The Current Waste Generation and Management Trends in South Africa: A Review

Nhlanhla Nkosi, Edison Muzenda, John Zvimba and Jefrey Pilusa

Abstract—This paper, a continuation and expansion of the work of Muzenda et al, 2012 [1] looks at the current waste generation and management trends in South Africa. The waste tyre problem in South Africa is also briefly discussed. Solid waste management is a growing environmental problem in developing countries such as South Africa. The increasing standard of living and economic growth results in challenges in the management of both general and hazardous waste. Landfill sites life spans have been reduced and hence the need for waste minimization, utilization and alternative disposal methods. Waste tyre management is challenge as they are non compactable and non-biodegradable. The Integrated Waste Management Plan (IWMP) proposed by the Recycling and Economic Initiative of South Africa (REDISA) is a waste tyre recycling and utilization initiative. This paper is review on the current waste generation and management in South Africa. The objectives of this paper were achieved through a literature review.

Keywords—Environmental, Recycling, REDISA, Waste Hierarchy, Waste Management

I. INTRODUCTION

IN generic terms, waste can be defined as "an unavoidable by-product of most human activity". Economic development and rising living standards have increased in the quantity and complexity of generated waste. Moreover, industrial diversification and the provision of expanded health-care facilities have added substantial quantities of industrial hazardous waste and biomedical waste into the waste stream with potentially severe environmental and human health consequences. There are two fundamental waste classes, namely, general waste (municipal waste) and hazardous waste (health care risk waste and certain industrial waste). Waste tyres fall under the general waste category which gives rise to land filling, health and environmental challenges.

Waste tyres can be characterised as polymers which are non-biodegradable because of their complex mixture consisting of several rubbers, carbon black, steel cord and other organic and inorganic components.

Waste tyre has been disposed via land filling. The disposal of waste tyres is a growing environmental problem for the modern society, especially in developing countries. The major concerns are (i) tyre stockpiles provide breeding ground for mosquitoes and vermin, this in turn, causes serious diseases, thus affecting human health, (ii) fire hazards in large stockpiles that could consequently cause uncontrollable burning and air pollution, (iii) the current ''conservation of natural resource concept'', precisely, the reuse (retread) first, then reuse of rubber prior disposal, does not accommodate the ever increasing dumping of tyres, (iv) due to the high cost of legal disposal for tyres, illegal dumping may increase, (v) disposal of tyres is becoming more expensive, while this trend is likely to continue as landfill space becomes more scarce. Tyres require large quantities of air space because their volume and non compactability [2]. Different recycling processes are being practiced such as reclaiming, incineration, retreading, grinding etc. but these have weaknesses and drawbacks [3].

II. CLASSIFICATION OF WASTE

A. Waste Classes

The waste classification system is based on the concept of risk. It is accepted that there is no waste that is truly "non-hazardous", since nothing is entirely safe or ideally non-hazardous. No matter how remote the risk posed to man and the environment by a particular waste, it nonetheless exists. However, it is possible to assess the severity of the risk, and to make informed decisions on that basis. The classification system therefore distinguishes between waste of extreme hazard, which requires the utmost precaution during disposal, and waste of limited risk, which requires less attention during disposal. Thus waste is divided into two classes in accordance with the risk it poses, namely, general waste (poses little risk to the environment) and hazardous waste (poses a significant risk). For waste to be properly managed, its properties and its risk potential must be fully understood.

- General waste

General waste is waste that does not pose a significant threat to public health or the environment if properly

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managed. Examples would include domestic, commercial, certain industrial wastes and builder's rubble. General waste may be disposed of at any landfill that is permitted in terms of the Environment Conservation Act (73 of 1989) [4]. Domestic waste is classified as general waste even though it may contain hazardous components. This is because the quantities and qualities of hazardous substances in domestic waste are sufficiently minor to be a potential risk. In addition, the Minimum Requirements for Waste Disposal by Landfill require leachate control at certain general waste disposal sites.

– Hazardous waste

Hazardous waste is defined as waste that has the potential, even in low concentrations, to have a significant adverse effect on public health and the environment because of its inherent toxicological, chemical and physical characteristics. Hazardous waste requires stringent control and management, to prevent harm or damage and hence liabilities. It may only be disposed of on a hazardous waste landfill (Section 3, *Minimum Requirements for Waste Disposal by Landfill*) [4]. Applying the Precautionary Principle, waste must always be regarded as hazardous where there is any doubt about the potential danger of the waste stream to man or the environment.

TABLE I
SOURCES AND TYPES OF GENERAL WASTE

Source	Typical waste generator	Types of solid wastes
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g. bulky items, consumer electronics, batteries oil, tyres) and house hold hazardous wastes
Industrial	Light and heavy manufacturing, power and chemical plants	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes
Industrial	Stores, hotels, restaurants, markets	Paper, cardboard, plastics, wood, food wastes, glass, special wastes, metals, hazardous wastes
Institutional	Schools, hospitals, prisons, government centres	Same as commercial
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc.

III. The Waste Hierarchy

The conceptual approach to waste management is underpinned in the waste hierarchy, which was introduced into South African waste management policy through the White Paper on Integrated Pollution and Waste Management. It was a hallmark of the 1999 (National Waste Management Strategy) NWMS [5], as represented in Fig. 1. The essence of the approach is to group waste management measures across the entire value chain in a series of steps, which are applied in descending order of priority. The foundation of the hierarchy, and the first choice of the measures in the management of waste, is waste avoidance and reduction. Where waste cannot be avoided, it should be recovered, reused, recycled and treated. Waste should only be disposed of as a last resort.

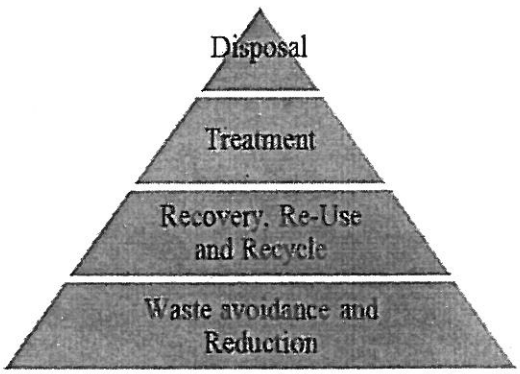

Fig. 1Waste hierarchy, 1999 [5]

The Waste Act, and consequently the NWMS address those situations in which the waste hierarchy is not implemented successfully, through providing additional measures for the remediation of contaminated land to protect human health and secure the wellbeing of the environment. Implementation of the waste hierarchy requires changes in the way products are designed and manufactured in order to promote their re-use and recycling, giving effect to the concept of 'cradle-to-cradle' waste management. This is an important advance on the previous "cradle to grave" approach, which entailed producer responsibility for the entire lifecycle of a product until its final disposal. Cradle to cradle management ensures that once a product reaches the end of its life span, its component parts are recovered, reused or recycled, thereby becoming inputs for new products and materials and this cycle repeats itself until the least possible portion of the original product is eventually disposed as shown in Fig. 2.

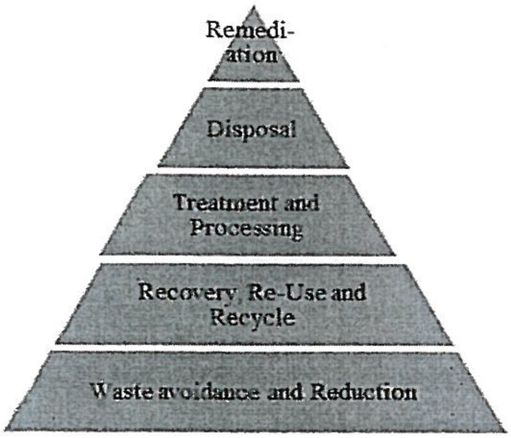

Fig. 2 Waste Hierarchy, 2010[6]

– Waste avoidance and reduction

Waste avoidance and reduction is the foundation of the waste hierarchy and is the most preferred waste management option. The aim of waste avoidance and reduction is to achieve waste minimization and thus reducing the amount of waste entering the waste stream. This is particularly relevant for waste streams where recycling, recovery, treatment or disposal of the waste is problematic. While waste minimisation is difficult to quantify, available figures indicate that waste generation per capita and per GDP (as a proxy for waste minimisation) are on the increase, as supported by the 2010 figures [6]. Waste minimisation occurs largely as a result of competitive pressures and economic incentives, and through producer responsibility initiatives implemented by industry on a voluntary basis. To date the most notable of the national government initiatives in respect to waste minimization has been the plastic bag levy initiative. This is a tax instrument being used to effect change in behavior at both consumer and industry level. Furthermore, there is also a proposed levy for the management of end of life tyres entering the waste stream.

– Recovery, re-use and recycling

Recovery, re-use and recycling make the second step in the waste hierarchy. These are very different physical processes, but have the same aim of reclaiming material from the waste stream and reducing the volume of waste generated that moves up the waste hierarchy. Recycling rates in South Africa are relatively well established [9], driven primarily by industry-led, voluntary initiatives with funds managed independently of government via non-profit organizations, which oversee the recovery or recycling processes and facilities.

– Treatment and disposal

Section 2 (a) (iv) of the Waste Act clearly indicates that the treatment and disposal of waste is a "last resort" within the hierarchy of waste management measures. In terms of waste treatment and processing, the Department of Environmental Affairs (DEA) supports the development of alternatives to land filling such as incineration, gasification, and pyrolysis. While there are cost implications for the adaptation of the incineration process as a waste processing technology, the option requires attention considering the rising costs of landfilling. It is anticipated that appropriate incineration, gasification and pyrolysis facilities will increase over time and ultimately replacing landfills as the primary waste disposal mechanism [6].

– Remediation

Remediation of the effects of waste and pollution is the final step in the waste hierarchy. There is a lack of data on the number and extent of contaminated sites in South Africa due to the various mining activities in the country plus the historical under-regulation of such areas.

IV. Waste Generation

Over 42 million cubic metres of general waste is generated every year in South Africa, with Gauteng Province contributing 42% [7]. In addition, more than 5 million cubic metres of hazardous waste is produced yearly, mostly in Mpumalanga and KwaZulu-Natal. This is a result of the concentration of mining activities and fertilizer production in these two provinces. The average amount of waste generated per person per day in South Africa is 0.7 kg [7]. This is closer to the average produced in developed countries (0.73 kg in the UK and 0.87 kg in Singapore), than to the average in developing countries such as 0.3 kg in Nepal [7]. By far the biggest contributor to the solid waste stream is mining waste (72.3%), followed by pulverized fuel ash (6.7%), agricultural waste (6.1%), urban waste (4.5%) and sewage sludge (3.6%) [8].

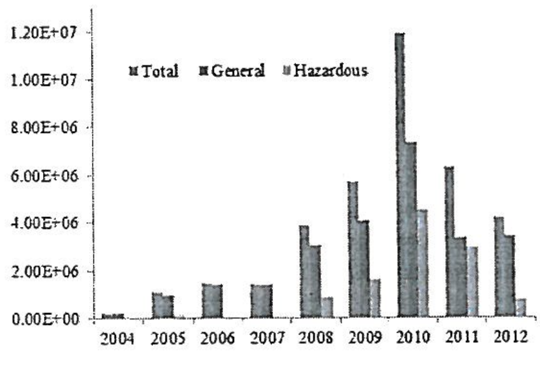

Fig. 3 General and hazardous waste disposal in tonnes [9]

South Africa has been implementing the "end on pipe" approach in the management of solid waste. Disposal at landfills was the only option utilised, hence the main focus was on acquiring land space for landfilling. Waste disposal has been increasing since 2004, Fig. 3 resulting in increased number of disposal sites, South African Waste Information Centre (SAWIC) [9]. However as result of global environmental pressure developing countries such as South Africa adopted new waste management strategies and systems as supported by the figures from 2011 to date.

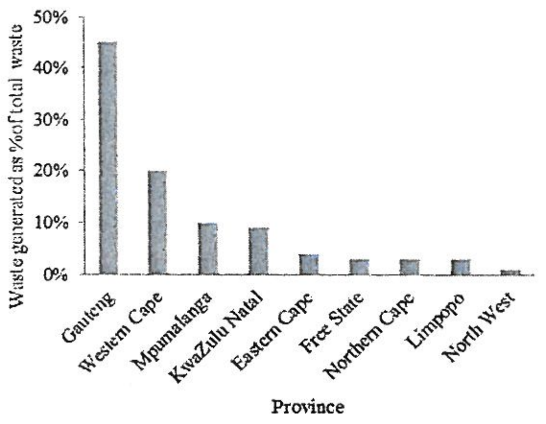

Fig. 4 Provincial municipal waste contribution in South Africa, 2011 [10]

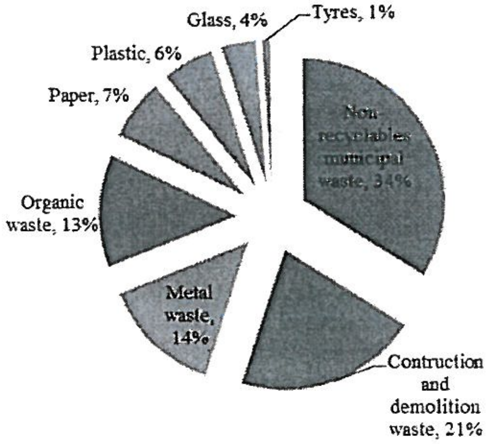

Fig. 5 General waste composition, 2011 [10]

Fig. 4 shows the provincial waste contribution in 2011 and the general waste composition is shown in Fig 5. Gauteng, the economic hub of South Africa with a population of 11328 x 10^3 in 2011[11] contributes the most to waste stream.

Globally more than 330 million tyres are discarded annually and accumulated over the years in various countries [12]. South Africa requires a plan to deal with its increasing waste tyre problem, which is increasing at a rate of about 200 000 tons per year, or one million waste tyres generated [13]. The disposal of waste tyres at landfill sites is environmentally unfavourable and discouraged as they require huge airspace relative to their weight. As a result they are often illegally dumped or burnt to recover steel for recycling. In 2009, regulations were promulgated requiring tyre producers and importers to develop an integrated industry waste plan for waste tyre management and funding. This gave rise to the REDISA Plan which was re-gazetted on the 30th of December 2012 by the Minister for Environmental Affairs.

V. Waste Management

This section centres on the current waste management practices in urban communities. Plans exist for waste management as economically and safely as possible. Waste produced by urban communities may, if left uncontrolled, not only be an aesthetic problem, but also pose serious health risks. This can be aggravated by the presence of hazardous material in the waste stream. Thus waste must be collected from all sources as efficiently as possible, and disposed of in controlled disposal facilities [14]. Various options are available for the treatment of either whole general waste or of materials separated from it for recovery/recycling or pre-treatment prior to disposal. After waste prevention and re-use, the waste management hierarchy accords the highest preference to recycling over energy recovery and disposal options.

A. Mobilisation

A common feature among the waste management options is the need for collection, sorting, processing and transport from source to the waste treatment / disposal facilities and end markets for recovered materials.

B. Recycling

The evolving standard of living in South Africa's developed commercial and industrial areas, particularly in the larger cities, reflects an increasing demand on the individual's life style and leisure preferences. These demands have changed consumption needs resulting in increased discarded goods and packaging material. Recycling diverts components of the waste stream for reuse. The success of recycling is largely dependent on the market availability for both the raw and re-manufactured products. Economically, recycled products should be priced at a rate that covers the cost of their recovery less any subsidies. The price commanded by recycled materials is highly dependent on their quality. Clean, well-sorted and contaminant-free secondary material attracts a higher price than mixed, low quality or sordid material. Low quality recycled products have no market and must be disposed of at cost [15]. Figs. 6 and 7 show the recycling rates for common general waste in 2007 and 2009 respectively. Generally there is an increase in recyclable material from 2007 to 2009, with the exception of beverage cans. This can be attributed to environmental awareness and recycling initiatives by both private and public sectors. On the contrary, the recycling of beverage cans dropped slightly during that period.

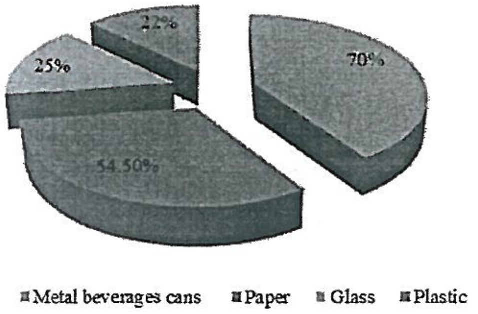

Fig. 6 Recycling rates in South Africa in 2007 [6]

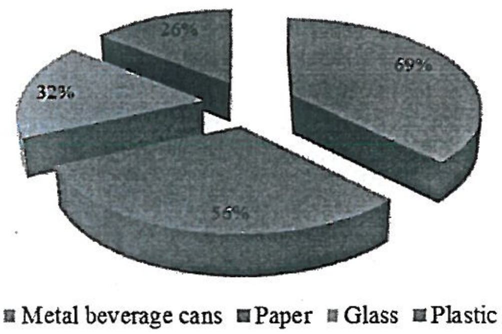

Fig. 7 Recycling rates in South Africa in 2009 [6]

C. Landfilling

Land filling involves the managed disposal of waste on land with little or no pre-treatment. The formation of landfill gas (biogas) results from the biodegradation of landfill waste. Thus landfilling is different from dumping which is characterised by the absence of control of the disposal operations and management of dump sites. Waste dumping still occurs in less-developed communities in South Africa but this is gradually disappearing [15]. The volume and content of the waste to be disposed of will dictate the size and classification of the landfill, and necessary requirements for licensing purposes. Broadly, there are two distinct types of landfills, namely; general and hazardous waste landfills. Some of the major problems associated with landfilling include (i) wind dispersing debris (ii) rodent, insect and bird infestation (sometimes disease-carrying) (iii) pollution of ground and surface water (iv) spontaneous combustion hazard, and (v) foul odours.

D. Incineration

The demand for land and the need to protect the limited groundwater resources in South Africa dictates that alternative solutions to landfilling need to be explored. Incineration as an alternative has been considered as a waste management strategy with the potential for job creation. The purpose of thermal treatment of waste (which in the narrow sense usually means combustion in incinerators) is to reduce waste bulkiness before disposal as inert inorganic ash residue. Modern incinerators are designed to recover the energy released from the combustion process and this can replace electricity and/or heat from other sources [15]. Large-scale incineration is capital-intensive, but has the advantage of; (i) reducing the volume of waste requiring landfilling (ii) combating the spread of disease (iii) providing a potential energy source.

E. Pyrolysis and Gasification

Along with the combustion technology outlined above, there is increasing interest in the advanced thermal conversion technologies of pyrolysis and gasification. These technologies differ from combustion in that the waste is first heated either in the absence of air or with a very restricted quantity of air. Organic matter is thermally broken down to give a mixture of gaseous and/or liquid products that are then used as secondary fuels. The secondary fuels are used to provide heat input for the process, thus promoting self sustainability. Some processes may also produce solid coke residues which may be used as a coal substitute. Fig. 7 shows the schematic waste cycle.

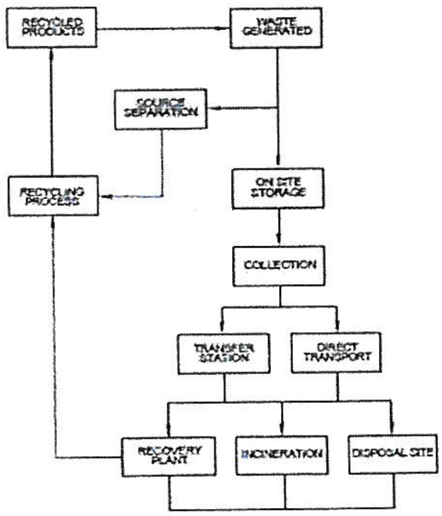

Fig. 7 The waste cycle

VI. Conclusion

The South African economy and the standard of living have been growing at a significant rate resulting in more waste generation. However due to international pressures to save and protect the environment, South Africa is required to adopt safe and ecologically waste disposal methods. This can be through recycling, re-use as well as energy and material recovery. The REDISA Plan which is awaiting implementation is expected to address the waste tyre problem.

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