SOLID WASTE STREAMS REGIONAL AND CULTURAL VARIABILITY

J E Olley
Environmental Policy and Sustainable Development (EPSD) Department, Environmental Resources Management (ERM), London, UK

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Summary

The article examines the global trend towards increasing waste generation and changing waste compositions and highlights the main factors affecting these trends. The article discusses the variations in waste generation and composition caused by: industrial and economic development; climate and seasonal variations; and cultural and religious differences.

The current situation in low, middle and high income countries is compared. Europe is used as a case study for high income countries. European efforts to deal with increasing waste arisings are evaluated with particular focus on the concept of producer responsibility and the successes and constraints of this approach highlighted. The situation in low and middle income countries is then explored using India as an example and the need to upgrade current disposal practices and build upon existing informal recycling systems is identified.

Finally the article summarizes the waste management strategies and approaches that are most likely to have a positive effect on improving waste management services and controlling the upward trend in waste arisings for high, middle and low income countries.

1. Introduction

Over the past 25 years the increase in total global waste arisings has accelerated significantly. According to the OECD the total amount of waste produced in OECD countries in 1990 was 9 billion tonnes. The global total is estimated at several times this amount. The World Conference on Environment and Development highlighted the fact that increasing waste production poses significant threats for the environment and suggested that this situation was no longer acceptable.

The aim of this article is to examine the global trend towards increasing waste generation and changing waste compositions and highlight the main factors affecting these trends. The scope of the discussion is limited to trends in municipal solid waste (MSW) arisings. Although MSW rarely makes up the largest proportion of waste arisings it is the group of most concern to the local authorities that are legally required to provide waste management services to the urban population.

The article examines how high income countries and in particular Europe, have attempted to deal with this trend and evaluates the successes and constraints of the approaches used. The article then explores the current situation in many low and middle income countries where effective and efficient waste management systems are generally less well established and regulated. The waste management system in India is used as a case study.

Finally the article summarizes the waste management strategies and approaches that are most likely to have a positive effect on improving waste management services and controlling the upward trend in waste arisings for high, middle and low income countries.

2. Factors affecting Waste Arisings

Municipal solid waste can be classified by:

- Source (household, commercial, institutional and selected industrial wastes);
- Composition (organic, inorganic, recyclable); and
- Chemical and physical characteristics (density, moisture content etc.).

The definition of municipal solid waste varies from country to country and can include all or only some of the sources listed above. The generation rate, composition and characteristics of municipal waste are affected by a number of different global and local factors and will change over time. In this section the main factors affecting waste arisings are discussed and explained.

The following factors are examined:

- Industrial and Economic Development;
- Climate and Seasonal Variations; and
- Cultural and Religious Differences

2.1 Industrial and Economic Development

The global trend in waste arisings has been towards increasing waste generation. In addition, there has been a marked change in waste composition in many countries. This trend is closely linked to levels of industrial and economic development of the country.

Industrial and economic development can be measured by considering:

- Urbanization and population growth;
- Economic growth and recession; and
- Changing consumption patterns.

2.1.1 Urbanization and Population Increase

The process of industrialization leads to the concentration of populations in urban areas and the migration of a large section of the rural population to cities in search of greater economic and social opportunities. In industrialized countries this process began during the nineteenth century and has continued to the present day.

Country	GNP Per Capita (1995 US$)	Current Urban Population (% of total)	Current Urban MSW Generation (kg/capita/day)
Low Income	**490**	**27.8**	**0.64**
Nepal	200	13.7	0.5
Bangladesh	240	18.3	0.49
Myanmar	240[a]	26.2	0.45
Vietnam	240	20.8	0.55

Country	GNP Per Capita (1995 US$)	Current Urban Population (% of total)	Current Urban MSW Generation (kg/capita/day)
Mongolia	310	60.9	0.6
India	340	26.8	0.46
Lao PDR	350	21.7	0.69
China	620	30.3	0.79
Sri Lanka	700	22.4	0.89
Middle Income	**1,410**	**37.6**	**0.73**
Indonesia	980	35.4	0.76
Philippines	1,050	54.2	0.52
Thailand	2,740	20	1.1
Malaysia	3,890	53.7	0.81
High Income	**30,990**	**79.5**	**1.64**
Republic of Korea	9,700	81.3	1.59
Hong Kong	22,990	95	5.07[b]
Singapore	26,730	100	1.1
Japan	39,640	77.6	1.47

a) Estimated GNP b) More recent figures from the Environmental Protection Department in Hong Kong give municipal waste arisings at 1.04 kg/pcd and C&I waste at 1.1 kg/employee/day

Table 1: Current Urban Municipal Solid Waste Generation

For many developing countries industrialization and urbanization has had most effect within the past 20-30 years. Currently rural to urban migration is said to account for 40-60% of annual urban population growth in the large cities of low and middle income countries. This migration has led to a large increase in waste arisings in the cities. The relationship between urbanization levels and waste generation for low, medium and high income countries in Asia is illustrated in Table1.

2.1.2 Economic Growth Rates

There is a strong link between the economic position of a country and the per capita waste generation rate. It is generally observed that as GNP and hence standard of living rises, waste generation rates also increase. Table 1 is derived from recent research in Asia and compares current urban municipal solid waste generation rates with GNP and level of urbanization in low, medium and high income countries in the region. The bolded figures show the weighted average for each of the income groups based on the information collected in this research.

Composition	High Income Countries			Cities in middle and low income countries				
	USA	Holland	UK	India (Delhi)	China (Wuhan)	South Africa (Soweto)	Peru (Lima)	Mexico (Mexico City)
Garden and food waste	25	48	25	47	16	9	56	56

Paper	35	24	30	6	2	9	14	17
Metals	10	3	8	1	0.5	3	4	6
Glass	9	9	12	0.6	0.6	12	3	4
Textiles	3	3	3	-	0.6	1	4	6
Plastics	8	7	5	0.9	0.5	3	7	6
Wood	4	1	-	-	1.8	63	12	5
Dust, ash, other unidentified	6	2	17	44.5	78			
Waste Density (kg/m^3) uncompacted	-	-	145	420	600 estmtd	400	350	
Refuse generation rate (kg pcd)	1.7	1.7	1.4	0.38	0.54	0.41	0.9	1.5

Table 2: Characteristics of MSW landfilled in low, middle and high income countries

Low income countries generally have the lowest generation rates, ranging from 0.4 - 0.9 kg pcd. In middle income countries the per capita waste generation rates increase to between 0.5 - 1.1 kg pcd. High income countries have the greatest generation rates varying from 1.1 - 5.07 kg pcd[10]. However, the figure of 5.07 kg pcd for Hong Kong would appear to be a mistake. The Environmental Protection Department of Hong Kong provides a figure of 1.04 kg/person per day of domestic waste plus 1.1 kg/employee per day for commercial and industrial waste in its recent report Monitoring of Solid Waste in Hong Kong 1997. This figure is more in line with figures from the other high income countries in Asia and would bring the weighted average closer to 1.1kg pcd.

Waste composition and characteristics are also found to vary considerably between low, middle and high income countries. Table 2 shows the varying characteristics of municipal solid waste landfilled in low, middle and high income countries. The main differences in composition are fairly consistent and can be summarized by the following points:

- The percentage of organic compostable material by mass is usually much greater in low and middle income countries except where wood and coal are still predominant over gas as a domestic fuel (see Section 2.4.1). In the latter case the percentage of inorganic material e.g. Inert materials such as dust and ash will be much greater.
- The quantity of recyclable material (e.g. Paper, plastic, metal and glass) in the waste increases with economic development;
- Waste density generally decreases as recyclables with relatively high volumes such as plastic bottles become more common in the waste stream.

2.1.3 Changing Consumption Patterns

Worldwide economic development has lead to an increase in production and consumption. As the economic situation in a country improves there is a parallel, if

uneven, increase in disposable incomes. People with higher disposable incomes begin to spend money on luxury items such as newspapers and magazines, pre-packaged food and mass produced goods. This has a knock on effect on waste composition. There is generally an increase in the percentage of consumer packaging in the waste stream. Paper, plastic, glass and metal are all more prevalent in the waste of high income countries. There is also an increase in problematic wastes e.g. electrical and electronic waste, batteries and tyres etc. In high income countries formal 'take back' and 'recycling' schemes have been introduced to deal with these wastes. In the case of low and middle income countries the informal recycling sector works to remove a significant proportion of the recyclable and problematic wastes that would otherwise require disposal. This is discussed in more detail in Section 2.3.1.

Another aspect of the consumer or 'throw away' society is the increased tendency towards litter problems. Even with collection services that are 99.9% efficient a significant proportion of waste may be dropped indiscriminately as litter in public places especially in more densely populated areas. Governments generally seek to counter this tendency by mounting public awareness campaigns e.g. the Hong Kong Bring Your Own Plastic Bag Campaign. However, these campaigns often raise awareness without bringing about any significant change in public behavior.

2.2 Climate and Seasonal Variations

The climate of a country has a number of effects upon waste arisings and composition. In particular, it has an effect on the moisture content of the waste and hence the density of waste requiring disposal. The climate also affects the speed with which the biodegradable component of the waste decomposes and therefore the required frequency of waste collection if increased risk to public health and the environment is to be avoided. Many countries run source separation schemes for compostable waste. This waste can be stored longer in the winter without degrading significantly than in the summer. Hence collection systems need to be designed to take this into account.

Finally climate can have a direct effect upon the type of food that is grown and hence the diet of the population and the subsequent biodegradable content of the waste stream. One example of the effect of diet on waste arisings comes from Uganda. A study carried out in 1989 in 7 towns in Southern Uganda found a significant day to day variation in waste arisings. Closer investigation discovered that on days when waste arisings were relatively low families were eating a type of porridge which did not produce significant waste amounts. On the other days families were eating a plantain called matoki. This plantain was purchased at the market with stem and skin still attached and significant waste quantities were generated during food preparation. Thus local eating habits had the effect of increasing average waste generation rates to a value significantly higher than would normally be expected in a low income country.

Uganda is a country on the equator and hence there are generally no marked seasonal variations to waste arisings in that country. However, elsewhere in the world significant seasonal variations are detected. The seasons can affect fuel use, diet and generation of green or yard waste. In many countries in the winter months there is a significant increase in the amount of inert material generated caused by the increased use of coal

and wood as fuel. The availability of fruit and vegetables varies seasonally and effect generation rates, biodegradable material and waste moisture content. Examples of particularly marked effects include water melon skins in some Chinese cities and coconut husks in Sri Lanka each of which can account for a significant proportion of waste in the season.

Green waste has also been shown to increase in many countries during the growing season. In the UK, the National Household Waste Analysis Project found that waste arisings rose slightly in spring and late summer and concluded that this could be attributed to the disposal of increased amounts of green waste from more affluent households.

In addition, not only are there significant increases in waste generation during public holidays and religious festivals but there is often an increase use of packaging waste e.g. wrapping paper during the Western Christmas period.

Finally, tourist resorts show a dramatic increase in waste generation rates during the holiday months. This can be a particular problem for island communities where there is only limited disposal site capacity.

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Biographical Sketch

Ms Olley is an environmental consultant specialised in municipal and industrial waste management. She is a member of the Environmental Policy and Sustainable Development (EPSD) team of Environmental Resources Management in London, UK. The main focus of her work has been on developing municipal waste management systems in low and middle income countries. She has worked on donor funded waste management projects in Asia, Africa, Eastern Europe and Latin America. Her recent assignments have taken her to destinations as far apart as Ukraine and Nicaragua.

A significant proportion of her work has been in the area of waste strategy development and implementation. She co-ordinated team inputs for the development of a national solid waste management strategy for the Philippines and is currently part of the team developing a regional industrial waste management strategy for the Kharkiv region of the Ukraine. Her professional experience also includes waste collection, treatment and disposal upgrading; capacity building and technology transfer; informal recycling and composting; project and programme evaluation and stakeholder identification and participation.

Ms Olley has prepared and carried out a number of solid waste management training courses. Most recently she developed and delivered a training course for municipal staff working in solid waste management in Cali, Colombia. She is a guest lecturer for the Solid Waste Management module of Loughborough University's Master Course in Water and Waste Engineering.