Noise Emission Levels from Dredging Activities and Equipment at a Dredging Site in Rivers State of Nigeria

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Measurement of the emitted noise level from dredging activities and its associated equipment at a dredging site in Umuechi, a coastal Community in Rivers State of Nigeria was undertaken. The measurements were carried out with a Smart Sensor Sound Level Metre. The position of the Community as measured with a Global Positioning System (GPS) shows that it is located at 4^0 55' 12.5''N and between 006^0 53'43.8''E and 006^0 53'29''E. The measurements of the Sound Levels were taken at radial distances of 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 metres away from the sources and the average Sound Power Level at each of the radial distances recorded. The results obtained indicates that the measured sound level at 10 metres from the dredging site was 138.8dB and reduces to 91.6 dB at a radial distance of 50 metres from the site, and further to 43.5 dB, which is the same as the ambient environmental noise level, at 100 metres radial distance from the source. These values of the measured noise levels were seen to be above the standards stipulated in the National Environmental (Noise Standards and Control) Regulations by NESREA. A number of recommendations which range from substitution of the noisy equipment with less noisy ones, proper engineering control of the equipment and/or operation to reduce their noise emission, adequate management of the dredging site/operation to control personnel movement to proper use of adequate Personal Protective Equipment (PPE) were made to protect personnel and the environment.

Key Words: Noise, Emission, Dredging, Operation, Equipment, Environment, NESREA.

1.0 INTRODUCTION

Dredging is a potential environmentally-impacting anthropogenic endeavor undertaken in the marine environment for the purposes of creating new project, deepening of waterways or for the purpose of maintaining existing facilities and sustenance of the hydrologic characteristics of the environmental setting. Dredging activities are usually undertaken in different forms. Maintenance dredging tends to be undertaken at regular intervals in existing navigational routes in response to the continuous deposition of sediments from littoral surfaces. This is usually the situation around majority of the Ports all over the world where new dredging operations are required to be undertaken to enlarge or deepen the access channels, provide turning basins and maintain appropriate water depths along aquatic highways. Dredging is also an important means of producing offshore aggregates in the forms of sands and gravels for reclamation purposes to accommodate the effects of pressures which may arise from population increase and as a very important part of infrastructural developments. On much smaller scales, dredging may be undertaken for the purposes of constructing flood control structures (dams or dykes), creating or maintaining storage capacities of water supply reservoirs, facilitating placement of pipelines and many others [6].

There are also some direct environmental benefits derivable from dredging through the use of dredged materials to create or replace eroded habitats mostly noticeable in the case of reclamation of eroded beaches thereby helping to reduce the likelihood of further erosion or flooding. Dredging is also used in remediation schemes. For this purpose, the dredging operation is designed such

that contaminated sediments are taken away in order to improve water quality and restore the health of the marine habitat, especially in industrialized areas.

The dredging process is carried out with the help of some widely varying specialized water-based and land-based equipment that comes in many sizes and types, and is classified according to their methods of excavation and operation as mechanical dredgers, hydraulic dredgers and special low-impact dredgers [2]. While the mechanical dredgers: bucket-ladder, backhoes and grab dredgers are particularly suitable for removing hard-packed materials or debris and for working in confined locations with the dredged sediments transported by barges, the hydraulic dredgers comprising of the stationary suction, cutter-suction and the trailing suction hopper dredgers make use of hydraulic centrifugal pumps as a means of providing the desired suction and lifting forces that removes the materials in a liquid slurry form. The hydraulic dredgers are basically used for loose silts, sands, gravels and soft clays. The cutter-suction dredgers has attached cutting devices that help to increase the dislodging force thereby making them suitable for use in highly compacted clays, sands and rocks; while the dredged materials are transported through the use of associated pipelines and hoppers after the addition of large quantities of process water to the sediments to change their original structure. The dislodging and transportation process has some environmental consequences [2],[4],[6]. The special low-impact dredgers emerged because of the need to increase precision and reduce excessive excavation. These types of dredgers are basically used for dredging off contaminated sediments in environmentally-friendly manners.

Despite the vital roles played by dredging in the socio-economic and infrastructural development as well as enhancement of the environmental health of coastal settings of many industrialized areas of the world, there still exist lots of concerns over the detrimental environmental impacts of dredging, which may be direct, indirect, short- or long-term in nature. These negative environmental effects traceable to dredging are those that affects water quality through increase in the concentrations of suspended solids, leaching of contaminants from disposal sites and release of contaminants during dredging or disposal; disposal of the benthic community (benthos); increase noise emission with its attendant impact on the aquatic and residential communities, unfavourable change of topography and changes in the aquatic physical processes- wave, current, drainage and consequent erosion or deposition of waste materials, among others.

2.0 SOUND AND AQUATIC LIFE

Underwater sound can be naturally occurring in the aquatic environment through vocalizations from marine animals, naval traffic, wind, rain, wave action, underwater volcanic eruptions and seismic operations as well as through the anthropogenic sources which result from constructions of marine infrastructures, extraction of marine aggregates (dredging), military operations, geophysical explorations activities and other industrial operations such as drilling, all of which constitute serious sources of underwater sound.

Incidentally, these underwater sounds when within the levels produced by natural activities are important in the lives of the marine species as it serve as means of communication among and between aquatic species or organisms. The preying aquatic organisms also use sound for navigational purposes and a means of

finding their preys. It has also been reported that naturally occurring sounds are used by fishes and the marine mammals for orientation purposes, [13].

However, sound can affect marine organisms in variety of ways ranging from minor to strong behavioural reactions in the forms of startling response to sound or complete avoidance of the area due to the prevalence higher levels of sound. Short and impulsive sounds like those from striking of pile drivers, seismic airguns etc. are capable of causing behavioural changes in fishes and whales, dolphins and porpoises up to distances of several tens of kilometers from these sound sources [1],[5],[9],[10]. Higher than natural sound levels are also capable of masking biologically beneficial signals such as those used for communication among fishes and other aquatic mammals. Higher level Sounds can also cause temporary or permanent hearing problems in certain aquatic species while extremes of these sound levels may result in severe injuries or death, especially when the aquatic organism is too close to the sound source without any opportunity of moving away. It was also reported that sound in conjunction with other stress factors like population density can lead to conditions that may cause low productivity thereby posing strong obstacles to the survival of the affected species [2],[3].

2.1 NOISE- EMISSION POTENTIALS OF DIFFERENT ELEMENTS OF DREDGING OPERATIONS

A combination of factors such as the type of physical environment, nature, quantity and level of contamination of the material to be dredged, placement method as well as the distance to the placement site affects the selection of dredging equipment for operation. All of these factors come to play in the

selection of the type and amount of materials to be used in the dredging operation. As stated in [2], the dredging process consists of a number of noise-emitting activities which were grouped under sediment excavation, sediment transport and placement of sediment (dredged materials) at the disposal site. All these activities will involve a number of noise-emitting equipment set-ups, including tug boats, work boat, support crew boats, light towers, electric power generators and high solid pumps as well as dump trucks used to convey the sediments from the dredged site to locations where they are needed for use. The work and tug boats provide the means of maneuvering the barges, some of which are used to convey heavy equipment, and have tremendous noise-emission capabilities while the light tower presents itself as the least noise-emitting equipment involved in the dredging operation as it only serves as a means of positioning light around the dredging site during dark periods and in dark environments. The electric power generators and the dump trucks are some of the serious noise sources around the dredging site just like the dredgers.

It can be observed from the foregoing that the different methods used for dredging requires particular forms of vessels and equipment as well as methods that will be suitable for the operation while considering such factors as the scale of the operation, the nature and type of the material to be dredged, the type of the seabed, the purpose and scale of the dredging operation as well as some environmental factors among which is the noise impact of that operation. Perhaps some description of the sediment extraction mechanisms of each type of dredger may yield better understanding of the noise-emission potentials of dredging operations.

The bucket ladder dredgers are typically moored dredgers, as they are usually not self-propelled rather they use a set of buckets on a circulating chain. The scraping of the sea floor is done by the buckets which also serve as the means of removing and carrying the scraped materials to the surface where they are discharged into a barge.

The Cutter Suction Dredgers (CSDs) are also usually towed to sites where they are moored in place with the aid of spudpoles to provide stability for the platform for effective removal of the desired materials. Subsequently, the cutter head which moves in arc-like manner is lowered to provide the dislodging mechanism while suction is used to bring the materials to the surface.

The grab dredgers use grabbing devices that are usually winched to and from the sea bed with the aid of a crane. The grabbing mechanism is lowered to the seabed with the grabber closed and then raised to the surface where the material is deposited into a hopper.

For each of the dredging methods outlined above, a variety of factors will determine the nature and character of the emitted noise profile. These consists of the size of the vessels, the power capacity and age of the installed engines as well as size and mounting mechanism of the suction pumps and type as well as nature of the seabed. The significant processes that have serious contributions to the dredging-related noise as outlined in [12] include:

- Collection noise resulting from retrieval of the dredged material from the seafloor;
- Pump noise associated with driving of the pump through the seabed;

- Transport noise during the lifting dredged material from the seafloor up the suction pipe, rotation of the pipes (for bucket ladder dredgers) and those from the lifting/dropping of the grabbers (for grab dredgers);
- Deposition noise associated with the placement of the dredged material in the barge; and
- Machinery noise emitted from the onboard engines, propellers and thrusters of the dredging ship or dredgers.

Generally, dredging noise is continuous in nature such that it may be possible to identify events occurring at regular intervals especially those causing significant additions to the noise levels. But the emitted frequencies of the human activity's noise-generating events in the marine environment range from several Hertz (Hz) to several Kilohertz (KHz) resulting from seismic operations, with their associated sound levels varying widely and can be as high as 250dB re 1μPa at 1m for some offshore operations and constructions, seismic explorations and exploitations [9], [11].

Obviously some parts of the different dredger types will emit more noise at varying levels during various stages of their operations. In the works of [7] and [11], it was reported that the hopper-type dredgers produced the highest fluctuating noise levels with the TSHDs producing the loudest noise especially during loading and offloading stages of its operations. The maximum $(1/3)^{rd}$ octave band level occurred at 100Hz and nearly 180dB re 1 μPa at 1m, and has the greatest detection range, distance at which the dredging noise falls below the ambient noise level, of 25km [11]. Clarke et all [4] also measured the sound of the CSDs and showed that majority of the sounds occurred in the 70Hz to I kHz range,

with a maximum Sound Power Level, SPL, of slightly less than 110 dB re 1 μPa and a suggested detection range of 500m.

3.0 MATERIALS AND METHODS

The study area is a coastal community in the Niger Delta Region of Nigeria located at 4^0 55' 12.5" N between 006^0 53' 43.8"E and 006^0 53' 29.5" E, and altitude of 3m above Sea level. The site has two Cutter Suction Dredgers (CSDs) with long hoppers used to convey the dredged materials to two placement sites, a Swamp boogy used for maneuvering and clearing of trees in soft terrains, two excavators and an electric power generator. There are also three tug boats and a work boat for movement of materials and personnel to and from the dredgers as well as a number of trucks used to convey the dredged materials from the placement sites to various locations for final usage.

The Sound Level measurements were taken with an Intel Smart Sensor Sound Level Meter at radial distances of 10m interval from the sources up to a distance of 100m.

4.0 RESULTTS AND DISCUSSIONS

The results of the SPL measurement at various radial distances around the materials at the site are shown in table 1 below.

Table 1: Average Measured Sound Power Level at the Specified Radial Distances from the Sound Source

S/N0	Radial Distances (m)	Sound Power Level ($dB\ re\ 1\mu Pa$)
1	10	138.8
2	20	123.1
3	30	118.2
4	40	103.7
5	50	91.6
6	60	79.6
7	70	63.4
8	80	54.2
9	90	48.7
10	100	43.5

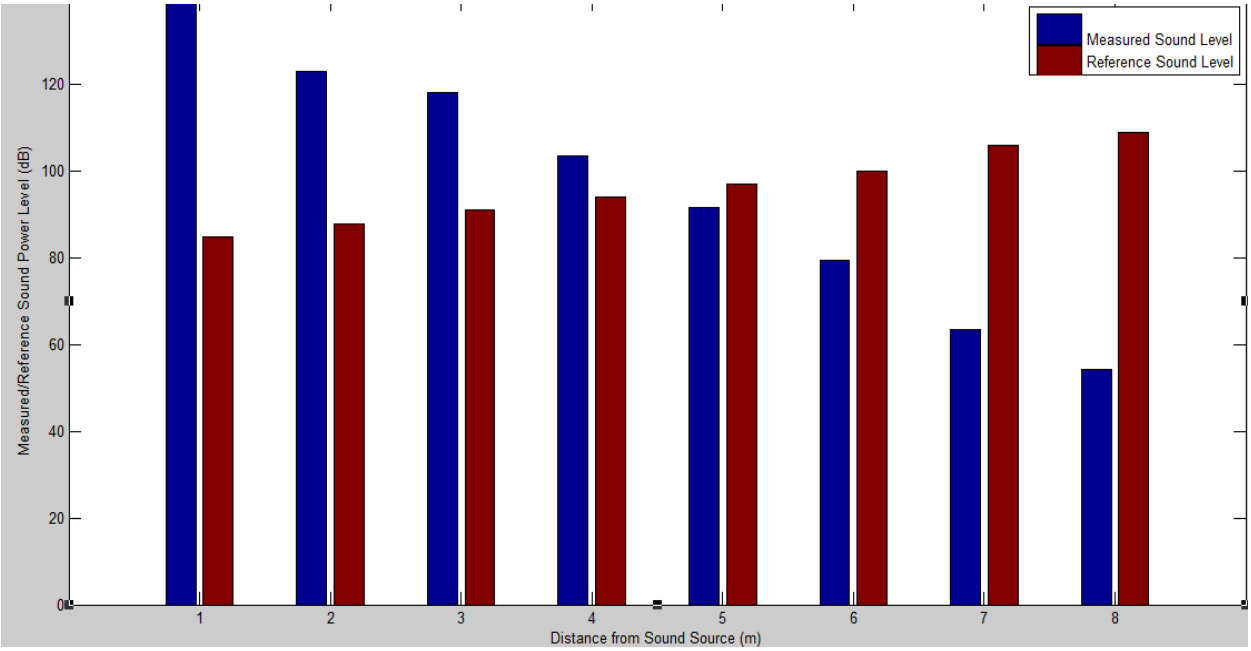

Figure (1): Comparison of Measured Sound Power level with the Reference Standard

The results obtained from the sound level measurement indicates that the emitted sound from the dredgers and its associated equipment on the site is far above the Noise level stipulations in [8] by the Nigeria's National Environmental Standards Regulations and Enforcement Agency (NESREA). While the noise standards in the regulations stipulates that no worker should be exposed to noise above $90dB$ for an 8hr working period per day, it was observed that the measured average noise level at this dredging site when all the equipment were in operation was as high as 138.8 $dB(re\ 1\mu Pa)$ at a radial distance of 10 metres from the source. Further reduction in the sound level were observed at a radial distance of 20 metres from the source with an average noise level of 123.1 dB; 118.2 dB at 30metres from the source; 103.7 dB at 40metres and 91.6 dB at 50 metres away until the ambient environmental sound level of 43.5 dB was

achieved at a radial distance of 100 metres away from the sound source. This result clearly show that the noise level of about 90 dB as stipulated in the above regulation can only be achieved at a radial distance of 50 metres from this operational site.

5.0 Conclusion/Recommendations

The emitted noise level at a dredging site at Umuechi Community of Obio Akpor Local Government Area of Rivers State, Nigeria was undertaken for the purpose of ascertaining the emitted noise level at the site in order to predict the potential impact of this operation on the environment from a noise perspective. The measured average noise level was as high as 138.8 dB at 10 metres from the source and reduced to 91.6 dB at a radial distance of 50 metres while the ambient environmental noise level of 43.5 dB was obtained at about 100 metres away from the operational site.

Based on the measured noise level, it is recommended that:

- Machines and/or equipment with less noise-emitting capability should be used at the site of this dredging operation;
- The working time should be planned such that workers, especially those working with a radial distance of less than 50 metres from the sound source are not allowed to work for longer periods;
- Adequate noise barriers should also be used to cordon off the site so as to reduce or outrightly prevent the emission of the sound to the surrounding;
  Movement of other members of the public should be restricted in the operational site of the dredgers as much as possible to prevent unwarranted exposure;

- The use of adequate Personal Protective Equipment by workers on the site, especially those workers that work within 50 metres of the equipment, should be taken serious by the management of the company;
- Measures should also be taken by the Government and other agencies concerned to ensure that the aquatic environment and its organisms are duly preserved after the operation.

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