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Community responses of intertidal soft-bottom macrozoobenthos to oil pollution in a tropical mangrove ecosystem, Niger Delta, Nigeria

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ABSTRACT

Preliminary impact assessment of two large oil spill incidents at Bodo Creek, in the Niger Delta, was undertaken, focusing on intertidal macrozoobenthos. Post-spill number of species and abundance were measured against recent pre-spill baseline data from the same study area. Results show that surface and infauna communities suffered severe reduction in abundance and number of species reduced by 81% after the spills, with two of the resampled sites having no taxa at all. *Capitella capitata* populations increased several-fold over pre-spill numbers. The impact of the oil spills is discussed in relation to local livelihoods and ecosystem integrity. The Niger Delta endemic lucinid, *Keletistes rhizoecus*, is proposed as a potential bioindicator for monitoring hydrocarbon contamination in Niger Delta estuaries.

1. Introduction

Oil pollution occurs in the Niger Delta almost on a daily basis (Odiete, 1999), making the delta one of the most severely oil spill impacted regions in the world (UNDP, 2006; Olsson, 2012; Zabbey, 2009). Despite the suspension of crude oil production in Ogoniland since 1993, presence of active Trans-Niger Pipelines (TNPs) traversing Ogoniland to Bonny oil terminal continues to make the area vulnerable to oil spills (CEHRD, 2008). A recent publication by the UN Environment Programme (UNEP, 2011) on the Environmental Assessment of Ogoniland reveals high-level hydrocarbon contamination of surface and groundwater, soil and sediments.

Two major operational spills occurred at Bodo Creek in 2008–2009, having severe livelihood consequences (Al and CEHRD, 2011; Vidal, 2012; Pegg and Zabbey, 2013). Accufacts, Inc., an independent American company estimates that, during the first spill alone, between 103,000–311,000 bbls of crude oil spilled (Vidal, 2012). Zoobenthos are the most preferred indicator fauna used in the evaluation of environmental quality of aquatic ecosystems (Moreno and Calisto, 2006), owing to their longevity, abundance, diversity, large sizes and relative immobility (Jones, 1987; Odiete, 1999; Jordan and Smith, 2005) and they occupy variable microhabitats (Zabbey and Hart, 2006). The limited dispersal of most zoobenthos after settlement suggests that they will be consistently exposed to disturbed ecological conditions (Sikoki and Zabbey, 2006). Effects of oil spills differ between ecosystems and amongst the component biotopes and biota of the same ecosystem (Zenetos et al., 2004). A body of scientific knowledge exist on the short, medium and long term impact of oil pollution on macrobenthos (Guven et al., 1998; Duavin, 2000; Peterson, 2000; Gomez Gesteira and Dauvin, 2000). These range from episodic defaunation of sensitive species, succeeded by proliferation of opportunistic tolerant polychaetes to significant changes in community structure following recovery (Sanders, 1980; Gomez Gesteira and Dauvin, 2000; Gesteira and Dauvin, 2005). Presence of hydrocarbon above 50 ppm in sediment is capable of changing the structure of benthic communities (Kingston, 1992).

The *Aegean* Sea oil spill impacted on macrozoobenthos species richness, structure and abundance at Ares-Betanzos Ria (Gomez Gesteira and Dauvin, 2005). They found that the affected community went through 3 distinct time-dependent phases of high mortality, low abundance and gradual recovery. Joydas et al. (2012) reported incomplete recovery of macrobenthos 15 years post the Arabian Gulf oil spill. About 67% decrease in macrobenthos taxa richness occurred along the Galician coast following *Prestige* tanker oil spill (de la Huz et al., 2005).

Snowden and Ekweozor (1990) noted that the lack of pre-disturbed baseline data affects the quality and validity of conclusions reached in post-impact assessment studies. This paper presents an investigation of the biological impact of the 2008–2009 Bodo oil spills, focusing on macrozoobenthos. In addition to the general characteristics of macrozoobenthos that qualify them

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as highly preferred indicators and biomonitoring taxa (see above), the choice of macrozoobenthos in this study was further justified by the availability of pre-spill data-sets on the composition, density, relative abundance and spatio-temporal variations of macrofauna communities on mangroves, surface fauna and infauna in the intertidal flats of Bodo Creek (Zabbey et al., 2010; Zabbey, 2011; Zabbey and Malaquais, 2013).

1.1. Study area

Bodo Creek is a network of creeks flanking the Bodo community and linking the Andoni and Bonny River estuaries. The creek complex and hydrology have been described (Onwugbuta-Enyi et al., 2008; Zabbey et al., 2010) (Fig. 1). The region is a shallow, tidally influenced mangrove ecosystem that, before the spills, supported important fisheries for local residents.

1.2. Sampling stations

Five intertidal sampling stations at Bodo Creek that were extensively surveyed monthly for 2 years (May 2006–April 2008, Zabbey, 2011) prior to the two massive spills were re-evaluated in July 2011.

Station 1: The most upstream station was established in the Sivibilagbara swamp (approximately 4°36′29.7″N, 7°15′30.2″E). Hitherto a protected mangrove swamp, characterised by a dense homogenous red mangrove community (Zabbey et al., 2010), the swamp lush vegetation was clear-fell following defoliation and mangrove death as a result of the oil spills.
Station 2: Located approximately 1.28 km downstream from station 1 on an open, unvegetated tidal flat locally called 'Si Eeva'. Facing downstream, the station lay to the left of

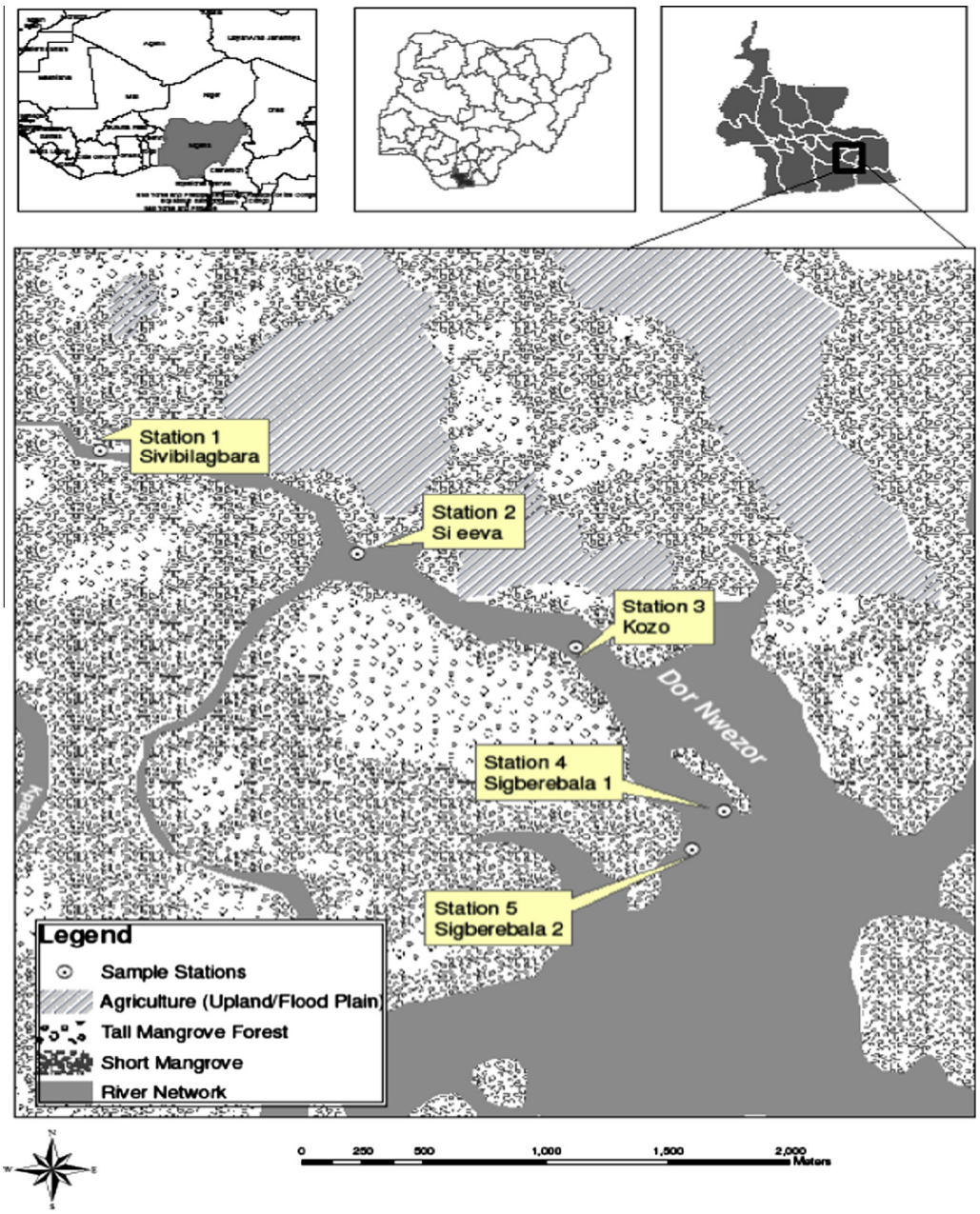

Fig. 1. Map of Bodo Creek showing sampled stations at Dor Nwezor channel.