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Challenges and emerging solutions to the land-based plastic waste issue in Africa

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ABSTRACT

In recent years, there has been a tremendous increase in work that focuses on the amount and types of waste entering the marine environment from multiple geographies around the world. To date, however, there are few reports about the scale of waste entering the coastal and oceanic waters around Africa. To address this knowledge gap, existing information was collated on waste mismanagement that can become marine debris in Africa at the continental scale. This paper focuses on identifying sources and seeking solutions to waste mismanagement. Stories are shared about opportunities that have arisen and solutions that are taking place in several countries around Africa. Finally, impediments to success are discussed and sectors are described where investments can be made to significantly reduce this growing global problem.

1. Introduction

Plastic has been found on the remotest of beaches; afloat in the middle of the ocean; frozen within polar ice; building up on the sea floor; and inside marine animals and sea birds. Global cumulative production of plastic since 1950 equals 8.3 billion metric tons, with half of that being produced in the past 13 years and projected to increase in the future [1]. In fact, this manufactured material is now recognised as being one of the most noticeable pollutants affecting the ocean worldwide [2].

Recent studies have suggested that the ocean receives an estimated 8 million metric tonnes of plastic waste per year [3]. As plastic remains in the environment for hundreds of years, the trillions of plastic pieces accumulating in the ocean form part of a global pollution issue that affects all coastal countries [4]. In parallel with this stark reality, levels of awareness of this issue have grown alongside a global consensus that action must be taken to stem the flow of plastic entering the ocean.

Ecological, economic, and aesthetic damage are also associated with marine debris and especially plastic debris. Plastic waste in our ocean results in harm to wildlife [5,6, 7, 8], with nearly 700 species known to interact with anthropogenic debris [6]. While the population level impacts associated with plastic impacts on marine fauna are not well quantified across multiple taxa [5], there is still ample cause for concern. Floating plastic also provides habitat for the transport of invasive species [9], can be a navigation hazard [10], and can result in significant losses in tourism revenue, as has been reported in California [11] and Korea [12] al.,.

Current estimates of the volume and weight of plastic entering the ocean from land have been generally based on the following indicators: (i) waste generation per capita, (ii) proportion of waste that is plastic

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and (iii) percentage of waste that is mismanaged. Calculations using globally available data at the time have shown that rapidly developing economies (e.g., Southeast Asia) that have not been able to keep pace with solid waste management infrastructure can contribute significantly to marine debris [3]. However, data has been challenging to access on this subject and with even less available data available from the majority of countries in Africa, the amount of mismanaged waste in this region is more difficult to estimate with accuracy. Plastics have been used in Africa since the late 1950s, long before adequate recycling policies were in place. Hence, a significant portion of this durable material is likely to still remain in the environment.

This knowledge gap is addressed for the continent with the largest population growth globally [13]. The best available information are used to make an estimate of likely sources of marine waste in Africa. We also focused on quantifying the scale of the problem, identifying much-needed solutions and opportunities for investments. Finally, several successful interventions that are currently being employed to reduce the problem before it reaches the ocean are discussed.

2. A continental overview of Africa

Africa is experiencing unprecedented population growth with predictions that it will add 1.3 billion people to the planet by 2050 [13]. This is the equivalent of 3.5 million more people per month, or 80 additional people per minute, thus making Africa the biggest contributor to the future global population growth [13]. Furthermore, the highest rates of population growth and urbanisation are expected in the coastal zone with an estimated 49 million more people in low elevation coastal flood plains by 2060 [14]. Alongside this rapid rate of urbanisation, Africa's growing middle class is creating large consumer markets for plastic goods and those packaged in plastic with supermarkets now replacing informal shops and markets [15]. Eighty percent of the continent's GDP is concentrated in just 11 African countries (Nigeria, South Africa, Egypt, Algeria, Angola, Morocco, Sudan, Tunisia, Kenya, Ghana and Libya) - all of which are have prominent coastlines [15].

Similar to the expanding coastal populations in Africa, there are an increasing number of people, in high densities, living short distances from river systems (Fig. 1). For example, the population density of the Nile Delta is 1000 people per square kilometre which is much higher than the global average for coastal areas (80 people per square kilometre) [16]. The extensive river basins of the Niger, Congo, Zambezi and the Nile contain some of the largest cities in the world and empty a significant volume of freshwater into the Atlantic Ocean, Indian Ocean and Mediterranean Sea. A lack of adequate waste management infrastructure in these areas also means that these rivers are likely to transport a large quantity of land-based waste, including plastic pollution, as they make their way to the ocean [17].

While land-based sources of waste entering the ocean are significant, mismanaged waste resulting from Africa's shipping and maritime activities such as aquaculture and fishing also enters the ocean. Abandoned, lost or otherwise discarded fishing gear contributes an estimated additional 640,000 t of marine debris globally [18]. Similarly, studies have shown that polystyrene buoys used in aquaculture can result in large amounts of plastic debris ending up in the ocean and washed up on beaches [19, 20]. One study from a South Korean beach in close proximity to an aquaculture farm found that polystyrene particles from aquaculture contributed 95% of all plastic debris encountered [19]. With over 12 million people engaged in Africa's fisheries sector [21], plastic pollution from this sector alone is likely to be a non-trivial factor in African waters. Furthermore, given that subsistence fishing is significant in African countries and the proportion of protein intake from fish is high (i.e. 50% in Mozambique, 60% in Sierra Leone and Ghana, and 70% in Tanzania) [22], marine debris represents a potential threat to food security, economic development, the viability of the marine ecosystems and establishment of a vibrant and productive ‘blue economy’ (the term used to describe the concept of sustainable use of the ocean's resources for continued growth, economic benefit, and improved livelihoods whilst ensuring marine ecosystem health and persistence) [22].

The increasing trend in per capita consumption, urbanisation, and population growth is concerning when combined with a lack of sufficient infrastructure to manage the increased waste generation. Plastic waste presents not only an environmental issue for African countries but also a major socio-economic development challenge which impacts biodiversity, infrastructure, tourism and fisheries livelihoods. The lack of clean drinking water only exacerbates the problem, as in many city centers, even drinking water is packaged in single use sachets and plastic bags [23]. The projected growth and “business-as-usual” scenarios of mismanaged plastic waste present a significant risk to human health, the environment and the economy. For example, in the Ghanaian capital of Accra, plastic bags and other plastic consumer goods accumulated in waterways and clogged drains during heavy rains in 2015. These plastic products caused a significant flooding event in which at least 150 people died and millions of dollars of damage occurred [24]. In response to the environmental and health threat posed by plastic bags, more than 20 countries on the African continent have now put bag bans and taxes in place [25] (Fig. 2). However, appropriate enforcement mechanisms remain a challenge. Furthermore, improperly disposed waste on land may also contribute to the spread of disease by providing standing water for mosquitoes to use as breeding grounds. This can enable the spread of diseases such as Zika virus, Dengue fever, malaria and Chikungunya [26].

Although the data is patchy, a recent study estimates the quantity of mismanaged plastic waste available to enter the ocean from each of Africa's coastal and island countries [3]. Of particular relevance are Egypt, Nigeria, South Africa, Algeria and Morocco which are estimated to be among the top 20 countries around the world contributing to marine debris each year (see Fig. 3 for an estimate of the quantities of mismanaged plastic waste available to enter the ocean for 2010 and without any changes (“business as usual”), the estimated quantities of land-based waste entering the ocean by 2025). Based on the best available country-level data (from [3]), the total mismanaged plastic waste (out of 32 million metric tons globally) for the continent is estimated at 4.4 million metric tons in 2010. This could be as high as 10.5 million metric tons in 2025 if nothing changes to deliberately reduce the flow of land-based plastics to the ocean (Fig. 3).

3. Drivers, sources and movement of marine debris

Plastic and microplastic has recently been documented in and around the African continent [27]. Waste or debris can end up in the environment through a variety of pathways and as such there are often clear patterns between plastic in the marine environment and plastic waste from nearby sites. With the majority of studies on the drivers, sources and movement of debris having been conducted outside of Africa, there is a significant lack of survey data from this region. However, these patterns can be used to create models that predict the amount of waste at un-surveyed sites. As such, the information from other international studies can provide a basis for inferring contexts where the amounts are particularly high and concerted action and investment have maximum effect.

Global analyses have identified a number of variables that affect waste loads, including weather-related variables (e.g. wind force, water flows), socioeconomic factors, population density and accessibility to a particular location[28]. Studies have shown that the primary pathway for waste entering the ocean includes human movement and behaviour (littering or dropping items), vehicular transport, wind and water (i.e. along rivers, creeks, streams and stormwater outfalls)[28]. Studies have also found that human deposition was by far the most important factor in determining the debris load at a site [28]. Accordingly, it has been argued that the three strongest predictors of debris at a site had to do with economic wealth and social disadvantage in the population near