BIO-DEGRADABLE PLASTICS
Proposal for Green Technology

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ABSTRACT

Plastics have emerged to become a major domestic and industrial packaging material. Once used, plastics are disposed using conventional solid waste management technologies. In developing countries of Eastern and Southern Africa recycling of plastics is still underdeveloped. As a consequence, urban areas are often littered with plastic waste pausing serious threat and damage to the urban environment. This paper analyses the evolution of plastic industry in urban Africa including its growth as a packaging material in industry and commerce, and maps the environmental consequences of this trend. To contribute to better 'environmental governance' the paper proposes a 'green' technology to develop biodegradable plastics as a solution to the growing plastic menace.

INTRODUCTION

During the last four decades production and use of plastics in Africa has been growing steadily.[1] In country after country plastics have emerged to become a major domestic and industrial packaging material. This is demonstrated by the general increase in the production of all types of plastics. In

[1] Statistics on production and use of plastics are very difficult to come by especially because, in general, data from most countries tend to be highly aggregated.

relative terms, the market share of plastics packaging has increased over time. However, the rapid growth in production and use of plastics raises broad and complex issues, which have hitherto not been analysed and prioritised, and therefore remain largely unresolved. For example, there is need to map out the long-term impact of the growth in plastic production and use. In the absence of adequate capacity for recycling and given existing inefficiencies in urban solid waste management in most cities (Odero et al, 2002), technological solutions such as the production of biodegradable plastics need to be given serious consideration.

Once used, plastics are disposed using conventional solid waste management technologies. In developing countries of Eastern and Southern Africa recycling of plastics is still underdeveloped. As a consequence, urban areas are often littered with plastic waste pausing serious threat and damage to urban environment. This phenomenon of 'plastic pollution' has not received nearly as much attention as it deserves and/or has tended to be subsumed under general debates about the state of urban environments. Departing from the status quo, this paper analyses the evolution of plastic industry in urban Africa including its growth as a packaging material in industry and commerce, and maps the environmental consequences of this trend. To contribute to better 'environmental governance' the paper proposes a 'green' technology to develop biodegradable plastics as a solution to the growing plastic menace.

AFRICA'S PLASTIC INDUSTRY: AN OVERVIEW

In global terms, Africa's plastic industry is relatively small and underdeveloped. The plastic industry in South Africa, which is one of the most advanced, comprises polymer producers, polymer processors, plastics converters and plastics recyclers. In 1998, for example, plastics contributed 0.8%

to total GDP of South Africa. Other notable polymer producers include Algeria, Egypt, Libya, Morocco, Nigeria, Tunisia and Zimbabwe. In addition to these countries, there is a proliferation of plastics converters throughout Africa, from very small, basic, 'backyard' operations to large, highly sophisticated companies. Products commonly manufactured are pipe, cable and packaging.

The manufacture of plastics in countries such as Algeria, Libya and Nigeria is linked to the petrochemical industry. With the exception of Zimbabwe, the plastic industry in the above-mentioned countries comprises both polymer production and plastics conversion. Although Zimbabwe does not produce virgin polymer, largely due to limited natural petroleum resources, it has a relatively well-developed plastics conversion industry, particularly in the areas of plastic packaging and pipe.

ZIMBABWE'S PLASTIC MARKETS

Africa's plastic markets for both virgin and recycled materials are generally small when compared to those in Asia, Europe and the United States. Characteristically, per capita consumption of plastics in Africa ranges from less than 5 kg in the poorest countries to about 20 kg in middle-income countries. Dependence on imported chemicals by non-oil producing countries such as Zimbabwe means that domestic plastic markets are subject to trends in international market prices. Availability of foreign currency to pay for imported inputs and the relative price of local substitutes, for example coal, natural gas and salt are other additional factors that influence the market for virgin material. Virgin polymer is supplied into a wide range of markets, with the packaging sector being by far the largest. Table 1 shows the typical uses of various types of plastics.

TABLE 1: TYPE OF PLASTIC AND USE OF TYPICAL PRODUCTS	
Material	Product
Low-density polyethylene (LDPE)	Carrier bags, bin liners, squeeze detergent bottles, food storage containers, foam for sports shoes, etc.
High-density polyethylene (HDPE)	Milk and bleach bottles, bottle crates, kitchenware, toys, supermarket check-out bags, etc.
High impact polystyrene	Yoghurt pots, clear egg boxes, TV cabinets, fridge door liners, toy construction kits, disposable cups, etc.
General purpose polystyrene	Toys and jewellery, cosmetic packaging, ball point pens, cassette boxes, etc.
Foamed polystyrene	Hamburger and egg boxes, packaging for fragile objects and electronics, insulation, etc.
Polyvinyl chloride (PVC)	Squash bottles, cling film, records, watch straps, flooring wallpaper, window frames, drainage pipes, cable insulations, etc.
Polymethyl methacrylate (acrylic)	Spectacles and lenses, safety glasses, bath tubs, skylights, jewellery, car reflectors, etc.
Polypropylene	Washing up bowls, kettles, margarine tubs, freezer containers, microwave food trays, biscuit and sweet wrappers, crisp bags, string and netting, car bumpers, etc.
Polyamide (nylon)	Clothes, zip fasteners, curtain rail fittings, food mixers gears, nuts and bolts, etc.
Polyurethane	Soft furnishing foam, boot and sport shoe soles, roller skates wheels, lacquers and paints, etc.
Acrylonitrile Butadiene Styrene (ABS)	Telephones, cameras, shavers, food mixer covers, tubs and lids for margarine and salads, personal computer keyboards, car dashboards, etc.
Polyesters (unsaturated, GRP)	Car bodies, boat hulls and surf boards, etc.
Polyesters (thermoplastics, including PET)	Fizzy drink bottles, oven-ready meal dishes, coffee makers and toasters, audio and video tapes, metallised food wrapping, etc.
Polycarbonate	Babies' feeding bottles, film and slide cassettes, CDs, double glazing for conservatories, etc.
Melamine Formaldehyde	Decorative laminates such as Formica and Ware rite, quality tableware, ashtrays, etc.

Source: Department of Environmental Affairs (1993). 'The potential for using fiscal instruments to promote the recycling of plastic waste in South Africa.' **Research Report** (2), Pretoria.

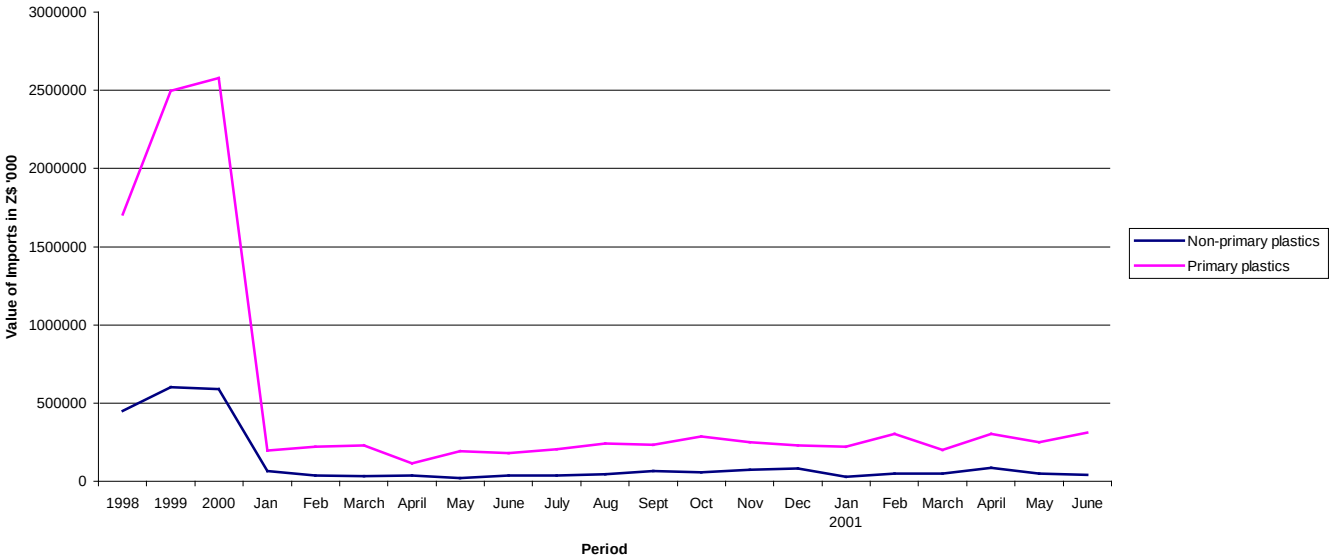
Because most African countries are net importers of plastic products, plastic markets are heavily impacted by existing international agreements regulating movement of hazardous waste across international boundaries. In general, national legislation on the subject is none existent or poorly developed.

Moreover, additions to the Montreal Protocol are making it increasingly difficult for economically disadvantaged nations to conform. Difficulty is found in implementing the protocols of Prior Informed Consent (PIC), and Persistent Organic Pollutants (POP) and standards for compliance to global climate change (MBendi Website, 2002).

In value terms, Zimbabwe's imports of plastics (in non-primary form) increased by 33.7% from Z$0.45 billion to Z$0.6 billion in the 1998-999 period before declining by 1.8% from Z$0.6 billion to Z$0.59 billion (1999-2000). Imports of plastic (in primary form) show almost a similar trend increasing by 51% from Z$1.71 billion to Z$2.58 billion (1998-2000). As Figure 1 shows, imports of plastics in non-primary form were valued at Z$0.45 million while import of plastics in primary form amounted to Z$1.7 billion. Month by month figures for 2001 show a steady stream of imports for both forms of plastic (CSO, 2001). In gross terms primary forms of plastic cost more relative to non-primary forms of plastic.

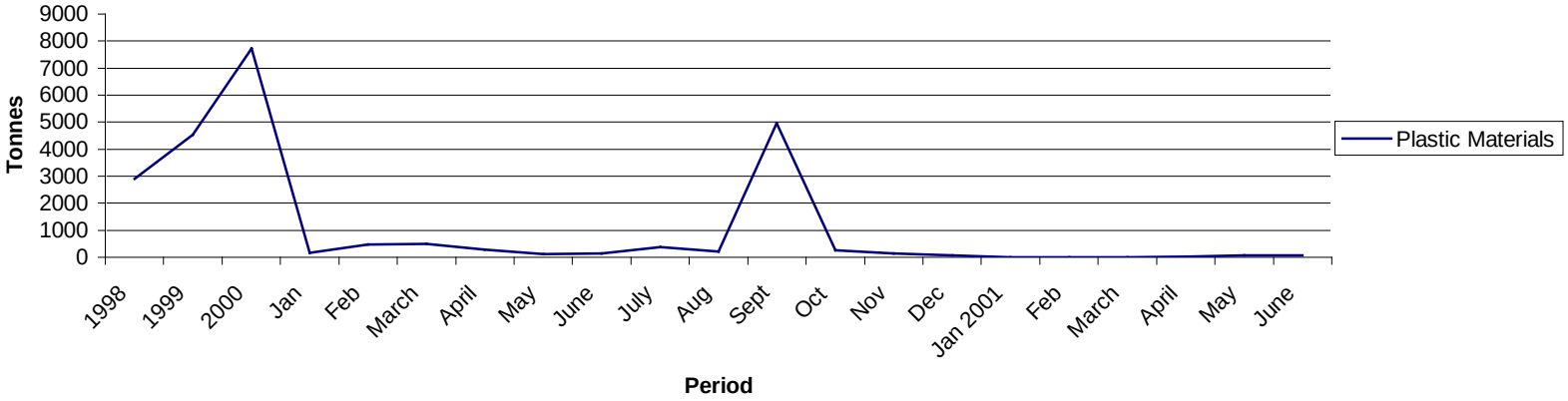
By comparison, export of plastic materials increased (in volume terms) by 165% from 2,915 tonnes in 1998 to 7,723 tonnes in 2000. Assuming the official figures are correct, there was a sharp increase of exports in September 2000, which explains the significant increase in export volumes in the 1999-2000 period (CSO, 2001). Month to month figures for the first half of 2001 show a significant drop in volume of Zimbabwe's plastic exports compared to the same period in 2000 (Figure 2).

Fig 1: Zimbabwe Plastic Imports, 1998-2001



Source: Central Statistical Office (2001). **Quarterly Digest of Statistics**, Harare: CSO, September**.**

Fig 2: Plastic Materials Exports (in tonnes), 1998-2001



Source: Central Statistical Office (2001). **Quarterly Digest of Statistics**, Harare: CSO, September.

Several factors point to increasing prices for plastic products: High inflation averaging 120% in the first half of 2002; shortage of foreign exchange; and shortage of fuel (mostly in 2001). The impact of these conditions on prices of different plastic products, consumer preferences and cost of collection is not known. However, its is reasonable to assume that in the short-term they are not likely to fundamentally alter the structure of domestic plastic markets. In the medium- to long-term, however, the government's measures to improve economic stability, which aims to manufacture more chemicals within the country so as to reduce the loss in foreign exchange, is likely to be more visible (MBendi, 2002). This policy is likely to lower the relative price of plastic products in the local market and perhaps reinforce the rapid growth in the use of plastics for various kinds of packaging (see Table 1).

PLASTICS AND THE ENVIRONMENT

Five resins or polymers account for more than 50% of all plastics used in Zimbabwe. These are the low-density polyethylene used in garbage bags; polyvinyl chloride, used in cooking oil bottles, high-density polyethylene used in milk jugs; polypropylene, used in car battery cases; and polystyrene, used in disposable food containers. Although the volume of plastics recycled in Zimbabwe is unclear, it is evident that existing capacity for recycling is far below what is generated. Much of the plastic waste ends up in municipal landfills, at best, and worse in open dump (Odero, et al, 2002).

From a solid waste management perspective, plastic waste is a problem because plastics contain additives such as colorants, stabilisers and plasticisers, which may include toxic constituents such as lead and cadmium. These compounds and other plastic additives potentially

contribute significantly to leachate produced in municipal solid waste landfills. Plastics that contain heavy metal-based additives may also contribute to the metal content of incinerator ash. Because of its resistance to degradation, littered plastics debris can have a particularly serious effect in aquatic environment (Environmental Protection Agency, 1996). Enhancing the degradation of plastics offers a viable solution for managing tonnes of post consumer plastic generated in Zimbabwe and other developing countries.

BIODEGREDABLE PLASTICS: AN INNOVATIVE SOLUTION TO MUNICIPAL AND ENVIRONMENTAL POLLUTION?

Biodegradation is an innovative technique, which applies a natural resin or polymer such as cassava starch that degrades into smaller pieces of plastics when exposed to the appropriate environment.[2] Another technology that has been proposed adds a sun-sensitive component that triggers physical disintegration when exposed to sunlight (EPA, 1996).

Laboratory research carried out in Uganda has developed techniques for extracting starch from cassava tubers. Cassava is widely grown in central parts of Africa where it forms the staple for some communities. There is scope for increasing current levels of productivity to meet food requirements and demand for industrial use. In addition, cassava can be grown under diverse agro-ecological conditions, including regions with infertile soils and low rainfall. Tolerance to low moisture and resistance to pest, among other characteristics, make cassava particularly attractive for our project in particular and for addressing poverty in semi-arid and arid lands in general.

It has been pointed out that degradable plastics do not reduce the volume or toxicity of waste produced and that for certain applications,

[2] Maize starch or vegetable oils have also been suggested as alternative natural resins.

additional plastic may be required to offset the weakening effect of adding biodegradable components (EPA, 1996). Our analysis show that the amount of additional plastics required for engineering plastics is not significantly different from what would be used with normal plastics. The level of toxicity in biodegradable plastics is significantly lower by about 30%. We also think that the 'reduction in volume' argument is spurious because, at more or less the same level of waste generation, it makes more environmental, social and economic sense to manage biodegradable plastics than normal plastics.

There is no justification for fear by plastic recyclers that degradable plastics will contaminate the recycled plastic waste stream, resulting in products that do not perform well (EPA, 1996). Even if such concerns were valid, they would not affect solid waste management in developing countries where recycling of plastic waste is still at its infancy. Priority in Zimbabwe and other African countries must be on cleaner production, hence this proposal. It would naturally be naïve to think this is a magic bullet for the problems of plastic pollution. Notwithstanding, it is has the potential to contribute substantially towards solving a serious and burgeoning urban environmental problem.

CONCLUSION

This paper has outlined the problem of solid waste management. Focusing on Zimbabwe in particular and Africa in general, the paper has discussed the evolution of plastic industry in Africa including its growth as a packaging material in industry and commerce, and mapped the environmental consequences of this trend. To contribute to better environmental governance, the paper proposes the 'engineering' of plastics to make them less resistant to degradation. Biodegradable plastics, the paper argues, are 30% less toxic than normal plastics.

However, like most environmental problems, there is no such thing as a magic bullet. This technology should be seen as one among many other environmental management devices (consumer education, recycling, etc.) designed to deal with the challenges of plastic pollution.

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