, 3, and 4 respectively. Observations made in each location included taking note of the sediment and checking for the presence or absence of mangrove regeneration. Observations were then analyzed with statistical elements for further discussions.

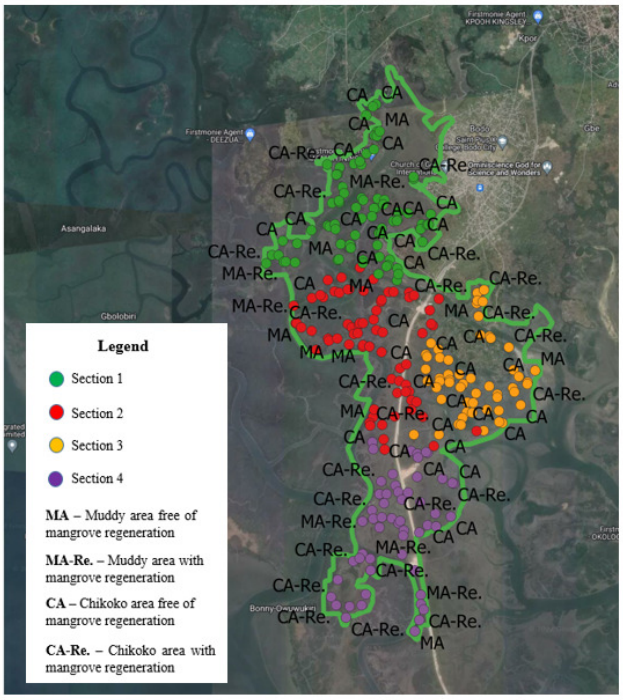

Fig. 5 Map of the Study area showing observations in the various sections

Fig. 6 Closer view of section 1

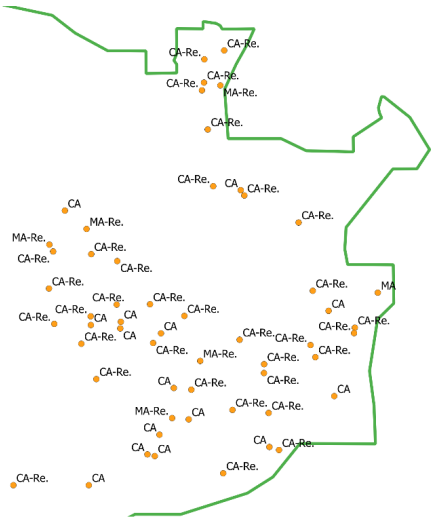

Fig. 8Closer view of section 3

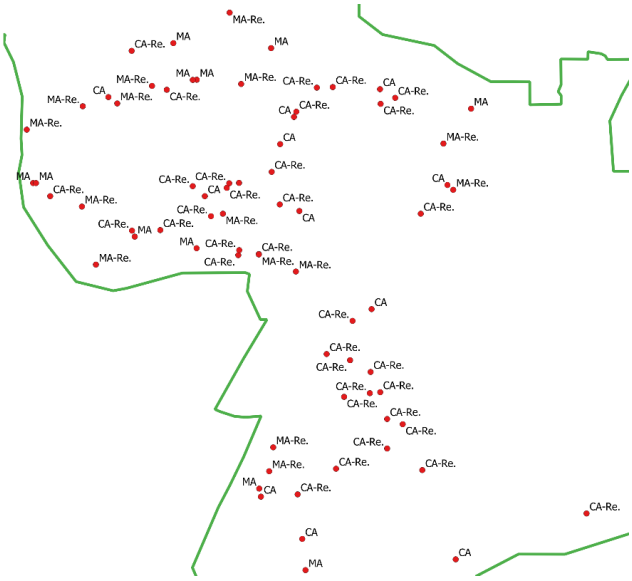

Fig. 7 Closer view of section 2

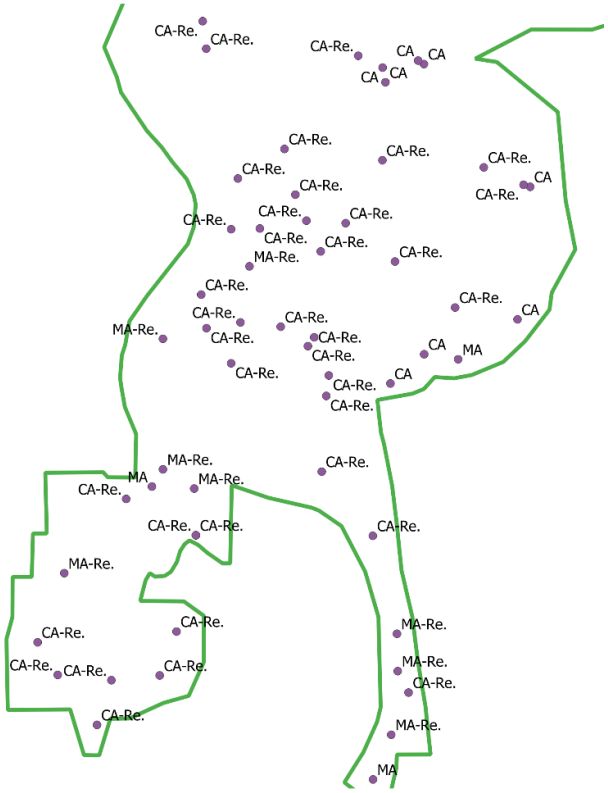

Fig. 9 Closer view of section 4

3. RESULTS AND DISCUSSION

Within the muddy area, observed sediment types are mud and chikoko mud while chikoko, muddy chikoko, and sandy chikoko were observed within the chikoko area. Observations were made in 264 different locations. Regeneration was observed in 176 locations; 43 of these locations consisted of mud and chikoko mud while the remaining 133 consisted of chikoko, muddy chikoko, and sandy chikoko beyond 30cm depth.

Section 1

Out of 79 assessed locations in section 1, regeneration was observed in 40 locations, 12 within mud sediment while the remaining 28 observed mangrove regeneration is within chikoko sediment (table 1, fig.10).

Section 2

Out of 73 assessed locations in section 2, regeneration was observed in 51 locations, 15 within mud sediment while the remaining 36 observed mangrove regeneration is within chikoko sediment (table 1, fig. 11).

Section 3

Out of 55 assessed locations in section 3, regeneration was observed in 39 locations, 6 within mud sediment while the remaining 33 observed mangrove regeneration is within chikoko sediment (table 1, fig. 12).

Section 4

Out of 57 assessed locations in section 4, regeneration was observed in 46 locations, 10 within mud sediment while the remaining 36 observed mangrove regeneration is within chikoko sediment (table 1, fig. 13).

TABLE 1
NUMBER OF LOCATIONS IN EACH SECTION WHERE MANGROVE REGENERATION WAS OBSERVED

Sediment	Sec. 1	Sec. 2	Sec. 3	Sec. 4
Mud and chikoko mud	12	15	6	10
Chikoko, muddy chikoko, and sandy chikoko	28	36	33	36
	40	**51**	**39**	**46**

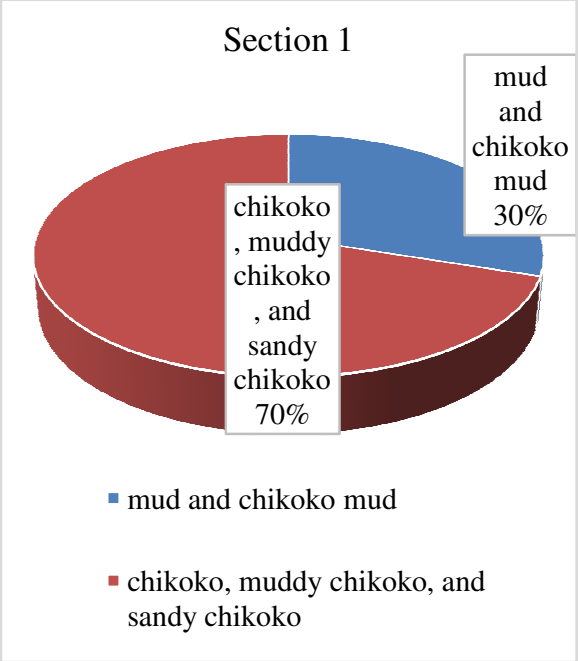

Fig. 10: Percentage coverage of muddy and chikoko area where mangrove regeneration was observed in section 1

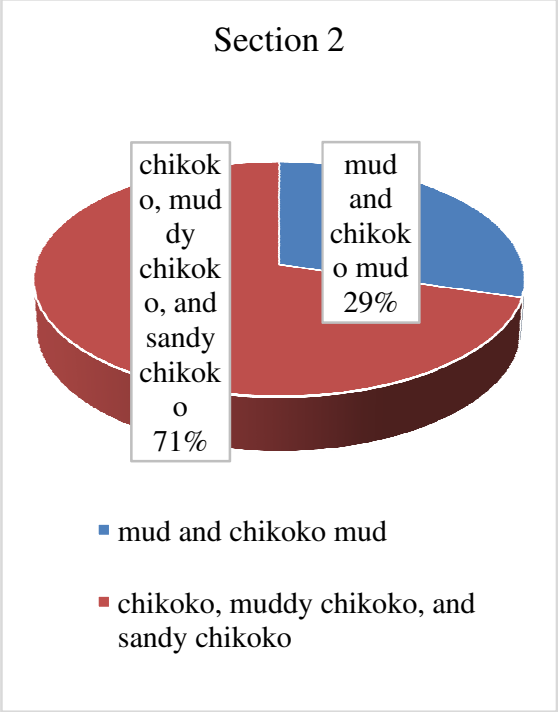

Fig.11: Percentage coverage of muddy and chikoko area where mangrove regeneration was observed in section 2

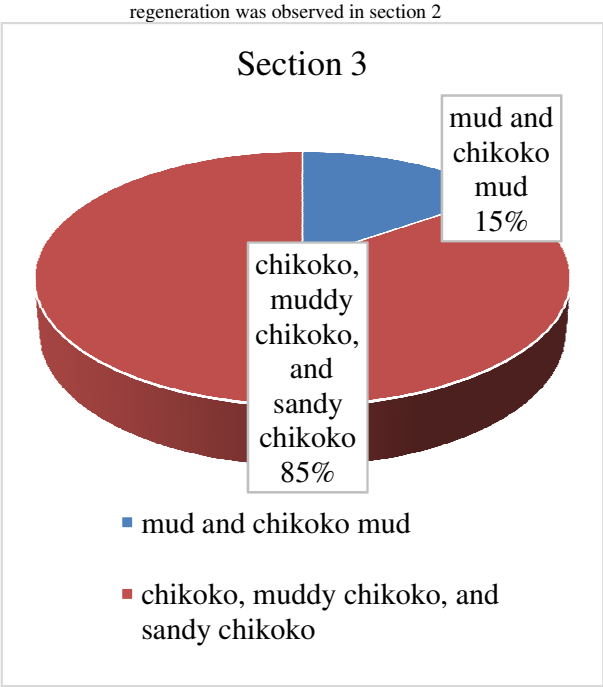

Fig.12: Percentage coverage of muddy and chikoko area where mangrove regeneration was observed in section 3

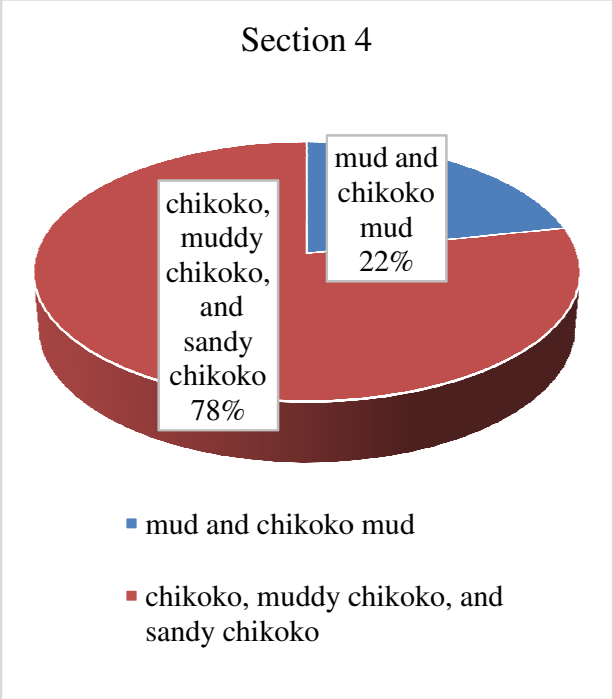

Fig.13: Percentage coverage of muddy and chikoko area where mangrove regeneration was observed in section 4

Fig.10 to 13 indicates that percentage coverage of mangrove regeneration observed across the 4 sections of the study area ranged from 15% to 30% within the muddy area while mangrove regeneration observed within the chikoko area ranged from 70% to 85% indicating that chikoko showed more potential for mangrove regeneration than mud.

4. CONCLUSION

The study assessed the potential of mud andchikoko for mangrove regeneration in Bodo creek and concluded, based on its findings, that chikoko dominated area has higher potential for mangrove regeneration than muddy dominated area. While enumerating causes of failure of mangrove regeneration, (Holguin et al., 2001) [6] stated that compacted mudflats often have permanently saturated soil with poor drainage, leading to anoxic and potentially acidic soil. These characteristics may render the site less suitable for mangrove regeneration. Holguin's

hypothesis was therefore supported by findings at Bodo creek where regeneration was observed less in mud dominated areas. This also implies that the study at Abel-Kiri on natural regeneration of some mangrove species in a Melaleuca Leucodendron plantation that suggested that mud is better for mangrove regeneration than chikoko soil is possibly limited only to the study area or could have been due to the influence of other factors such as crude oil impact levels in the sediment. Okeke et al 2000 [4] described the Abel-Kiri study area to be in Abonema community within the Sombreiro River in Akuku Toro Local Government Area (LGA) of Rivers State Nigeria. Coincidentally, the lower section area of the same river has been studied by Iheonye et al 2019 [7] for petroleum contamination via chemical fingerprinting of aliphatic hydrocarbons and the study showed that gas Chromatography analysis of obtained water samples from the lower section of the river indicated presence of aliphatic hydrocarbon within C9 to C40 range. Though the study focused on identification of spill impact in the lower section of Sombreiro river, the area harbours abundant oil and gas reserves [7], and the Niger Delta region as a whole has about 600 oil fields and over 3000km of crude oil pipelines crisscrossing the area [8]. Spill incident data published by Shell Petroleum Development Company (SPDC) shows that virtually all spill incidents in the Niger Delta occur on land [9]. This suggests that impact in the water ways such as Sombreiro river is via spilled crude oil migration from land mainly by surface runoff aided by gentle slope topography that usually exist along water or channel edges. Though direct impact on the water ways is possible if the water way is used as transport medium for crude stolen from the transmission pipelines. From the map of Sombreiro river (fig. 14), Abonema where mud was observed to have higher mangrove regeneration potential than chikoko soil according to Okeke et al 2000 [4] is within the lower section of Sombreiro river where spill impact has been observed [7]. This implies that it is possible that the reverse observation in Abonema could be due to high impact levels in the chikoko sediment compared to mud sediment. Assessment of the mean TPH levels in chikoko and mud sediment for surface and subsurface samples in all assessed locations of the study area in Bodo creek showed that chikoko had lower values that ranged from 187.7 mg/kg to 607.9 mg/kg for subsurface samples and 623.8 mg/kg to 1652.5 mg/kg for the surface samples while mud sediment TPH levels were higher with a range of 619 mg/kg to 1823.6 mg/kg for subsurface samples and 1450.3 mg/kg to 2022 mg/kg for the surface samples across the 4 sections.

While this study shows that chikoko has higher potential than mud sediment, the study at Abel-Kiri seems to suggest that the reverse could be the case and correlation with another study within the area points to higher impact level as possible cause of the reversal. However, a critical look at chikoko areas (unmixed with any other sediment) within the 4 sections of the study area in Bodo creek where regeneration was not observed suggests that high impact level may not be the case as there were locations where the TPH levels in the subsurface samples were relatively low yet there was no regeneration. In section 1, 6 different locations where regeneration was not observed had low subsurface TPH of 28.41 mg/kg, 67.38 mg/kg, 108 mg/kg, 458 mg/kg, 508 mg/kg, and 691 mg/kg respectively. In section 2, 4 locations where there was no regeneration had low values of 79.97 mg/kg, 86.92 mg/kg, 116 mg/kg, and 238 mg/kg subsurface TPH respectively; though high value of 1014 mg/kg was observed in 1 location. In section 3, all the 7 locations where regeneration was not observed had low subsurface TPH of 9.54 mg/kg, 81.21 mg/kg, 105 mg/kg, 133 mg/kg, 142 mg/kg, 150 mg/kg, and 159 mg/kg respectively. In section 4, all 6 locations where regeneration was not observed had low subsurface TPH values of 15.8 mg/kg, 32.82 mg/kg, 33.19 mg/kg, 49.6 mg/kg, 53.37 mg/kg, and 97.65 mg/kg respectively. This suggests that there are other factors other than

high impact level that could have limited the higher potential of chikoko compared to mud sediment for mangrove regeneration in Abel-kiri. In general, however, this study supported by Holguin's postulation reveals that chikoko supports mangrove regeneration than mud sediment.

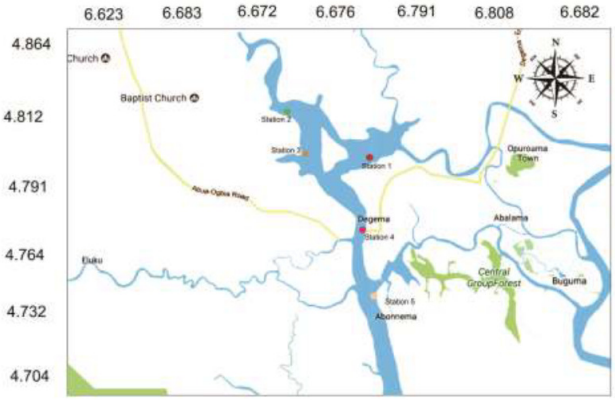

Figure 14: Map of Sombreiro river (after Olopade, O.A. et al, 2019) [12]

ACKNOWLEDGMENT

I acknowledge Shell Petroleum Development Company of Nigeria Limited (SPDC) for granting me approval to use Bodo project chemical sampling and analysis data.

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