# Assessment of the incidence of microplastics at Ndibe, Cross River, Nigeria

**Nwonumara, G. N. [1*], Okoro, P. O.[1] and Okogwu, O. I.[1]**
[1]Department of Applied Biology, Faculty of Science, Ebonyi State University, PMB 53, Abakaliki, Nigeria
*Corresponding author: ngnkwuda@gmail.com

## Abstract

The menace of microplastics in the aquatic ecosystems is of increasing concern worldwide mainly due to their impact on the entire ecosystem and human health. In order to contribute to knowledge, the incidence of microplastics in water and fish samples from Ndibe beach area of Cross River, Nigeria was studied. Ndibe beach is a recreational beach that hosts thousands of tourists and commuters annually. Recently, several residential and commercial areas have developed around the beach with attendant increase in the amount of plastics and other types of wastes deposited in and around the beach. Water samples collected from ten locations within the beach and fish samples (50 *Chrysichthys* sp. and 30 *Clarias* sp.) were analysed for microplastics using standard methods. The results showed that the water and fish samples contained microplastics of various sizes. The microplastics level was higher in water samples (68%) compared to the fish samples (32%). This calls for proper sensitization of residents and tourists around the area on the dangers associated with microplastics in aquatic ecosystem in order to regulate its discharge into and around the Cross River. This will help to mitigate the negative consequences of microplastics on the ecosystem integrity of the river and human health.

**Keywords:** Human health; Afikpo North; plastic wastes; water pollution.

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## Introduction

Plastics as contaminants in water were first reported in North America as polystyrene spherules in plankton tows along the coast of southern New England in 1970s (Carpenter *et al* 1972). Plastics have so far been found in the form of debris in different water columns and marine organisms (Galgani *et al* 1996; Kukulka *et al* 2012; Gall and Thomson 2015). The breakdown of plastic into smaller sizes known as microplastics (< 5mm) are usually influenced by wave action, light, mechanical abrasion, and temperature fluctuations (Arthur *et al* 2009). Presently, microplastics have been reported in most large water bodies including oceans, seas, lakes, and rivers. Based on size and source, microplastics could be primary or secondary (Andrady 2011; Rillig 2012; Horton *et al* 2017; Guerranti *et al* 2019). Primary microplastics include those produced during industrial or production processes (Guerranti *et al* 2019) while secondary microplastics are from the tearing, wearing, breakdown or degradation of plastic material in the environment aided by physicochemical factors (Singh and Sharma 2008; Cera *et al* 2020). For instance, microplastics from personal care products and plastic pellets produced during manufacturing are primary while those produced by abrasion of tyres, laundering of synthetic materials, road markings and city dust, transport, use and recycling of plastics are secondary (Arthur and Baker 2011; DEFRA 2012; Eriksen *et al* 2013; Galgani *et al* 2015; Boucher and Friot 2017; Imhof *et al* 2016; Horton *et al* 2017). Once microplastics get into the environment, they can be transported through wind, sewers, agricultural run-offs or storm drains to rivers, lakes and oceans (Zylstra 2013; Galgani *et al* 2015; Tibbetts 2015; Boucher and Friot 2017; Horton *et al* 2017). The presence and abundance of microplastics in the air, on land and in water (rivers, lakes, groundwater and ocean) is influenced by a combination of environmental factors including exposure to UV radiation, latitude, temperature, buoyancy and by the properties of the polymer from which they are made (Andrady 2015). Available reports show that microplastics pose risks to aquatic environments due to their ubiquity in the ecosystems, long residence times, and proclivity to be ingested by aquatic animals (Galgani *et al* 2010; Andrady 2011). Filter feeding organisms ranging from nano-zooplankton to Baleen whales ingest microplastics without noticeable hazardous effects (Andrady 2011). Meanwhile, microplastics toxicity in the organisms may arise from toxic additives or residual monomers such as bis-phenol A incorporated into the product during production (Vandenberg *et al* 2007). Intermediate products formed on degradation (Andrady 2011), dissolved chemical pollutants such as polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and perfluorooctanoic acid (PFOA) as well as metals (e.g. cadmium, zinc) that get adsorbed to microplastics in water are also sources of toxicity (Khan *et al* 2015; Boucher *et al* 2016). However, the knowledge of the toxicity of

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microplastics to aquatic organisms is low (Everaert *et al* 2020).

Studies on microplastics in aquatic ecosystems are mainly from Europe, Asia and Americas, and few from Africa and Nigeria (Akindele *et al* 2019; Briggs *et al* 2019; Ebere *et al* 2019; Verla *et al* 2019; Olarinmoye *et al* 2020). None of such studies is on the Cross River system despite the economic importance of the river and increasing human activities around the river. Ajith *et al* (2020) reported that studies on the presence and abundance of microplastics are typically local or regional and that there is need for more information from different parts of the world to provide a global scenario. Faltynkova *et al* (2021) emphasized the need for more information on the distribution and effects of microplastics in order to bridge the knowledge gap and mitigate any potential negative effects.

Hence, this study was designed to assess the incidence of microplastics in water and fish samples from Ndibe beach area of Cross River. The study provides baseline information on the presence of microplastics in water and some fish species in this section of the Cross River. It is hoped that this study will provide the foundation for further studies on microplastic pollution in this ecologically and commercially important ecosystem. We hypothesize that there will be more microplastics in the water than in the fish samples.

## Materials and methods

### Study area

Ndibe beach lies at latitude 05º 50´ 32.0´´, 05º 50´ 32.5´´N and longitude 007º 56´ 52.8´´, 007º 56´ 53.5´´E and extends over a distance of more than 0.315km along the Cross River channel in Afikpo North Local Government Area of Ebonyi State, Nigeria (Figure 1). The beach is among the numerous beaches along the Cross River channel. It is about 5 kilometers away from Eke market, which is within the centre of Afikpo town. The beach is 81.5m above sea level. It is a landing site for some fishermen, transporters, lumber men and a stopping point for researchers and tourists. Sand mining also takes place few kilometers away from the beach in the river channel. These activities keep the place busy, leading to the use and discard of plastics and plastic materials. Away from the area of major human activities on the shore, there is sparse vegetation that is predominantly made of palm trees. There are litters of plastics on both sides of the beach close to the landing site (Plate 1) and heaps of sand dumped strategically along the beach by sand miners.

### Sample collection

Water samples were collected 2m away from the shore at the surface water using new plastic bucket properly rinsed with distilled water. The samples were collected against water flow, transferred to pre-cleaned glass containers until it got to the 1 liter mark and corked immediately. Water samples were collected from ten designated locations, 30 meters away from each other. Fish samples were purchased from artisanal fish farmers at the beach and taken to the laboratory in a container for treatment and analysis. Water and fish samples were handled properly to avoid contamination during transportation to the laboratory. Both samples were collected on October, 2018 when flood water had receded and water flow restricted to the river channel.

### Pre-treatment of water and fish samples for microplastics identification

Treatment of samples for microplastics identification was carried out according to the procedures described by Kang *et al* 2020 (modified). Each water sample collected was carefully decanted in an enclosure (safety cabinet) to exclude settled large organic materials, filtered over 0.7µm Whatman GF/C glass fibre and the filter rinsed with 40ml of 35 per cent hydrogen peroxide into 100ml flat bottomed flasks (tilted at intervals). The treatments were allowed for 48 hours to digest the remaining organic matter content at room temperature.

The fish samples were washed with distilled water on arrival at the laboratory. They were dissected and the gastrointestinal tracts were removed, opened and the content emptied into pre-cleaned glass petri dishes, covered immediately and moved to safety cabinet to avoid contamination. Within the cabinet, the samples were transferred to 100ml flask and each diluted with 10ml of distilled water. Thereafter, 40ml of 35 per cent hydrogen peroxide was added to each of the samples, tilted at intervals and allowed for 48 hours to digest the organic matter content.

After 48 hours, five millilitres of Nile red was added to the pretreated samples and allowed for 24 hours. The stained samples were mounted on microscopic slides, kept in a desiccator for another 24 hours to dry. The samples were viewed on Olympus binocular microscope (Model: BHTU BH-2) fitted with AmScop-MT-300 digital camera and connected to a computer imager for microplastics identification. The microplastics images were captured and the sizes measured using the AmScop-MT-300 digital camera software.

## Results

One hundred and four (104) and forty-nine (49) microplastics were identified from the water and the stomach contents of the fish samples collected, respectively during the study (Figure 2). Sixty-eight percent (68%) of the microplastics recorded in this study were in water and 32% in fish samples.

The representative micrographs of microplastics in water and fish samples from the study area are shown on Plate 2. The microplastics were of various sizes and ranged from 2µm to 22µm (Plate 2).


**Plate 1**: Plastic litters and human activities that can introduce macro/microplastics into the river

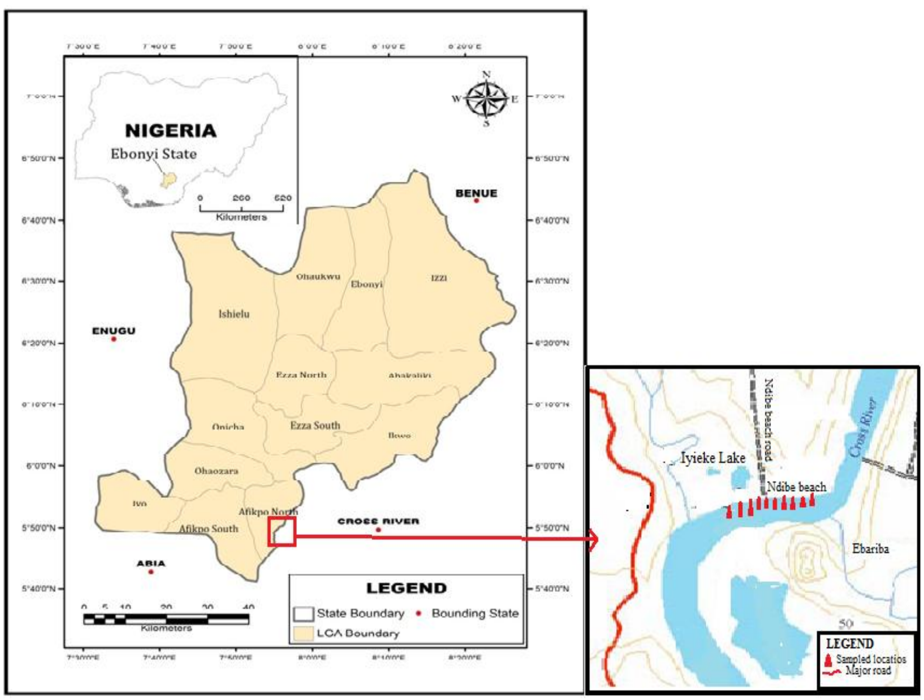


**Figure 1**: Map of Nigeria (inset) and Ebonyi State showing the location of the study site

**Discussion**

The result obtained from the analysis of water and fish samples from Ndibe beach area of Cross River showed that microplastics are present in the river and were more abundant in water than in fish samples. The presence of microplastics in the river may have been enhanced by the transport of microplastic litters from the river catchment (Plate 1) by wind action, runoffs or direct deposition into the river by humans.

Studies by Moore *et al* (2005) was among the first to report the presence of microplastics in rivers and they recorded an average of 30 to 109 items per cubic metre in three Californian rivers, and 12,000 items per cubic samples in the midstream of the Los Angeles River. The

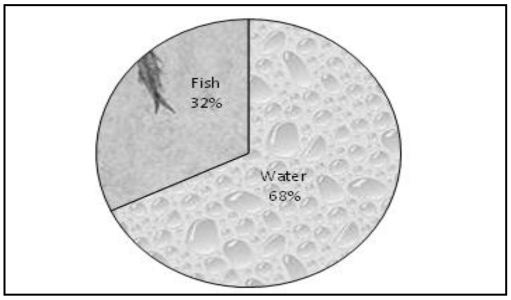


**Figure 2**: Percentage of microplastics abundance in water and fish samples

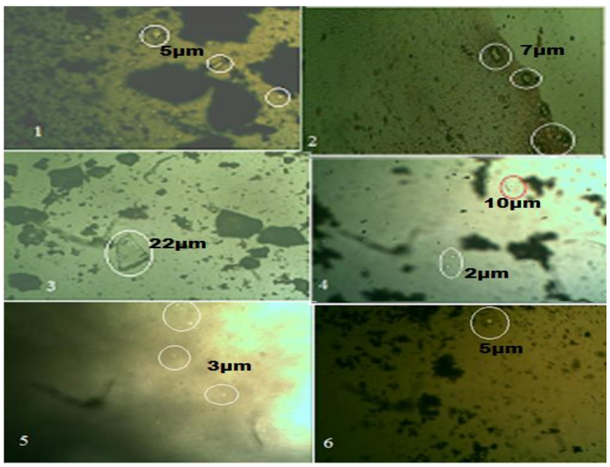


**Plate 2**: Microplastics in water and fish sample

implication of their findings was that over 1 billion microplastic items may be discharged into the Pacific Ocean then. Lechner *et al* 2014 reported about 900 and 50 plastic items of size class 0.5 to 50 mm in 1,000 cubic meters of samples from Danube River in 2010 and 2012, respectively with a discharge capacity of 1,500 tons of plastics per year into the Black sea. A recent study by Olarinmoye *et al* in 2020 in Lagos Lagoon, Nigeria showed that water samples from Liverpool, Makoko, Ojo and Agbowa had 303, 204, 184 and 139 plastic particles per litre, respectively.

The number of microplastics particles recorded in the present study was less than that reported by Olarinmoye *et al* (2020) for Lagos Lagoon. This does not imply that microplastic level in the Cross River does not exert significant harmful effects on the ecosystem as its effects may depend on species, life cycle stages of organisms and the type of microplastics present in the ecosystem. Furthermore, the presence of microplastics in the Cross River may contribute significantly to the amount of microplastics in the Atlantic Ocean, since the river empties into it.

Ingestion of microplastics by fishes could have deleterious effects such as clogging of intestinal tract, suppression of feeding due to satiation, inhibition of gastric enzyme secretion, imbalance of steroid hormone levels, and delay in ovulation and infertility (Azzarello and Vleet 1987; Wright *et al* 2013), hence affecting the fish productivity of the ecosystem. Recent study by Everaert *et al* (2020) showed the various risks associated with floating microplastics to some marine species. Similar scenario may occur in freshwater ecosystems. Since microplastics are non-biodegradable, fishes that feed on invertebrates that have previously consumed microplastics could indirectly ingest microplastics (Messinetti *et al* 2017; Lo and Chan 2018).

The sizes of microplastics recorded in the study were comparable with those reported in some species of the Phyla Mollusca, Arthropoda and Chordata in the marine ecosystem (Gregory 2009; Messinetti *et al* 2017; Detree and Gallardo-Escarate 2018; Lo and Chan 2018; Cong *et al* 2019 and Wang *et al* 2019). Meanwhile, microplastics of smaller and larger sizes have been reported in several studies (Kaposi *et al* 2014; Gray and Weinstein 2017; Jacob *et al* 2019 and Olarinmoye *et al* 2020).

From the findings of the study, it is suggested that riparian communities along the Cross River should be sensitized on the dangers associated with the presence of macro and microplastics particles in the aquatic ecosystem, especially as related to its effects on the biological, economic and social well-being of the ecosystem and humans. This might help to control indiscriminate disposal of plastic wastes around and into the river channel. Such awareness could ensure sustenance of ecosystem integrity and ecological services, and protect human health.

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