

## Chapter 10

# Innovations in Recycling for Sustainable Management of Solid Wastes

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### ABSTRACT

*Rapid generation and accumulation of waste in developing countries is due to the increase in development, urbanization, industrialization, poor government policies, and population explosion. Various kinds of waste are produced in the developing countries but due to non-availability of ecofriendly environmental techniques, lack of resources, or the technical expertise, it is becoming difficult to treat the waste at the disposal sites. Most of the waste produced in developing countries is directly disposed to the landfills without any proper sorting and segregation, where it produces greenhouse gases, thus results in global warming. Recycling and composting is helpful in reducing the volume of the waste and producing valuable products which can have multiple applications. Thus, the requirement is to manage the waste by implementing strict laws, increasing awareness, utilization of innovative, as well as latest techniques (global system of mobile, geographical information system) in order to control the growing menace of the solid waste in developing countries.*

## **INTRODUCTION**

Human activities are responsible for the creation of the solid waste which degrade quality of the environment as well as the health of organisms living in that environment (Saxena et al., 2010; Zhu et al., 2008). Solid waste is the waste that has been rejected for further use (Nandan et al., 2017) and include industrial, mining, municipal and agricultural wastes (Sharholy et al., 2007). The enormous quantity of the waste generated is due to rapid increase in development, urbanization, rapid industrialization, population explosion, poor collection, inadequate transportation (Bundela et al., 2010; Sharholy et al., 2007) and improvement in the living standards of the people (Gidde et al., 2008; Rathi, 2007). Municipal solid waste (MSW) is generally a combination of household and commercial refuse which is generated from the living community (Rajkumar et al., 2010). The waste generated mainly consists of organic matter (51%) (Jha et al., 2011) recyclables (17.5%) and inert material (31%) (Annepu, 2012). Metropolitan cities (Delhi, Mumbai, Kolkata and Chennai) account for more than 42% of India's urban population (Ghosh & Kansal 2014) and has been a top producer of MSW in India due to its high occupancy. Municipal solid waste (MSW) production has rapidly enhanced since 1960 and has drastically increased by a factor of 2.6 (Tozlu et al., 2016). According to World Bank, world cities generates about 1.3 billion tonnes of MSW and the amount is expected to reach 2.2 billion tonnes by the end of 2025 (World Bank, 2012). It has been noticed that with economic improvement, the generation of waste has increased drastically (Turan et al., 2009) and most of waste is contributed by Industries and urban cities (Nandan et al., 2017). The per capita waste generation varies with countries population size and living standards (Table 1) and excessive use of resources generates immense quantity of solid waste which is challenging global sustainability (Ziadat & Mott, 2005). All these consequences lead to severe human health hazards which can only be minimized by implementing cost effective technical and policy measures (Saleem et al., 2016).

MSW generation is influenced by economic conditions, living standards, urbanization (Liu & Wu, 2010), and population (Chiemchaisri et al., 2007). The main objectives of solid waste management are to use the waste collection and disposal techniques in economical way so that environment and human health can be easily protected (Nandan et al., 2017). Developed countries like Italy, Japan, USA, and UK are practicing zero waste concept of municipal waste management (Zia & Devadas, 2008; Mickael, 2016; Jones & Harrison, 2016; Kothari et al., 2010; Heberlein & Murphy, 2008; Tsang and Apps, 2005) and are strictly following the concept of reduce, reuse and recycle (Gutberlet, 2010). Due to improper solid waste management, waste has become one of the pollution sources that have caused diverse environment impacts as well as detrimental to human health (Mohanty et al., 2014; Das & Bhattacharya, 2013). The management of solid waste is big problem in urban areas of developing nations as continuous establishment of industries and good economic growth has resulted in increased municipal solid waste generation per person (PPCB, 2010). Current SWM systems are inefficient and emission of greenhouse gases is common problem related to these methods of waste management (Biswas, 2010). Developing countries are lacking far behind than developed countries in using latest technology for the management of the waste (Saleem et al., 2016).

## **Waste Generation in India**

The estimation of the quantity and characteristics of MSW in India and forecasting future waste generation is fundamental to successful waste management planning (Rana et al., 2014). The quantity of MSW generated depends on living standards, the extent and type of commercial activity, eating habits

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