Health of Mother Earth Foundation


DEAD FISH
IS NOT
MANNA

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Edited by

Ogechi Cookey

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Our appreciation goes to the communities of fishers, especially those in the FishNet Alliance, who continue to monitor and speak up against ecological harm to our aquatic ecosystems.

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List of Abbreviations

FAO:	Food and Agriculture Organisation
CDC:	Centre for Disease Control
CSOs:	Civil Society Organisations
GDP:	Gross Domestic Product
HOMEF:	Health of Mother Earth Foundation
NGOs:	Non-Governmental Organisations
NIMASA:	Nigerian Maritime Administration and Safety Agency
NIOMR:	Nigerian Institute of Oceanography and Marine Research
NOSDRA:	National Oil Spill Detection and Response Agency
RFABs:	Regional Fisheries Advisory Bodies
RFMO:	Regional Fisheries Management Organisation
WHO:	World Health Organisation
WTO:	World Trade Organisation

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Introduction

Fish has both economic and nutritional importance to man and society. It is a veritable source of livelihood for many, especially in rural communities. It can be said that the fisheries sector is one avenue that, if well nurtured, can be used to alleviate poverty at the grassroots. On a larger scale, fisheries contribute to the GDP of many nations. Yet issues that challenge this sector are mostly overlooked. The exploitative and environmentally degrading activities of the extractive industry have had a debilitating impact on the productivity of fishers. The current COVID-19 pandemic has added to the challenges that confront fishers.

This publication aims to bring to the frontline issues that beg for attention in the fisheries sector.

Chapter One, titled *COVID-19 and Fisheries*, highlights how the pandemic has affected the fisheries subsector. This chapter shows that COVID-19, for a period, significantly reduced demand and supply of fish by as much as 82%, and decreased its price by as much as 36%. It also shows that the pandemic reduced fisheries employment by as much as 64%, and negatively impacted on the economies of its workforce, but did not adversely impact captive fish stocks as much as on aquaculture. It recommends, among other things, that measures such as supporting the most vulnerable fishery workers, protecting fish culture, and maintenance of fisheries operations be taken in a post-pandemic era.

Chapter Two, titled *Dead Fish is not Manna*, captures the peculiarities and challenges of the fishing industry in Nigeria, noting the contaminated state of some of the fish sold in the country's markets. It raises our consciousness concerning

careless consumption of imported fish products. This chapter also draws attention to the exploitative fishing activities of industrial trawlers and foreign fleets in Nigeria and other maritime nations in West Africa, leading to a hike in the price of fish and increased importation of cheaper fish products. It calls for better knowledge management to explain the importance of the ocean to policy makers and the multiple stakeholders in the fisheries sector, as a task that can be facilitated by NGOs.

Appendix 1, titled *Dead Fish on the Niger Delta Coastline – A Call for Thorough Investigation,* is a call for action made by FishNet Alliance, Health of Mother Earth Foundation and Oilwatch Africa. It was a statement issued in response to speculation on the cause of the incidence of dead fish along the Niger Delta coastline between February and May 2020. The second appendix is another statement, issued after the National Oil Spill Detection Agency (NOSDRA) issued a statement conveying the outcome of their study of the dead fish situation. Titled *Environmentalists Reject NOSDRA's Report on Dead Fish along Niger Delta Coastlines,* it focused on the deficiencies in NOSDRA's report, and asked for further investigations to bring closure to the saga.

Chapter 1

COVID-19 and Fisheries

By Christopher Ezike

Introduction to Fisheries

'Fisheries' refers exclusively to the industry of keeping, harvesting, processing and marketing of finfish and shellfish for human utilisation and benefits. It also comprises the workforce in the fisheries sector, the fish species, the tools and equipment used, the places (whether on land, where fish are bred, or in fishing grounds, where fish are caught by fishers) and the water bodies (whether marine, brackish or freshwater) where these fish are found. Capture and culture fisheries form the two broad areas that are respectively concerned with catching or fishing, and breeding or raising fish, as carried out in aquaculture.[1]

The word 'fish' represents both finfish and shellfish. The external morphology of finned fish, for example, catfish, is of three main parts: head, trunk and tail. The head comprises the mouth (terminal, superior and inferior) which is used for feeding and breathing; a pair of eyes used for vision; two nostrils for odour perception and the operculum or gill cover for protecting the gills which help the fish breathe in water. The trunk comprises the lateral lines for perception and vibration; various scales (e.g. cycloid in tilapia, ctenoid in perch, ganoid in eggars and placoid in sharks) for skin protection; paired fins (pelvic and pectoral) for controlled swimming movement; and unpaired fins (dorsal, anal and caudal fins) for movement.[2]

The main external morphology of crustacean shellfish, for example lobster, crayfish and prawn, is the head, thorax and abdomen, while that of the mollusc shellfish, for example snail and bivalve, is the mantle, visceral mass and foot.

Capture Fisheries: Artisanal and Industrial Fisheries

In capture fisheries, the fish stock is continuously hunted down by artisanal fishers on the coastal areas of marine, brackish or inland waters, where the shallow depth of water enables fishers to use local tools such as hook and line, cast nets, drag nets, seine nets, knives, traps and baskets, in the dugout or planked canoes, to take out fin and shellfish from the water.[3,4,5]

On the other hand, the industrial capture fishers (mostly foreigners), use advanced technology such as electrofishing and trawlers attached to large vessels, to remove a large quantity of fish in the open, deeper portion of the marine water.

Harvest from capture fisheries is unpredictable, despite the extensive efforts that are required, especially by the industrial fishers.[6] It is restricted to the surrounding water body, therefore cannot easily be expanded or combined with other types of agriculture. Freshly caught fish, if left unpreserved or unprocessed, begins to lose its quality, either by spoilage micro-organisms or by enzyme and chemical actions, and, as a result, should be processed as quickly as possible.

The artisanal fishers use various traditional methods, such as sun-drying and smoking, to remove moisture from caught fish, or salt is used to increase the osmotic pressure, but these methods leave the fish with only a short shelf-life.[7] The industrial capture fishers are better equipped with cooling and freezing compartments in their vessels, where freshly-caught fish are preserved by inactivating the actions of the spoiling organisms and rigour-causing enzymes. They can also pre-cook the fish and preserve it by canning, freeze-drying, quick freezing, steam heating, hot-air drying or soot-free smoke drying.

Culture Fisheries or Aquaculture

Culture fisheries, also referred to as aquaculture or fish farming, may be for breeding or production purposes. In either case, the breed must be suitably culturable, with characteristics such as having fast growth, accepting prepared feed, having an acceptable taste and high market value, ability to breed in captivity as well as being hardy or disease-resistant, and a good converter of feed into flesh.[8]

Culture Fisheries for Fish Breeding Purposes

Several factors must be put into consideration when going into culture fisheries for breeding purposes. There must be an adequate supply of water of acceptable quality, an overhead tank, live or prepared feed, electricity, pumps and tanks available, before fish can be bred. Fish species of choice may be egg layer, for example tilapia, catfish or carp, or livebearer like shark, dogfish and some ornamental fish such as molly. Live bearing is exclusively done in outdoor shallow ponds where specified numbers of males are kept with females and are provided with suitable natural conditions to sensitize copulation and spawning.

This is followed by internal fertilization, within the body of the female fish which will later give birth to live young fish in prepared nests, positioned at the shallow areas of the pond. For egg layers, the first task is to construct a hatchery, which comprises the indoor hatchery house and associated facilities and implements, along with spawning tanks where the female fish are stimulated to lay mature eggs. It also includes hatchery tanks where the fertilized eggs are hatched out inside an incubating facility, larval rearing tanks where hatched-out larvae are placed to develop, to be able to start feeding on

live food, and nursery tanks where they are placed to mature into the fingerling stage, before they can be stocked.[9]

The next step following establishment of the hatchery is to sex the broodstock, which must be appreciably mature and of known history, to avoid diseased or poorly growing ones. The opposite sex must be in separate spawning tanks if spawning is purely artificial, and induced with either natural (hypophysation) hormone, for example carp pituitary hormone, or artificial hormones like egovaprim (0.5ml/kg), which should be injected into the female fish at an angle of $30\text{-}45^{0}$ near the caudal fin. The female fish should be adequately protected to ensure minimal stress, by covering the eyes and holding the tail fin with a wet towel. Thereafter, the fish is released back into the spawning tank to allow for a latency period of 8-10 hours, depending on the temperature of the water and the surroundings. The eggs are collected into a dry container when they become mature. The male sex cells, or milt, need to be collected and used to fertilize the eggs by mixing well with a drop of water; fertilized eggs are then placed into the incubating tank, ensuring that only one layer is placed on the tray. The larvae hatch out after about 18 hours for catfish, and move into the dark-coloured area of the larval rearing tank through a connection channel, or by siphoning them with rubber tubing.[10]

The larvae with egg yolk at the neck region do not feed until the third day after hatching. They are first fed live food in larval rearing ponds, using *artemia nauplii* or other locally available species such as Moina and other cladocerans, for 10-14 days before being transferred into the nursery tank where supplementary feed can be provided. The use of good quality water and regular checks on good stocking rate must be strictly adhered to. An adequate supply of oxygen-rich water

using a flow-through, aerators or re-circulatory aquaculture, may also be employed.[11, 12]

Culture Fisheries for Fish Production Purpose

To venture into aquaculture for production purposes, one must have good quality fish species of known history, available feed, quality water, and soil with good water retention. The site should have a gentle slope, be accessible, be close to the market, have good security apparatus, etc. Other issues that should be considered are discussed below.

Pond Construction and Management

Two major types of ponds exist: earthen and concrete. However, other materials such as plastics, fibreglass, tarpaulin and even wood can act as holdings to rear fish. The selected site for pond construction should be cleared and freed of stumps and topsoil capable of damaging the pond dyke for earthen ponds or walls of concrete ponds. The area should then be pegged, measured out and excavated to 1.2 - 1.5m. This is necessary to form a gentle slope at the base corresponding to the shallow and deepest floor of the pond depth. The excavated soil should be piled around the pond and well compacted to form a wall or dyke with a suitable slope, which helps to prevent runoff from gaining entrance to the pond. The wall and floor of the pond must be properly compacted, smoothened or rammed to avoid leaks and cracks. Then the outlet should be constructed near the deepest part and complemented with a sluice-gate to facilitate easy screening and removal of water at harvest or during draining of pond water. The pond, following completion, should be limed with recommended

lime at the appropriate rate and fertilized with poultry dung or chemical fertilizer, which must remain for 10-14 days before flooding and stocking can be effected.[13, 14]

Concrete ponds may be constructed on any site, since soil type is not a concern, however waterlogged and sandy areas should be strengthened with reinforced cast concrete floors and walls, to avoid cracking and early collapsing of the ponds. It should follow the same steps earlier explained, which are clearing and digging out the topsoil before preparing the concrete floor and side walls. Cement, sand and gravel, mixed in the ratio of 1:2:4 respectively, should be used and walls concreted between7.5-10cm. The side walls must be dug and constructed with reinforced iron rods using a well-concreted mix of cement and gravel at the four corners of the pond, since they are likely areas of cracking and leakage. The side walls can be built with solid blocks in solid soil areas. The overflow, inlet and outlet pipes must be screened with nets to prevent loss of fish and entry of unwanted species. The inner wall and floor should be plastered, using special cement mixed with water to prevent leaks. The pond may be lit to attract insects, which may serve as supplementary feed for some fish species.

After pond construction, the effect of cement may be removed by liming and fertilizing the pond with poultry dung tied in jute bags and left for 4-7days before flooding and stocking can take off.[15]

Fish seed transport and stocking

Fish to be stocked may be collected from the wild, but it is preferable to buy them from reputable farms, where the history of the fish is well known and their cultural characteristics are well established and determined. The fish

are transported after starving them for 12- 24 hours to empty their stomachs, thereby freeing them of stress. Transportation is achieved either by a closed system, where the distance to be covered is far, using oxygen bags to oxygenate the water, or by the open method, in containers such as glass aquariums, or plastic cans opened at the mouth to allow free diffusion of air. On getting to the pond site, the temperature of the two containers of water must be equilibrated. Stocking should be carried out in the cool of the morning or evening, at an appropriate rate, by allowing the fish to swim freely into the pond water. [16]

Fish feed formulation and feeding

Feeding of fish accounts for close to 60% of the expenditure incurred in fish production practice, which shows the important role occupied by fish nutrition. The culturist must ensure that a balance in the gross protein need and amino acid profile requirements of fish is met, to achieve maximum growth for any given species of fish.[17]

The sequence of activities leading to fish feed preparation includes: first, the procurement of the various feed sources (proteins, energy, vitamins, minerals etc), then thereafter making a selection of the best feed in terms of quality; and secondly, using the gross protein need to formulate the amount needed by the pond fish within a specified time, using either computer programming or the Spearman's method. The latter is simple, and preferred by most people, as the protein sources are grouped and combined with energy diets to determine the percentage needed by the fish.

These amounts are then determined and weighed out, broken into desired particle sizes using various mills, and mixed

using various mixers, to achieve a homogenous composite of the different nutrients. Mixed diets may be combined with binders to improve homogeneity, following pelleting or extrusion of the feed. The feed, after being dried with dryers or exposed to sunlight, may then be fed to the fish or bagged and stored in a cool dry place, free from pest infestation. Feeding must be carried out at a specified time and in a specific portion of the pond, preferably in the cool morning, evening or night hours, to minimize stress to the fish. A suitable particle size corresponding to the size of the mouth and percentage body weight of the fish must be considered during feeding. Feeding must never be *ad-libitum* because fish easily become satiated, and when they do, they stop picking up the feed.

Sorting and grading of fish

Certain species, for example catfish and heterobanchus, that eat up smaller, younger or wounded members, should be subjected to periodic sorting and grading to avoid a reduction in the number of stocked fish.[18]

Water quality management and disease control

Provision of good quality water and its maintenance is the greatest factor affecting the health status of the pond fish. Fish in the tropical gulf area of Guinea and Congo require a temperature range of 25-32^{0}C, pH range of 6.5-8.5, dissolved oxygen range of 5.5-8.5mg/L, and ammonia and carbon-dioxide level of 0.02mg/L.[19]

So long as the water quality is maintained and the pond is kept clean, the disease-causing organisms of bacteria, fungi and viruses, even when present together with the parasitic

forms of protozoa, crustaceans and helminths, cannot attack the fish, because of high immunity sustained by the good quality and cleanliness of the surrounding water. [20]

Fish marketing

Fish is marketed to both domestic and export markets. However, fish marketing is dependent on the fish value, source, species, post-harvest processing treatment, quality and the type of preservation carried out on the fish. [21, 22] The majority of artisanal fisheries and some of the local pelagic fisheries sell fish such as bonga, sardine and tilapia fresh from the river, alongside harvested catfish and imported mackerel. These fish may also be processed by sun-drying or smoking, before being sold in the open fish markets found scattered in coastal communities.[23,24,25] Industrial fish products such as salmon, tuna and highly valued shrimps and lobsters are well preserved by being canned, filleted, freeze or smoke-dried, then properly packaged, before being exported to nations such as the United States of America and Britain. With this, they earn foreign exchange for the host country.[26] Some industrial fishers, who engage in sourcing for pearlfish and ornamentals, sell them at the international fish markets to earn foreign exchange.

The ornamental fish trade is still unknown to many local fishers and producers in the Gulf of Guinea. There is the need for government and non-governmental organizations to encourage breeders to venture into this area of the fish trade, which reportedly had an annual global turnover of over 8 billion US dollars as at 2008. [27, 28]

Economic Contribution of Fisheries within the Gulf of Guinea and Congo

The Gulf of Guinea and Congo and indeed the entire coast of West Africa is a vast and rich area of marine, brackish, fresh, delta and lagoon waters. These waters provide a habitat for many species of key pelagic and demersal fish, such as tilapia, mackerel, sardine, barracuda, seer, carangid and croaker fish, which serve as an important source of protein. They are also a tourist attraction and provide employment to artisanal fishers, industrial fishers and many women who constitute the majority of post-harvest workers, as they aid in the processing of freshly-caught or harvested fish. Many crustaceans, such as lobsters, shrimps and crayfish, as well as snails and pearl bivalves, are equally available, some of which are highly valued in the international market. They can, therefore, earn foreign exchange to host countries like Nigeria, Ghana, Senegal, Ivory Coast, Cameroon, Guinea, Congo, Benin, Liberia and Togo. They provide the highest employment and GDP in the Democratic Republic of Congo and Guinea. [29, 30, 31]

Since the majority of the fingerlings of the available pelagic fish in this region feed on mosquito larvae, they aid in the control of malaria caused by the malaria parasite, carried in the saliva of the female *Anopheles* mosquito.

Sharks and large mammals such as whales, which are also regarded as fish, are frequently sighted in the Gulf of Guinea. These fish could be a major source of foreign exchange earnings. This can be achieved if the government encourages tourist visits to the sites where the large fish are found, and ensures that such species are conserved, rather than being hunted down by the locals.

Fish by-products, such as fish skin, fish liver oils and fish

swim bladders, may respectively find important use in the leather, pharmaceutical and brewery industries, for example in the making of bags, cod liver oil and isinglass for wine clarification. Other by-products which are waste from fish are frequently converted to fish soap, fish glue or ground as chaff to be added to animal feed. Some communities within the Gulf, such as the Arugungu fishing locality in Nigeria, use fishing sport as a source of entertainment and tourism to attract both foreign and local audiences to witness different sizes of fish caught by the contenders. The exchange or sale of such fish during the sporting activity has, over time, added to the earnings of the community and nation at large.[32] Fisheries have also contributed to national employment, value addition and GDP of member nations, as shown in Tables 1-4.[33, 34, 35]

Table 1: Potentials of the fisheries sectors of some West African member countries of the Gulf of Guinea

Physical indicator	Cote d'Ivoire	Benin	Ghana	Liberia	Nigeria	Togo
Continental shelf (sq. km)	10,200	3,100	24,300	34	46,300	2,800
EEZ (nautical miles)	200	200	200	200	200	200
Coastal length (km)	550	121		579	835	50
Captive production (t/yr)	52,000	40,000	556,000	7,000	600,000	
Aquaculture production (t/yr)					100,000	
Consumption/head/yr (Kg/head/yr)	15	10	23-29		11	13
Contr. to GDP (%)	1.5	35.7	4.5	3.2	1.4	4
Employment	70,000	350,00	201,000	18,000	600,000	22,000
Industrial vessels	95	10-12	330	12-40	252	None
Artisanal vessels		35,850	11,213 24,000	3,500	858,000	3,500

Source: FCWC, 2009

Table 2: Employment in inland fisheries in sampled countries of the Gulf of Guinea

Country	Fishers			Processors			Inland fisheries
	Males	**Females**	**Total**	**Males**	**Females**	**Total**	**Total**
Benin	124,731	37	124,768	0	78,513	78,513	203,281
Congo, Dem Rep	154,666	9,161	163,827	22,530	175,717	198,247	362,074
Congo, Republic	39,486	1,362	40,848	8,475	11,159	19,634	60,482
Côte d'Ivoire	6,480	0	6,480	4,793	10,198	14,991	21,471
Guinea	11,523	3,839	15,362	0	11,524	11,524	26,886

Source: de Graaf and Garibaldi (2014)

Table 3: Total employment in the fisheries and aquaculture sectors in selected countries of the Gulf of Guinea

Country	Males	Female	Females	Employment
			(%)	**Total**
Benin	133,795	80,407	38	214,202
Congo, Dem	183,047	193,227	51	376,274
Congo, Republic	60,181	16,372	21	76,553
Côte D'Ivoire	39,793	57,309	59	97,102
Guinea	33,361	31,330	48	64961
Senegal	90,141	38,949	30	129090
Togo	19,300	12,093	39	31393

Source: de Graaf and Garibaldi (2014)

Table 4: Gross Value Added and contribution to GDP of local licenses in selected countries

Country	Inland	Marine	Marine	Total value	Contribution
	Fishing	Artisanal	Industrial	Local licenses	to GDP
	(US$)	(US$)	(US$)	(US$)	(%)
Benin		29,492	13,845	43,337	0.001
Congo, Dem	1,023,876	28,617		1,052,493	0.009
Congo, Rep Republic		50,025	569,494	619,519	0.005
Guinea		458,353	5,417,969	5,876,322	0.112

Source: de Graaf and Garibaldi (2014)

The Place of Fisheries in the Nutritional Needs of People in the Gulf of Guinea and Congo

The majority of the population of the Gulf of Guinea is predominately employed in the fisheries industry and its sub-sectors, with mainly womenfolk saddled with the post-harvest duty of having to process the fish to avoid spoilage. They frequently make use of fish as the major source of food for their households. The fish species caught in the Gulf of Guinea are enriched with a high percentage of protein, which meets the protein needs of the people for whom fish is a staple food. Fish also serves as a delicacy, as a gift, for marriage toasts, etc.

Fish contain highly valued amino acids that help to balance people's need for essential amino acids, such as lysine and fatty acid, omega-3-linoleic acid, and other micronutrient needs, such as vitamins and minerals.

Many children born within fishing localities experience normal growth, due to adequate protein supply from an early age.[36,37] The major challenge is non-availability of electric power and facilities for cold preservation. This leaves the fish with a short shelf-life and open to insect infestation. Over-consumption of ill-preserved fish, with inadequate energy intake, may convert the protein content of the fish, meant for growth, into energy, thereby leaving children who consume it with poor growth. Spoilt fish, when consumed, may result in food poisoning.[38] The government must ensure that coastal communities are provided with power and cold facilities to assist them to preserve their fish. Educating the women on the proper handling of freshly caught fish, the need for six-hour smoking, and methods of avoiding insect infestation, is desirable. The use of spoilt fish for fish meal must also be discouraged, to avoid the spread of disease to animals (who are fed with the meal) and humans. [39,40]

Impact of COVID-19 on the Economies of Fishers, Aquaculture, Artisanal Fishers and Fish Marketers

COVID-19 is an acronym for Corona (CO), Virus (VI), Disease (D) and the year 2019 (19) when the virus outbreak was reported by China to the WHO in the month of December.[41,42] It is a respiratory disease caused by the novel coronavirus SARS-COV-2, formerly referred to as 2019 novel coronavirus or 2019 nCOV. This disease was officially declared a global pandemic on 11th March 2020. The declaration was made because the virus was spreading by respiratory droplets from person to person globally. It predominantly affected the colder regions of the world. [43,44]

The United States Centre for Disease Control reported that there are many coronaviruses which cause mild upper respiratory tract illness, but SARS- COV-2 is a new virus not previously seen in man.[45] According to the report, the SARS-COV-2 virus which causes COVID-19 is spread primarily through the respiratory droplets of infected persons. Hence, when persons with the virus cough, sneeze or talk and droplets from their mouths touch the mouths or noses of nearby persons, those persons get infected.[46,47]

An infected person comes down with a dry cough, fever, difficulty in breathing or shortness of breath, and sneezing. Such persons must be isolated from non-infected persons to avoid the spread of the virus.

The virus has spread to nearly all the countries of the advanced and developing regions of the world, infecting close to two million people and causing the deaths of well over a hundred thousand persons across the world.[48] To curtail the spread of the virus, governments of most nations introduced measures such as restriction of movement and shutting down

of airports and seaports, thus halting international travel and, by implication, international trade.[49] Other measures taken by governments included lockdown of cities and businesses; border closures; social distancing; market closures; suspension of sporting activities; crew and passenger limitations; restrictions on religious, political, social and other gatherings; imposition of the use of face masks in public places; the use of hand sanitizers and temperature reading devices to ascertain body temperatures, etc. These measures have impacted on all aspects of human life, including fisheries and aquaculture. This review aims to assess the impact of COVID-19 on the economies of fishers, including aquaculture and artisanal fishers.

Impact of COVID-19 on the Demand for Fishery Products

Significant global reduction in the demand for fish and its products in most countries of the world, including member nations of the Gulf of Guinea, has been reported.[50] The captive fisheries' domestic and export markets decreased by 55% and 82% respectively, while aquaculture recorded a 36% and 64% decrease in the demand for its domestic and export markets respectively. These reductions were occasioned by rumours, at the onset of the pandemic, that the virus originated from a wet market in Wuhan in the Hubei Province of Central China. This, by implication, suggested that fish might be a carrier of the virus.

Demand for domestic stock dropped, probably owing to the negative impact on tourist industries and restaurants. Pelagic fishing came to a halt due to low patronage, as fewer people were buying fish for fear that it might transmit the virus.

There is increased demand for packaged and canned fish products but their fresh equivalents are limited, due to lockdown, movement restrictions, social distancing and the ban on international travel, which has limited the export market. Flight, hotel and restaurant closures, as well as a drop in tourist numbers, have also impacted on the demand for locally caught shrimps and lobsters.

Impact of COVID-19 on the Supply of Fisheries Products

Supply to the domestic and export markets from global captive fisheries decreased by 78% and 82% respectively, due to lockdown of fisheries, closure of international flights, movement restrictions and border closures.

Similarly, aquaculture reduced its supply of fisheries' products by 55% and 73% for domestic and export fisheries respectively, due to the inability to transport seeds and harvest from farms or obtain foreign supply, due to restrictions of movement, lockdown and flight closures.[50]

Impact of COVID-19 on the Price of Fish.

Prices dropped by 27% for captive fish and 36.5% for aquaculture (FAO, 2020). These reductions in price were due to the initial rejection of fish at the earliest period of the COVID-19 outbreak, when many people thought that fisheries' products might be a source of the spread of the virus. Panic buying of packaged and canned fish at the onset of the pandemic slightly heightened demand, but the availability of raw materials for such products was reduced by the restrictions in movement and lockdown pronouncements.[51]

Impact of COVID-19 on Employment in Fisheries

The Food and Agriculture Organisation (FAO) did a global assessment on the impact of COVID-19 on fisheries and aquaculture through its Regional Fisheries Management Organisation (RFMO) and Regional Fisheries Advisory Bodies (RFABs). The assessment revealed that employment in captive fisheries decreased by 64% during fishing activity and 24% during post-harvest activity, when the caught fish are processed, either on the ship or after landing. It also reported a 64% decrease in employment for aquaculture workers who are usually engaged during harvest and post-harvest to process the harvested fish from ponds. The time available for fishing by artisanal fishers was completely overtaken by lockdown and movement restrictions. Even when they were able to catch fish, the absence of patronage occasioned by restrictions made it impossible for them to make sales. The industrial fishers who were out at sea may have experienced difficulty in returning to the city, due to restrictions on movement, border closure and social distancing. Aquaculture suffered the same reduction in employment, both at production centres and at processing units, due to the reduced quantity of products, as farmers could not harvest or process grown out stock since processors and marketers were restricted in their movements.[52]

Economic Impact of COVID-19 on Artisanal Fishers

Artisanal fishers, according to Bennett et al. (2020), are small-scale fishers who use small non-motorized canoes, traditional tools and very few crew members.

Their income is dependent on sales from daily fishing, which they carry out in the shallow coastal areas.[53] Low sales

of fish arose from the illusion that aquatic animals were possible spread agents of the virus, coupled with the imposition of lockdown and restrictions of movement. These restrictions confined artisanal fishers to their homes, leaving them with no income to cater for themselves and their families.

Economic Impact of COVID-19 on Industrial Fishers

The industrial fishers use large vessels and multiple crew members, who are engaged in taking up the fish from the water and/or preserving the fish. Some of these fishers were caught up in the open sea, where they found it difficult to exchange crew members. Hence they remained at sea for a longer time. This foreclosed their chances of selling cold fish in the export market. The implication of this extended stay at sea was that any infected crew member would be more likely to spread the virus rapidly to other crew members.[54]

Economic Impact of COVID-19 on post-harvest Workers and Processors

The situation for post-harvest workers is precarious, because they cannot get paid for work not done. Income is generated from payment made when a duty has been carried out. But since fishing and harvesting came to a halt, many of these workers have been restricted to their homes, owing to market closures and lockdown. This has suspended the daily income they get from processing fish.[55, 56]

Economic Impact of COVID-19 on Fish Marketers

Fish marketers at the domestic and export end found it difficult to sell their fish owing to the market shut-down, both within countries and between member countries. The women, who constitute the major players, found it difficult to store previously smoked fish, due to non-availability of cold stores. The domestic marketers lost their fish to wastage due to spoilage and insect infestation. Governments can assist in enhancing income/revenue generation through fish marketing, by providing these marketers with cold stores for preservation, and storage boxes for unsold fish.[57]

Impact of COVID- 19 on Fish Stocks

As earlier mentioned, many people erroneously assumed that aquatic biota, mainly fish, might be carriers of the virus. It is, however, important to note that the CDC has confirmed that the virus has not been detected in either water or fish.

It has also not been detected in any other animal life, such as amphibians, reptiles or birds, except in limited mammalian groups that are companion animals to man. Examples are cats and dogs that are in close contact with an infected person.[58] There is no direct effect of the viral strain on fish at the moment, but the indirect impact on fish stocks, especially due to actions by governments of different nations, is significant.[59, 60] COVID-19 has impacted stocks of both captive fisheries and aquaculture.

Impact on Captive Fisheries' Stocks.

The impact of COVID-19 on captive fisheries' stocks is somewhat on the positive side. This is owing to the fact that

fishing activities of both artisanal and industrial fishers almost came to a halt due to COVID-19 restrictions on movement, total lockdown and subsequent reduction of fisheries' crew members, which all helped to reduce fishing activities and thereby limited the amount of fish taken out of the water. Water transparency improved, due to reduction in water turbidity owing to the crisscrossing of vessels, boats, trawlers and dredgers. With this, fish did not have to be in constant hiding from those that hunt them and the noise from large vessels of industrial fishers.

Impact on Aquaculture Stocks

Fish stocks that were ready for harvest in the production ponds may have been left there for a longer period of time. This may have led to increased expenditure on feeds and water quality management. Given that the majority of feeds come from advanced countries, the feeds may not have been readily available, due to lockdown of feed stores and restrictions on movement and international trade. As a result, the most likely impact would be increased mortality of the stock in the ponds. This would be compounded by the unavailability of cold preservation in many developing countries, including those member states that make up the Gulf of Guinea.[61]

Nursery ponds, especially fingerling ponds, would be left unstocked, because seed availability would be hampered by restriction of movement, which would make fish transport impossible. Many local hatcheries were forced to shut down because of the lockdown and movement restriction measures on the ground. As a result, they lost newly-hatched larvae and fry, due to their inability to offer adequate care needed at that delicate life-stage of fish.

Fisheries in a Post COVID-19 Era

In a post COVID-19 era, measures must be put in place to resolve the many issues generated as a result of the efforts of governments to curtail the spread of the virus, which indirectly impacted negatively on fisheries, as noted earlier.

The FAO has highlighted some of the measures that must be adopted to usher in a post-pandemic era, especially concerning fisheries globally. These include measures to support the supply chain, protect the most vulnerable fisheries workers, protect fish production and income, and maintain fisheries' operations.[62]

Measures to support the supply chain

i. Governments and agencies responsible should ensure the stability of fisheries' access by reducing unnecessary regulatory burdens that prevent access to and sustainable harvest from fishing grounds.
ii. Supply chain access for fishers that sell their products overseas should be ensured, as well as access to and cooperation from officials at ports, rail and border crossings, so that fishers can maintain their sales.
iii. The World Trade Organisation (WTO), in collaboration with the WHO and FAO, should prevent border restrictions in trading of food and fisheries products, to avoid shortages.[63]
iv. Fish products should be marketed directly to the end-consumers, as a potentially important approach.
v. Alternative marketing approaches should be used to help alleviate the need for prolonged storage.
vi. Governments should provide fishers and fishing

communities alike with insulated fish boxes, to help preserve unsold processed fish.

vii. There should be continued support for the supply chain, by using temporary fish storage mechanisms at home-based markets, and working with processors to adjust supply to same and replace products meant for export markets.[64]

Measures to protect the most vulnerable fisheries workers

i. The most vulnerable fishers and processors should be supported in cash and kind by local authorities, especially in such localities as the Gulf of Guinea member states, where social protection is unavailable.

ii. There should be improved hygiene in the fish markets during the post- COVID-19 recovery period, by insistence on the use of face masks and hand sanitizers to avoid possible spread of any of the strains of the virus.[65]

iii. There should be provision for payroll and unemployment assistance for crew members, artisanal fishers and small-scale fish farmers.

Measures to protect fish production and income

i. Fishers, crew members and post-harvest workers should be designated as essential workers, since they provide food to the nation.

ii. Government providence of institutional seafood need should be expanded.

iii. The fishing season should be extended to compensate for economic loss during COVID-19.

iv. Compensation should be provided by the government to owners and crews of fishing vessels who were prevented from fishing during the COVID-19 pandemic.
v. Where possible, the government should set up a department to fix a minimum floor price for important species.

Measures to maintain fisheries' operations:

i. Aquaculture must be designated as on par with agriculture, for priority to be accorded the sector in terms of lending, insurance, tariffs, etc.
ii. Production operations should be reduced where demand is low.
iii. Access to credit should be granted to fish farmers and fishers, with reduced interest rates and flexible repayment options.
iv. There should be grants to cover production and income loss, in order to maintain the domestic seafood supply chain and to ensure continued operation.
v. There should be forgiveness of non-payment of loans that were used to maintain payroll, and low-interest loans used to refinance existing debt.
vi. Certain financial obligations, such as utilities, rent, mortgages, etc, that were incurred during the COVID-19 pandemic, should be relieved.

Conclusion

In this chapter, captive and culture fisheries' sectors were highlighted, and the indirect impact of COVID-19 resulting from measures taken by governments to curtail the global person-to-person spread of the SARS-COV-2 virus were discussed. The manifestations of the impact included reduced fisheries' supply, demand and employment, which in turn impacted negatively on the economies of the fisheries' workforce. To experience a better post-COVID-19 era in the fisheries sub-sector, measures such as supporting the supply chain, protecting the most vulnerable fisheries workers, protecting fish culture and maintaining fisheries operations, must be taken.

Chapter 2

Dead Fish is not Manna

By Ako Amadi

Introduction

A Nigerian who has never eaten fish prepared in one form or the other – dried, fried, smoked, canned or stewed - must be a rarity. According to current statistics provided by the Food and Agricultural Organization (FAO) of the United Nations, each Nigerian consumes between 10 to 20 kilograms of fish per year. With an estimated annual per capita fish consumption of 13.3 kg in 2013, fish represents an important dietary element and one of the few sources of animal protein available to many Nigerians.[1]

With over 800 km of Atlantic coastline and the fact that several states in Nigeria are named after rivers, Nigeria cannot be said to lack water. When farmers' fields are irrigated in northern Nigeria, the aim is to avoid overdependence on rain-fed agriculture, which is filled with vagaries and uncertainties. Irrigation farming is, therefore, not practised in northern Nigeria because natural freshwater systems are non-existent. Fish is never a scarce commodity in Nigeria. Yet we import fish.

Most of the fish in Nigerian markets are captured wild, with the exception of growing supplies from aquaculture. The products are usually sun-dried, smoked or sold fresh from the rivers or ponds. The question is, how fresh are these products? Bacterial counts in fish sold in open-air markets in Nigeria can be quite substantial, given that the products are sometimes touched again and again by customers who may end up not buying them. Again, the products are usually left on display tables to incubate pathogens in hot and humid conditions. Supplies in the chest freezers of upscale supermarkets in the cities are sometimes already in a decaying state. Quality control measures revealing the rate and consequences of posthumous

decay are hardly carried out for fish in the West African marketplace. Dead ascarid and helminth worms are commonly detected in improperly gutted fish which are canned overseas and exported to West Africa. That a product is imported does not guarantee its good quality or health benefit.

Many Nigerians purchase and consume cans of sardines or mackerel without bothering about where and how the fish were caught, processed and packaged, and which country exported them to Nigeria. Do these fish imports not constitute the dumping of low-quality fish products in Nigeria, for example mackerel and frozen hake and cod, often described as rough fish in Europe? Dried cod (stockfish) from Scandinavia is an example of such a fish product, which is expensive in Nigeria but cheap and not exactly a desirable diet in Europe. Thanks to the manipulative use of artificial flavours, what is inside a can of fish may not be identical with the label depicting its content.

Nigeria exports about 60 tons of smoked fish per annum to the United Kingdom. There are indications that Nigeria and other neighbouring countries in West Africa are currently losing up to 40 per cent of their smoked fish exports to the United States and Europe, due to improper packaging and labelling, inadequate compliance with paperwork, insect infestation, and mould growth on products. Consequently, this represents an economic loss of about $2 billion in revenue generation and 300,000 job losses in West Africa.[2]

Fisheries constitute a major economic sector in Nigeria. According to a WorldFish survey carried out in Nigeria, the fisheries sector is estimated to employ over 8.6 million people directly and a further 19.6 million indirectly, 70 per cent of whom are women. The total fish demand for Nigeria based on the 2014 population estimate of 180m is 3.32 million metric

tons. A metric ton (MT) is a unit of weight equal to 1,000 kilograms (2, 205 lb).[3]

In 2015, the total fisheries production was estimated at 1,027,000 tonnes, to which marine catches contributed 36 per cent, inland water catches contributed 33 per cent, and aquaculture 31 per cent. The fisheries sector contributed 0.5 per cent of national GDP in 2015. Currently, Nigeria produces a total of just over 1 million metric tons of fish.[4]

Nigeria was said to have recorded a deficit of over 1.5 million metric tons of fish which was lost to the annual importation of fish. According to the 2010 Report of the Nigerian Institute for Oceanography and Marine Research (NIOMR), artisanal fisheries in inshore marine, estuarine and freshwater areas contribute to approximately 85% of Nigeria's total fish supply. Not many of us are aware of this.[5] Over the years, different workers have provided differing fisheries' statistics. Data on fish catch is difficult to collect in areas where industries and the non-mechanized artisans operate, and landing sites are dispersed and remote. The catching, processing and marketing of fish in the West Africa sub- region accounts for an average 4% of the GDP for the Gulf of Guinea maritime states. Senegal, Mauritania and Ghana are the leading producers, for the simple reason that their shelf areas are naturally richer in fish. The fisheries sub-sector reduces youth unemployment and is currently building profitable business ventures, especially in aquaculture, which is gaining increased attention in both the public and private sectors.[6]

Wild fish are fed and cared for by no-one and are therefore common property. Fishing is equivalent to hunting; hence fish may be considered as bush meat. The fish swimming in the ocean or in a lake or river, despite laws claiming exclusive economic zones (EEZ) and fishing rights, belong to nobody.

In theory, fish is available to anybody who can cast a net, be they rich or poor. But that is where the tragedy of fish stocks begins.

Superlatives describing the abundance of fish in the oceans provide a false sense of food security. Governments were led to believe that living aquatic resources had no difficulties with biological replenishment. Mistakenly, fish were seen as an infinite resource. However, harvests have now progressed from being selective to the present-day exploitation that has gone beyond maximum sustainable levels and maximum economic yields. Eyes have now been opened!

The majority of over 20,000 known species of fish in the world's oceans live in warm, tropical waters. But their concentrations are more heterogenic. This is to say that while the species diversity of the biomass is high, the individual numbers per species are lower than in temperate oceans, and this has consequences.[7] West Africa exploits multispecies and unstable fisheries in the Gulf of Guinea, which poses problems of management.[8] As an example, a trawl landing off Nigeria could contain as many as 40 different species, prompting the discarding of fish of lower commercial value, and harming the food web in the process. Because of higher water temperatures, tropical fish grow faster, but die earlier than species in boreal seas, even though they have thicker skulls.

A little more than 300 marine species are landed by fisheries in Nigeria. Not all of them are of commercial importance. This number also includes 50 species of sharks, rays and guitar fish, two of lobster, 15 of shrimps and prawns, 22 of crabs, 43 of clams, three of cockles, two of oysters, nine of squids, two of octopus, five of cuttlefish, and six of turtles. The highest landings from the Nigerian trawler fishery are made up of croakers, horse mackerel, snappers, threadfins, grunter and

barracuda, all of which are bottom-living in depths of up to about 50 metres.[9,10] Artisanal drift nets and encircling purse seines in the near-surface pelagic waters land clupeids, mainly bonga and sardinella.[11]

The Gulf of Guinea is the traditional fishing ground for its bordering countries, especially as far as artisanal fisheries are concerned.

Over the past few decades in Nigeria and in other maritime West African nations, we have witnessed the development of industrial trawler fisheries, accompanied by the operations of foreign long-distance fleets.[12] Many of these foreign vessels fish under licensed agreements. Others poach stocks without authorization, but with native collusion at the highest levels.

After Independence in 1960, the Federal Government of Nigeria established the Federal Department of Fisheries (FDF). It was soon followed by the creation of the Nigerian Institute for Oceanography and Marine Research (NIOMR) in Victoria Island. By 1970 the trawler fleet in Lagos and Port Harcourt had made enough profitable returns to encourage expansion of industrial fishing. Exclusive Economic Zones (EEZs) were introduced in 1974, after a series of United Nations Conferences on the Law of the Sea (UNCLOS).

The EEZ is an area of coastal water and seabed within a certain distance of a country's coastline, to which the country claims exclusive rights for fishing, drilling and other economic activities. But the sovereignty of a coastal state extends beyond its land territory to an adjacent belt of sea not exceeding 12 nautical miles (nm), described as its territorial sea. The EEZ of Nigeria extends to 200 nm and covers an area of 180,000 square kilometers (km^2). A nautical mile is equal to appoximately 1.151 miles or 1.852 kilometers.

It was after the introduction of EEZs that the first

multilateral fishing agreements were established. While this piece of EEZ legislation reduced the activities of foreign vessels in West Africa, it encouraged national exploitation at high levels. In time, the trawlers began to make less returns, in terms of fish and money, as the catch per unit of effort dipped. Currently, the depressed economies of West African maritime states have permitted the return of foreign fleets, including poachers.

As early as 1980, the FAO was sounding a warning in the Gulf of Guinea, complaining that:

> The most important pelagic stocks of fish are fully exploited, or overexploited, except perhaps for the sardinellas in the Senegal-Mauritania zone. Prospects for the expansion of demersal fishing in the region as a whole are equally slight. The coastal species are overexploited everywhere, and only some species that are currently discarded could enable the total production to be increased. The deepwater stocks, on the other hand, seem to be underutilized, even though their potential appears to be less. [13]

If trawler fishing in Nigeria landed about 60,000 tons of finfish and shellfish in the start-up years of the early 1960s, a peak of 244,000 tons was achieved in 1970. The increase in fishing effort through licensing of more vessels later began to bring in less harvest, as 1980 yielded approximately 180,000t; 1990, 160,000t; 2000, 120,000t; and 2010, 60,000t.[14,15] This Rise and Fall of the Fishing Empire in Nigeria was computed from statistics of Annual Reports of NIOMR and the FAO.

Industrial fishing across the world's oceans, driven by the developed nations of the world, has experienced rapid technological change that increases fish landings enormously. Today's fishing fleets are aptly described as factory ships -

equipped with sonar, fish finders, freezer and processing compartments, and even spotter helicopters for surface-swimming tuna. For years, trawlers capable of sweeping the ocean floor, and ships trailing drift nets and long lines baited with thousands of hooks, have damaged once-abundant fisheries to the point where, the United Nations says, 90 per cent of them are now fully exploited or depleted.[16] Multilateral agencies and financial institutions, including local banks, share the blame for pontificating about conservation of fish and shellfish stocks, but simultaneously advancing loans and credits for investments in their destructive exploitation.

The consequences for Nigeria and her neighbours have not only been higher market prices of local fish, but also increased imports of stockfish, frozen fish and canned fish, which are not cheaper. Of all the stresses that humans have inflicted on the world's oceans, including pollution and global warming, industrial fishing ranks high.

We must now add the advancing impact of climate change on marine ecosystems to the problem of overfished stocks. Freshwater fisheries in Nigeria can be categorized into river, lake, flood plain and reservoir. Fishing activities remain at the artisanal or small-scale level in Nigeria[17.] The catch, although high during the flood season, reduces drastically during the dry season after the mass cropping of fish from stagnant pools of seasonal rivers. The fish stocks in the rivers are generally replenished from their adjacent flood plains after each flood season, during which the fish breed. In view of this, any natural or artificial phenomenon such as drought or dam construction, which disrupts the natural cycle of flooding, is bound to affect fish species' diversity, both in lakes (natural or artificial impoundments resulting from dams on rivers) and in wetlands.

Hydroelectric and irrigation dams are somewhat

controversial, in view of their inadequate operations that lead to occasional flooding of communities, as well as their impact on wildlife and fish migration. The proliferation of snail vectors of the blood fluke (Schistosoma) is attributed to impoundments created by dams. This worm often causes an unpleasant disease known as schistosomiasis or bilharzia. Communities are always displaced and induced to resettle somewhere else when large dams are built. That can result in conflict.[18,19] There was some controversy in this context, before and after the construction of dams at Kainji and Akosombo in Nigeria and Ghana respectively.

Growing urbanization in Nigeria is responsible for high pollution levels around the country's freshwater systems. Most of them are choked with discarded polyethylene bags, plastic bottles and containers and polypropylene drink straws, to name a few of the waste products that are dumped in waterways. Contaminated water in rivers and lakes, which rural populations sometimes drink, is the primary cause of amoebic dysentery, typhoid, diarrhoea and other gastro-intestinal ailments.

In the Argungu area of Kebbi State, as well as in most parts of the Sokoto-Rima River floodplain ecosystem, active fishing takes place during the dry season (January to April). During the wet season months (May to September), fishermen engage in farming and only fish part-time. This area is noted for its Fishing Festival which has gained both national and international recognition.

The Argungu festival started almost 100 years ago, when the Emir of Sokoto, Hussan Dan Muhazu, came to Argungu to make peace with the Emir of Argungu after a series of wars between the Kabawas and the Fulanis. According to local history, to entertain the Emir of Sokoto, the Emir of Argungu,

Mohammed Sama, authorized his people to go into the Rima River to catch fish for the visitor. Thereafter, that day was marked by a fishing festival in Argungu. Remarkably, Argungu has remained a combination of closed-season resource conservation, sport fishing and tourist attraction. In other locations of northern Nigeria, freshwater fishing generally commences from June or July onwards, when a rise in the river water level is noticed, and generally lasts until April.

Flooding of low-lying banks and the flow of strong currents act as stimuli to spawning fish that include the commercially important characin, assorted species of catfish, elephant snout fish, tilapia, tiger fish, and the highly-prized gymnarchus (Yoruba, *ejaosan*), *giwanruwa* (Hausa), and the Niger perch.

Many of these species ascend the rivers and breed in the flood plains at river mouths. At the onset of the season, the current is too strong for the fishermen to operate their traps and hooks. Brisk fishing activity close to the river mouth is for spawners that have congregated preparatory to ascending the river. The catch is sold fresh to middlemen, who move with the fishermen from lake to lake. The fishermen are not involved in any form of processing. The middlemen are responsible for the processing and preservation of the fish, usually by sun drying, smoking and frying, in preparation for the various weekly markets.

Inland/freshwater fisheries are appreciably researched in northern Nigeria. Results constitute a good reference base, even if corresponding and supporting investigations in limnology (the science of freshwater systems) have always lagged behind. In the period between 1960 and 1990, the Federal Fisheries Service, which later became the Federal Department of Fisheries (FDF), operating from Malamfatori and Baga on Lake Chad in Borno State, the Freshwater Research at Kainji Lake

and the Hadejia-Nguru Wetlands project (Nigeria's sole Ramsar Site) prepared taxonomic lists, accounts of stock sizes and population dynamics from Nigeria's rivers, lakes and wetlands. The species composition of fish has not changed, but the harvest which was previously stable is reportedly lower, on account of the armed conflicts in the north of Nigeria.

Drawing from multiple sources, 40-70% of 200 million Nigerians live within 100 km of an Atlantic shoreline. This strip of coast is vulnerable to accelerated sea-level rise and extreme weather events. Undoubtedly, the mangrove forests in the Niger Delta were once the fourth largest in the world. They are still, however, among the last pristine ecosystems in Nigeria. Currently, Nigeria's mangrove stands are disappearing at an alarming rate, even though this form of vegetation protects the shoreline against erosion and storm surges by trapping sediments within aerial root systems. The Nigerian coast is currently typified by the inexorable drainage of estuarine wetlands, dredging of marine shelf sediments and realignment of channels, in a dangerous reconfiguration of hydrology. Much of this is followed by the forceful eviction of resident communities and landgrabs for construction of new cities and ancillary infrastructure.

The shoreline of the Niger Delta, with its remarkable indentations, makes up over half of Nigeria's marine coastline. While the massive and intricate tidal creeks, pools and lagoons should ideally prevent increased human settlement within the Delta, the system supports the vast Nigerian oil and gas industry.

As the oil wells expand to the shelf waters of the Eastern Gulf of Guinea, they are followed by populations 'reclaiming' land and placing houses, roads and infrastructure over natural wetlands. Without an exchange of water and sediments

between the ocean and inland rivers, estuaries in Nigeria are dying biologically. New cities and shelters with contingent infrastructure will continue to be constructed in the Delta to back up the petroleum industry. Ocean fertility all over the world is highest in the inshore areas, up to a depth of 200 metres. That contour line encloses an important coastal area, described as the shelf, in which most marine fishing takes place. The open sea, by comparison, is a desert. On the Nigerian shelf, fertility is greatly enhanced by the influx of freshwater through the lagoons and creeks of Lagos, the Imo, Qua Ibo and Cross rivers, and the Niger Delta.[20] They jointly transport mud, decayed substances (detritus), limestone, sulphates, phosphorus, magnesium, bicarbonates, nitrogen, etc.

Like forests, oceans, rivers and lakes are self-regulating systems if left undisturbed. Thus, the continental shelf slope, that coastal marine area bordered by a 200 metre depth contour, is a huge fan of sediment, rich in nutrients, and supporting life forms of burrowing and filtering organisms and juvenile fish feeding on fine organic material. The food web is completed by larger fish feeding on smaller fish and all sizes of shellfish.

The use of pesticides has escalated in Nigeria, with the increasing awareness of their usefulness in agricultural production, post-harvest technology and public health. However, chemicals, including those used in fish culture, find their way into the aquatic environment of freshwater and coastal marine ecosystems. This happens through run-offs, flooding and indiscriminate discharges. These activities and processes affect fish and other aquatic fauna and disrupt ecosystem equilibrium. Hazards from obsolete pesticides persist.

Researchers from the laboratories at NIOMR have

published copiously on the dangers of heavy metals and polychlorinated biphenyls that constitute major components of industrial waste in highly urbanized and industrialized areas, such as Nigerian coastal cities, in particular the megacity of Lagos.[21] Heavy metals (mercury, cadmium, arsenic, chromium, thallium and lead, that are toxic or poisonous at low concentrations) and polychlorinated biphenyls (PCBs) are highly toxic industrial compounds. PCBs accumulate in the sediments at the bottoms of streams, rivers, lakes and coastal areas. These chemicals can build up in the fatty tissues of fish and other animals, and, in high concentrations, pose serious health risks to people who frequently eat contaminated fish.

Recently, community protests, as well as expert debates, have been stirred up in the traditionally volatile Niger Delta over the recent massive death of fish in its inshore waters. Why did the report emerge several days after the incident? News of dead fish washed ashore first broke on 20th February 2020, when people from Foropa and Sagbama in Brass Local Government Area, as well as the Ogbulagha Kingdom in Burutu Local Government Area of Delta State, reported "fish floating and littering our shores!" [22]

Identical reports have also come from other fishing communities along the Atlantic coastline in the Niger Delta states of Ondo, Bayelsa, Rivers, and Akwa Ibom. Could this have been a one-off occurrence? The wide media coverage of the incident would seem to suggest that, from time to time, deaths of marine organisms are reported, but not in the magnitude recently witnessed.

Amidst fears of looming epidemics, community people and a broad spectrum of civil society groups have called for responses from relevant regulatory agencies, including the National Oil Spill Detection and Response Agency (NOSDRA),

the Nigerian Maritime Administration and Safety Agency (NIMASA), the National Environmental Standards and Regulatory Enforcement Agency (NESREA) and the Nigerian Institute for Oceanography and Marine Research (NIOMR).

Angola and Nigeria are the largest oil producers in Africa. Nearly all of Nigeria's primary crude reserves are concentrated in the Delta of the Niger River. There are regular but unreported leaks from offshore platforms. Toxic dispersants sprayed to break down crude oil molecules are used to clean up operational spills. Exploitation of fish, shrimp stocks and other harvests of the living resources in the Niger Delta, including the lucrative oil palm plantations, are now carried out alongside the vast commercial oil and gas exploration of the past 60 years. People living in the area are therefore likely to be impacted by a host of environmental issues.

As a continuum, the ocean cannot be viewed only from a narrow national perspective – pollutants are shared and the dangers of sea level rise, fisheries, nutrients, toxic substances, etc are equally shared. While regional bodies exist, there is no international authority with legally binding instruments for the conservation of the oceans. Nowhere in the UN Convention of the Law of the Sea has the term "traditional fishing rights" been defined. As a result, this concept has not been adequately developed within national fisheries' legislation in Nigeria.

Toxic trace metals and hydrocarbons (organic chemical compounds composed exclusively of carbon and hydrogen) are serially reported in various Nigerian coastal areas, particularly in the more placid lagoons and creeks. Hydrocarbons belong to the group of toxic substances from the petroleum industry capable of tainting food webs and posing dangers, sometimes of a carcinogenic nature (likely to cause cancer) to human consumers of fish and shellfish. Trace

metals are the metals normally present in small but measurable amounts in animal and plant cells and which are a necessary part of nutrition and physiology. However, the ingestion of, or exposure to excessive quantities of trace metals can be toxic. Clearly, there are risks to humans in the consumption of filter feeders, organisms such as periwinkles, shrimps, crabs and fish.

Communities in the Niger Delta are no strangers to environmental degradation, ecological injustice and associated political strife. By 1995, the Niger Delta Environment Survey (NDES), instituted by companies prospecting for oil and gas in Nigeria, stated its mission as:

> In concert with the communities and other stakeholders, to undertake a comprehensive environmental survey of the Niger Delta, establish the causes of ecological and socioeconomic change over time, and induce corrective action, by encouraging relevant stakeholders to address specific environmental and related socioeconomic problems identified in the course of the Survey to improve the quality of life of the people and achieve sustainable development in the region.[23]

The NDES was completed over 15 years ago. The results have still not been made public.

Generally, early investigations conducted on the cause of environmental disasters in the Niger Delta point accusing fingers at the oil industry, which actually has little to show in terms of green credentials or corporate social responsibility. If thousands of dead fish are washed ashore in coastal Nigeria, the public feeling will always be that the oil multinationals may have something to do with it. However, the discharge of toxic substances into the sea could be caused by other sources.

Without any doubt, the activities of the oil and gas sector

serially impact the environment of the Niger Delta. But in this particular case of the marine fauna, nothing is proven yet.

Notwithstanding the doubts, justifiable pressure is mounting on the oil companies operating in the mangrove swamps and continental shelf of Nigeria to come clean and recognize that sustainable development is a concept built on the tripod of economic prosperity, effective environmental management and social responsibility.

If no scientific evidence supports any hypothesis that indicts the oil companies, what could the fish have died from suddenly, massively, and over such a short period? While there are fears that people might pick up diseases from eating fish cadavers lying on the beaches, even the fish swimming and caught in nets and traps may actually be infested with the same toxins. Chemicals in the aquatic medium are not selective. Businesses concentrated in the coastal areas of Nigeria are often accused of concentrating on their financial performance and shareholder interests and putting the financial bottom line before their wider social responsibilities, to the detriment of other stakeholder groups impacted by the business.

Early investigations on the tissues of dead croaker fish (family Sciaenidae) from the Niger Delta suggest abnormal high-level accumulation of heavy metals, above the recommended maximum permissible limits set by the Joint FAO/WHO (World Health Organization) committee, in some cases. Such occurrences in the Niger Delta are often linked to frequent crude oil spills, as well as to industrial activity around the area. Poor people are hard to dissuade from consuming dead fish, irrespective of whether the fish mortality was from ingested toxic chemicals or not.

In Nigeria, emergent research results and the civil society school of thought continue to believe that the discharge of

toxic chemicals from oil company operations at the Forcados oil export terminal is the cause of the fish deaths. The challenge is then placed at the doorstep of government-funded institutions – the marine science departments at universities in Calabar, Port Harcourt and Lagos, NOSDRA and NIOMR – to throw more light on the disaster. Their role should go beyond merely speaking in defence of the oil companies.

A preliminary report by NOSDRA actually points to slightly higher dissolved oxygen levels in the waters where samples of the dead fish were taken. Does this rule out hypoxia as a cause of death? These early investigations have hardly discussed any possibilities that sudden increases in water temperature and current variations in the Eastern Gulf of Guinea could have caused ecological hypoxia (oxygen depletion).

The problems of land-based substances that enter the seas and freshwater bodies in Nigeria are not properly researched, because the aquatic environment has been a waste dumping area for centuries. The growth of waste in coastal cities like Lagos and Port Harcourt are the best examples. Waste disposal problems are acute in Nigeria. The easy way out for industry and municipal authorities is to dispose of effluents in places where nobody sees them – especially in natural aquatic habitats.

Plastics and toxic radioactive substances are reported present in all forms of marine and freshwater systems in Nigeria. But linkages invariably have to be made to the national population growth, urban densification and spread of coastal squatter settlements, dredging of the marine shelf, drainage of wetlands and to the construction of cities with supporting infrastructure like airports, seaports, oil refineries, etc.

Carcasses of boats littered on the Nigerian coast also have

an impact on water quality, and therefore on fish. The tendency to jettison cargo, including decaying products from fish cold rooms, in the attempt to keep endangered vessels afloat, or to make room for more valuable catch such as shrimps, is common practice in the high seas. There are no records of what is dumped into the sea of Nigeria. Additionally, the transportation and dumping of toxic cargo from distant places on the Nigerian coastline is not well-documented, despite the Koko toxic waste dumping incident that caused alarm in 1988 and led to the establishment of the Federal Environmental Protection Agency (FEPA), which later formed the building blocks of the Federal Ministry of Environment in Nigeria.

Clearly, we appear to know little about the potential impacts of other factors beyond heavy metals. Fish also die (though not in great numbers in a particular area) when they swallow and choke on bits of plastic which they cannot digest. The lives of fish are also affected by climate change. Climate change is not all about sea level rise and desert encroachment.

The depths of the oceans are heating up slowly. Researchers at the University of Queensland in Australia are projecting rapid temperature increases in the deeper parts of the oceans that would certainly task the adaptation of marine-living organisms to the changing regime.

Human-induced climate change threatens coastal and marine ecosystems through sea-level rise, acidification, and changes in weather patterns and water temperatures. The Intergovernmental Oceanographic Committee (IOC) now has a Committee on Ocean Processes and Climate (COPC).

Coastal areas in Nigeria are rightly included in the global hotspots of vulnerability, on account of their low-lying nature, the vast Niger Delta, and the several drowned river mouths draining into the Gulf of Guinea. There are the combined

impacts of accelerated sea level rise, subsidence, development of coastal cities, oil exploration, and activities of fisheries, that remain largely uninvestigated. These combined impacts come with a high level of disaster risk. A focus on this issue is important and should bring together the activities of the authorities working on oceanography, meteorology, coastal erosion and climate change.

Studies of the geophysics of the Nigerian coastline and the irregularities of ocean currents and circulation, rising sea temperatures, and the escalation of storm surges are currently progressing slowly, mainly due to lack of funds. But an encouraging start has been made. Results have, however, not been used appropriately in national policy development. Economic investments in oil and fishing override ecological and climate change adaptation concerns.

Ocean acidification (OA) is bad news for marine life. It occurs when CO_2 from the atmosphere is absorbed by seawater, resulting in more acidic water with a lower pH. Around a third of the CO_2 released by burning coal, oil and gas gets dissolved into the oceans. Since the beginning of the industrial era, the ocean has absorbed around 525 billion tons of CO_2, equivalent to around 22 million tons per day. [24] The rapid influx of CO_2 into the oceans is severely threatening marine life, with the shells of some animals already dissolving in the increasingly acidic seawater.

Factors such as coastal industries, shipping, agricultural runoff, and mangrove deforestation that lead to increased waste (including oil) and heat discharges, must be closely monitored as they eventually lead to higher carbon dioxide levels in the ocean. In many parts of the world's oceans that are not particularly rich in coral reefs, such as the Gulf of Guinea, OA is progressing unnoticed. Future predictions

indicate that with increases in global warming, the oceans will continue to absorb carbon dioxide and become even more acidic. The danger is that when shelled organisms (oysters, clams, snails, etc) are at risk, the entire food web, with fish as apical predators, may also be at risk.

For decades in Nigeria, fish culture has been considered as some augmentation of protein supply, and gradual amelioration of depleted marine stocks impacts this supply. Coastal aquaculture is growing, but on the coast, mangroves will have to be cut to make way for fish and shrimp ponds, destroying the nursery grounds of fish and shellfish, and inviting shoreline erosion and flooding. Additionally, aquaculture has become a source of pollution of rivers and lakes.

What future is there for fish and fisheries in Nigeria?

Nigeria is the largest market for fish in West Africa. Fish is a resource in international trade, national food security and nutritional health. The important contribution of fishery products within the agricultural sector towards alleviating poverty and improving food and nutrition security cannot be overestimated in Nigeria. Experts point to the low total daily protein consumption in Nigeria that is pegged at 45.4g per person per day, as against a minimum of 53.8g suggested by the FAO. The poor quality of Nigerians' diets is indicated by the fact that many Nigerians obtain up to 70%-90% of their calories from starchy foods and cereals.

Fish probably offers the best opportunity for increased animal protein supply for the large and growing population of Nigeria. Fish is one of the best protein sources. The protein content usually makes up more than 50% of the calories from

fish. They are therefore very high in protein, omega-3 fatty acids, vitamins and minerals. In view of their health benefits, fish are widely used when making stews and soups.

The artisanal sector, which contributes the most to fish production in Nigeria, needs credits and subsidies, storage, quality, pest and disease controls, refrigeration, transportation and distribution facilities, wider markets, and protective legislation. With marine and freshwater systems under stress from fishing, climate change and pollution, the question has often arisen in the last decades as to whether fish can be produced with increased efficiency in controlled environments.

Aquaculture/fish farming, either in freshwater ponds or in coastal marine floating cages and prefectures, is currently widespread in Nigeria. Could it address the deficit in fish production and protein supply? Is aquaculture a game changer? The FAO places the figure of fish production from aquaculture in Nigeria for the year 2018 at 291,233 tons. This puts the country at the top of the chart of aquaculture producers in Africa.

It has been estimated that if Nigeria is to be self-sufficient in fish production through fish farming, a total of about 1 million hectares of water surface must be cultivated to produce a minimum of about 1 million tons of fish per year.

On the question of pollution and fish deaths, the oil companies and the government authorities responsible for cleaning oil spills do not go far enough to ascertain the impact of the spillage on aquatic organisms. They simply clean up as much as they can, take away their equipment, then go to wait for the next spill. In this regard there could be broader collaboration between NOSDRA and coastal institutions which have expertise in marine science, not just in cleaning up oil spills.

A degree of understanding of the ecological context in which fish and shellfish live in Nigerian waters is essential. Studies on marine pollution, which are often carried out by federal and state government institutions and NGOs, appear not to be providing this much-needed information. These studies advance the 'polluter pays' principle, and stand to be criticized on the grounds that their results are seldom made public.

What the management of marine fisheries in Nigeria lacks is regulation, in terms of implementable policies, monitoring, surveillance, enforcement and, of course, research. For sustainable marine fisheries in Nigeria, the following questions may need to be answered: Are there legally binding bi-lateral treaties and agreements on fishing with other countries? With whom, and on what conditions and for what period of time? When will the fishing companies in Nigeria assist research by divulging more information on their operations? How does Nigeria prevent, deter and eliminate illegal, unreported and unregulated fishing? Why do feasibility studies on fishery investments not include an environmental and social impact assessment?

In light of controls and preservation of both the stocks of living marine resources and their environments, the issue of creating marine protected areas (MPAs) has moved back and forth from front to back burner in the past 20 years. If it is strategically attractive and sensible, how practically feasible is it? What are the expected impacts? Endangered marine turtles come ashore to lay their eggs all over the Nigerian shoreline. Old ships are sometimes used in other coastal areas of the world to create artificial reefs to which fish are attracted to live. Such fish aggregation devices (FADs), when properly marked, could become part of the structural components of

marine protected areas.

According to the World Wildlife Fund (WWF), the longer-term objective for any MPA is the establishment of a comprehensive global network of protected areas designed to conserve areas of high biological importance and productivity. [25] Nigeria and other maritime states in West Africa which are intent on MPAs must study the ecology and current uses of their coastal-marine environment thoroughly, in order not to make problematic decisions.

Again, despite the magnitude of oil installations and tanker traffic on the Nigerian shelf, there are still some tidal inlets with historical and cultural features in addition to ecological peculiarities, that deserve more targeted protection than presently. It is, therefore, incumbent on Nigeria to make a solid start to identify these natural systems and work with local communities around the vital issues of policy, legislation, funding, education, interpretation and capacity. In recognition of the fluid nature of the ocean, trans-frontier and regional MPAs are desirable. Nigeria could start within its borders with a few pilot MPAs to test their workability and impact. After all, charity begins at home! MPA networks that adjoin each other across international boundaries require a measure of international collaboration between participating countries to be effective. This will not come without the obstacles of legislative, institutional and political differences, roles and responsibilities.

A concern for the poorer nations is the poaching of their fishery resources by highly mechanized foreign fleets, some subsidized by their home governments, but all equipped with superior gear technology from the industrialised world. The damage is not just to fish and the ecosystem, but also to the people who depend on them for food and income. As a result

of poverty, some coastal West African countries are also entering into agreements for resources in their waters to be exploited by foreign vessels. What then is the scope of international obligations? And what is being done at the national level to ameliorate the impact of the activities of foreign fleets? What is a country like Nigeria doing? Does she lack the capacity to assess marine environmental impacts and achieve integrated coastal zone management? The answer is an emphatic 'yes.' Is it difficult to do so? No! So what is the problem? 'The political will' is often the refrain. That is the problem.

Another possible problem may arise from the fact that ocean research is expensive. Nigeria and neighbouring Gulf of Guinea states are unable to contribute effectively to technical and scientific knowledge of the marine environment, because their efforts falter on a lack of continuity fuelled by poor research funding. But, for over half a century, West African maritime states have been well supported in fisheries research by the Food and Agriculture Organization, UNESCO and the World Bank. There are functional regional bodies, such as the Nigeria - São Tomé and Príncipe Joint Fisheries Project.

Marine fisheries research in Nigeria was initially designed to study fish of economic importance, but not the dynamics of their populations. This implies that there was no alignment of marine ecology with fisheries science. Efforts by the Nigerian Institute for Oceanography and Marine Research hitherto concentrated on the stocks feeding at the bottom of the continental shelf in the Bight of Benin. These efforts are now complemented by work at the laboratories of the universities of Port Harcourt and Calabar. But not much is known about fish migrations within currents in the Gulf of Guinea. The exchange of research information with nations of the Congo

basin is growing, but not optimal.

Admittedly, in the 1990s the FAO, with the support of the Norwegian development agency (NORAD) and the Japanese International Cooperation Agency (JICA), started investigations with the Gulf of Guinea and Congo Basin states to ascertain the magnitude of fishery resources in deeper shelf waters, practically beyond a 50m depth.

A major objective was to provide palliative options to trawler operations, while giving the inshore fish the opportunity to recover from two decades of escalating fishing intensity. NIOMR had the strategic ambition to limit the licensing of trawlers in Nigeria. However, the trawler lobby triumphed when the government did not enforce the proposed regulations.

Results of offshore (50 – 200m depth) surveys by NORAD, NIOMR and JICA provided information on stocks of sea bream, drift fish, crabs, and trans-oceanic pelagic tuna (yellowfin and skipjack). Some trials with fish canning started at NIOMR and were successful, but the business community were cautious about venturing into industrial fish processing. The costs of acquisition of relevant machinery, and the skills to use them, as well as the costs of storage and refrigeration, and fuel for longer distance operations, remain prohibitive. Nigerian trawlers thus continue to fish in the inshore areas that are yielding fewer and fewer fish.

We certainly need better knowledge management to explain the importance of the ocean to policy makers and the multiple stakeholders in the fisheries sector. This could be done by extension and liaison work, a niche that civil society could occupy and nurture. Like forests, few Nigerians appreciate what goes on in the oceans, because we do not live in them. The NGOs could also become vehicles of conflict resolution in the

uses of the ocean. What about school syllabuses and curricula? How are Nigerian children learning about ocean life in the classroom?

Fish, the property of the commons, may appear to be manna from heaven from a distance. But in reality, it is subject to conflicts. A notion from the World Bank infers that resource degradation, such as we witness in the marine fisheries of the Gulf of Guinea, while labelled as the result of "common property systems," often originates in the dissolution of local-level institutional arrangements, whose very purpose was to give rise to sustainable resource use patterns. The result is that common property regimes are transformed into open access, in which the rate of capture drives each fisher to get as much as possible before others. The tragedy of the commons is actually the tragedy of open access.

Appendices

Dead Fish on the Niger Delta Coastline – A Call for Thorough Investigation

Community members, environmentalists and members of the FishNet Alliance have called on the relevant regulatory agencies, including the National Oil Spill Detection and Response Agency (NOSDRA), the Nigerian Maritime Administration and Safety Agency (NIMASA) and the National Environmental Standards and Regulatory Enforcement Agency (NESREA), to ensure that the cause of the dead fish washed ashore onto the Niger Delta Coastline is identified and addressed, and the perpetrators brought to book, should it be from an unnatural cause.

This call was made in a field report titled *Dead Fish Across the Atlantic Coastline of the Niger Delta* and made available to the media on 4th May 2020 by FishNet Alliance, Nigeria. Findings were gathered from field visits to affected communities, reports by other stakeholders, news publications and statements by members of the community.

According to the report, news of the dead fish was first carried by the media on 20th February 2020, when people from Ogbulagha Kingdom in Burutu Local Government Area of Delta State reported massive numbers of dead fish floating and littering their shores. "This incident has replicated itself in other fishing communities along the Atlantic coastline in the Niger Delta states of Bayelsa, Rivers, Akwa Ibom and Ondo. The species of fish mostly affected is the croaker fish, popularly called the 'Broke-Marriage' or *Onah* in the local dialect," the report stated.

The report added that, "The immediate cause of the incident is yet to be known, but there are speculations that it may be related to the activities of multinational oil and gas

production companies operating in the region. Among other pointers to the oil companies as the source of the incident are environmentalists e.g. Surveyor Furoebi Akene, who attributed the dead fish littering the Niger Delta coastline to discharge of toxic chemicals from Shell's operations at Forcados oil export terminal. Akene and other environmentalists urged the government to wake up to its responsibilities in the protection of the environment and providing services to the people.

They also called on NOSDRA to ensure that the results of the tests, when ready, reflect reality. Whereas Shell is being accused in Delta State, some persons in Chevron's host communities alleged that Chevron was responsible, and threatened to shut down the company's operations."

According to the report, "It is still not very clear why only one species of fish is affected - only a scientific investigation can determine this. One explanation given by a local fisher is that this particular fish occupies the lower section or portion of the sea/ocean. According to him, that is why fisher folk who target this fish (the *Onah*) have to set the fishing nets down deep enough. If this is true and the fish are dying from any particular pollutant, then that pollutant must be spreading at a lower level, near the seabed, where this fish species is naturally found."

The report confirmed that some persons in the community were picking up the dead fish and taking them home for consumption, or to process and sell to unsuspecting members of the public. In some communities, there were reported cases of dogs dying after consuming the dead fish. There were also fears that, if not properly and quickly investigated, this trend could continue, and even spread to other communities, given the interconnectedness of rivers in the Niger Delta and other waterways in Nigeria. These communities would need help, as

they were being faced with hardship caused by the lockdown to curb the spread of coronavirus, as well as the pollution of their waters, which are their major source of livelihood.

In the report, the Director of Health of Mother Earth Foundation, Nnimmo Bassey, expressed serious concerns, stating that when our coastlines become littered with dead fish, it is a clear indication of the toxicity of the rivers and has serious public health implications. He noted, "The dead fish are smoking guns for a serious crime. The coronavirus pandemic should not deter the relevant institutions from getting to the root of the matter. By now, NOSDRA should have let the public know exactly what the cause of the incident was, especially since there are oil platforms not too far from the coasts. This matter should not be swept under the carpet because we are focusing attention on the pandemic."

While the report acknowledged that NOSDRA and NIMASA had taken samples of the dead fish and water from the affected

areas for analyses, the stakeholders demanded a full and unbiased investigation into the issue and that perpetrators face the full weight of the law. They called on other stakeholders, especially environmental and health NGOs, to put pressure on the authorities to see this as a major disaster and to ensure that the cause of the pollution is quickly detected and the public duly alerted.

They also called for adequate sensitization to raise the awareness of people, especially in environments experiencing this phenomenon, to ensure that the dead fish were not consumed or sold, in view of possible health implications.

"While we anxiously wait for reports of investigations into this mysterious incident, affected communities should remain peaceful and follow all legal means available in addressing the situation," the report concluded.

See video report on the Bonny experience here:
https://youtu.be/2yIdB1Wldm0

Signed:
FishNet Alliance
Health of Mother Earth Foundation
Oilwatch Africa

Environmentalists Reject NOSDRA's Report on Dead Fish along Niger Delta Coastlines

We recall the reports of dead fish washing up on an extensive stretch of the Niger Delta coastline, which the media first dropped on 20th February 2020, when people from Ogbulagha Kingdom in Burutu Local Government Area of Delta State raised the alarm on the massive numbers of dead fish floating and littering their shores. Similar reports also came from fishing communities in Ondo, Bayelsa, Rivers and Akwa Ibom States.

We were pleased that the National Oil Spill Detection and Response Agency (NOSDRA) responded by taking samples of the dead fish, sediments and water from some of the affected areas for analysis – after the sustained outcry by affected communities, CSOs and other groups.

On 13th May 2020, NOSDRA issued a press release titled 'Alleged Mass Fish Kill along the Coastline of Bayelsa, Delta and Rivers States'. The title of the release played down, and even questioned the fact of the massive fish kill that was evident in many locations. The title rendered the result of the said analysis conducted by the agency questionable.

We expected a detailed and in-depth analysis from NOSDRA, done in conjunction with agencies and institutions including the Nigerian Maritime Administration and Safety Agency (NIMASA), the Nigerian Institute of Oceanography and Marine Research (NIOMR), the National Environmental Standards and Regulations Enforcement Agency, and the Federal Institute for Fisheries Research, which they said had been informed of the tragic occurrence. While the result of the laboratory analysis may reflect the true composition of the samples, the data interpretation may be misleading. For

example, it is a known fact that crude oil comes with a mix of heavy metals such as cadmium and chromium, which constitute some of the pollutants from the oil sector.

NOSDRA's conclusion that "In the light of the foregoing, noting that hydrocarbons were not responsible for the death of the fish, the plausible cause(s) could partially be attributable to other anthropogenic activities which are probably land-based" is capable of sweeping this serious issue under the carpet, while the affected communities are left to continue to live with the impacts and uncertainties that will follow.

Responding to the NOSDRA statement, Ako Amadi, a Marine Ecologist and former Head, Fisheries Resources Division of NIOMR, stated, "Fish deaths commonly result from oxygen depletion in the aquatic medium. In the case of this recent occurrence in the Niger Delta, mortalities were reportedly concentrated on the genus *Pseudotolithus*, the croaker, a bottom-feeder. It points to the fact that if the deaths had been as a result of ingestion of toxins, the entire food web, that is, the benthic fauna of invertebrates, including shrimps, crabs, zooplankton and juvenile fish, would have been affected. Evidence could then be deduced from toxicological examination of stomach contents, gills and bladder, or other respiratory and filtration organs of both dead and living croakers for comparison. This has not been the case."

Ako Amadi stated further that "The Nigerian Institute for Oceanography and Marine Research (NIOMR) in Lagos, and ancillary institutions in Port Harcourt and Calabar, have enough expertise in this regard. The residence time of suspected toxins in the benthic environment and land-based or ship transport sources are easy to determine. Aquatic toxins do not affect only particular species of fish but all the fauna in

an affected area. I also fail to see statements on tolerance of croakers and associated living organisms to variations of environmental change in the inshore waters of the affected system."

Amadi summed up his response by stressing that "The NOSDRA report hardly shows any evidence of possible links to sudden increases in water temperature and current variations in the Eastern Gulf of Guinea that could have caused ecological hypoxia (oxygen depletion), such as ocean acidification fortiûed by increased waste (including oil) and heat discharges from coastal industries and shipping as well as from agricultural runoff and mangrove deforestation. The NOSDRA's conclusions appear not to have been followed by immediate investigations, which infuses credibility cracks into the report. I hope that we can see more logical results to these investigations than what NOSDRA has currently presented."

In their short statement, NOSDRA declared twice that the contamination was not from hydrocarbon sources. The agency preferred to point fingers elsewhere when they stated that, "It is commonly observed that most industrial and domestic waste which contains heavy metals has found its way into drainages and onward transfer to the water bodies." Assuming this is true, it means the incidence was never an act of nature but a pure case of poisoning of the water bodies from sources that have to be stopped.

HOMEF believes that the report of laboratory analysis as presented by NOSDRA does not resolve the problem and can be diversionary. The Director of Health of Mother Earth Foundation (HOMEF), Nnimmo Bassey, in his reaction, expressed deep concern about the fate of the communities who depend on the affected water bodies for sustenance. He noted that the situation compounds the struggles of people in

the affected communities, who are battling the hardships brought about by restrictions occasioned by the COVID-19 outbreak.

Bassey added that what NOSDRA has reported is a very basic and tentative explanation, possibly merely aimed at ruling out the possibility of the cause being from hydrocarbons. They have mentioned the possibility of other chemicals being the cause, but went on to say that this would only affect fish in restricted areas and could not cause widespread death of fish.

He insisted that "The NOSDRA statement doesn't help the situation and doesn't erase the anxieties of the people of the region. We don't see anything curious about a specific fish species dying, as this has happened in other countries where, for example, species have succumbed to thermal or temperature increase shocks. It is true that NOSDRA focuses on hydrocarbon pollution and has restricted its review to sources in that field. Seeking to shift blame to other factors, sectors or communities cannot be the end of the story."

"The Ministry of Environment and relevant agencies have a duty to tell Nigerians what killed the fish, so that we know how to respond to this and future incidents. We are not satisfied with NOSDRA's report, as it doesn't bring closure to the saga. Explaining why we experienced massive deaths of fish on our coasts is not beyond our scientists, within and outside government," he concluded.

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About HOMEF

HOMEF is an ecological think tank and an advocacy organization promoting environmental/climate justice and food sovereignty in Nigeria and Africa.

Our main focus is on examining the roots of exploitation of resources, peoples and nations. We nurture movements for the recovery of memory, dignity and harmonious living with Mother Earth.

HOMEF believes in the rights of Mother Earth, the need to equip communities to push back oppression, and the need for justice for the environment, our food systems and natural cycles, at every level of policy engagement.

HOMEF believes in contextual solutions over externally generated and imposed ideas, and is firmly rooted in the ideals of solidarity and dignity.

Our Core Values

- Justice & equity in all circumstances
- People and the planet in harmony and free from exploitation
- Dignity (respect)
- Action (solidarity)
- Knowledge