

Review Article

Investigation on Solid Waste Management in Developing Countries

Ram Chandra Adhikari¹

Abstract

Solid waste is global problem relating to environment, society and economics. Waste management is challenging issue as the quantity has been increasing with increase of population, urbanization and economic status. Some dozens of printed and online published books, journals, dissertations, website of agencies etc. were reviewed and by making outline and following guideline this article was prepared. It is found that the waste production varies from 0.25Kg to 1.38 Kg per capita per day in developing countries. In south South American countries it was recorded 1.07 Kg/capita/day, in Asian countries 0.4 to 1.62 Kg/capita/day and in African region it was found 0.49 Kg/capita/day of waste production. The waste contains mostly biodegradable (50% to 80%). The collection system was very poor and from rural area only 10% to 20% waste and in urban area 44% to 90% of total produced waste was carried to collecting and management system. The common waste managements adopted in developing countries were open dumping, landfill site, composting, incineration and open burning etc. From 18% to 92% of waste were found to dumping. In east pacific region 46% and in American countries 68.5% of total waste was carried to landfill site. The use of incinerator is scarcely found. Only in few countries well managed composting plants could be observed. Some landfill sites and incinerating plants have generated electricity, biogas, bricks etc. Some pointed research gaps in this field are waste management and biodiversity, medicinal and hazardous waste management, vermicomposting etc. It can be recommended that for the waste management public awareness, participation of locals, application of reduction, reuse and recycling concept, waste management inside house premise, modernization and scientific management of solid wastes. Further researches are needed in different aspects of waste and management for the complete solution.

Keywords: Biodegradable, composting, landfill site, municipal waste

Introduction

Solid waste management is global issue in terms of environmental contamination, social inclusion and economic sustainability (Gupta *et al.*, 2015). Solid waste are those materials which are in solid form and we do not use at the mean time. On the other words any garbage or refuse, sludge from a wastewater treatment plant, houses, and other discarded material, resulting from industrial, commercial, mining, and agricultural

¹ Lecturer at Tribhuvan University, Department of Zoology, Post Graduate Campus, Biratnagar, Nepal, E-mail: ram.adhikari@pgc.tu.edu.np

operations, residential areas and from community activities are collectively called solid wastes. Some researchers have claimed that solid waste is not limited to wastes which are physically in solid form but may be converted to other forms and can be used in multi purposes.

The composition of solid waste varies greatly from place to place and it also depends on the community and human evolution and economic development and it changes significantly with time (Kumar *et al.*, 2016). At the beginning of 20th century, the domestic waste consisted of coal ash from open fires (Lewis, 2009).

Waste refers to materials which are byproduct but not prime product. Solid waste may be hazardous and useless material with low liquid content. Municipal garbage, industrial and commercial waste, sewage sludge, wastes resulting from agricultural and animal husbandry operations and other connected activities, demolition wastes and mining residues are included in solid wastes. Not properly managed solid wastes may have severe impact on human health on one hand and there is poor type of practice of management, i.e., landfilling technology. So, the probable and relative effects on both public health and environmental safety of tradition and modern landfill technologies will be evaluated with respect to proposed alternative treatment technologies (Hammer, 2003). The solid waste has been increasing with rapid urbanization, improved living standards and changing consumption patterns (Rao, 1985). Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area (Sharma *et al.*, 2014).

The solid waste is a burning issue in the environment sector. The advanced countries have developed many technologies which process upon the waste and after refining produce many useful materials which fill the demand of human being who are throwing the waste. But in developing countries it is established as a big problem since they could not manage it. Some researchers claimed that solid waste is not limited to wastes which are physically in solid form.

Solid waste management includes the collecting, treating, and disposing of solid material that is discarded because it has already given the service and now no longer useful in this form (Reddy, 2011). The Waste management comprises the activities and actions required to manage waste from its inception to its final disposal which is organized by the collection, transport, treatment and disposal of waste, along with monitoring and regulation of the waste management process and waste-related laws, technologies, economic mechanisms (UNSTAT, 2018).

Waste management describes all types of waste, including industrial, biological, household, municipal, organic, biomedical, radioactive wastes and it can pose a threat to human health (IFC, 2014). A developing country can be categorized with a less developed industrial base and a low Human Development Index (HDI) relative to other countries (Sullivan and Sheffrin, 2003). The United Nations has formulated some ideas to identify the developing countries. But the World Bank has stopped using these terms in favor of others, such as based on gross national income per person (UNCTD, 2018). Developing countries are those which have low human development index, undeveloped industrial base, have low living standards and socially and economically they are trying their best and also the annual per capita income between US dollar 875 to 10725 (IGI, 2017).

There is the close relation between economic level of people and solid waste production. The researchers have found a positive correlation between household waste generation and monthly income of people and household size. On the other hand, a negative correlation was found between household waste generation and the education level of the household head. Due to the low economic status people developing countries may produce less amount of solid wastes but not managed wastes have been creating many environmental and health problems. There are about 145 developing countries facing similar problems relating to the solid wastes due to urbanization, economic activity and quality of life. These problems have been accelerating with the acceleration of population growth and waste generation (Kumar *et al.*, 2019). The managements adopted in developing countries may differ than the advanced countries. Less economy may indicate poor management practices, lacking of technology and processing of wastes. Solid waste management is also an indicator of development and prosperity and it is important for health and hygiene. The general objective of the study is to assess the current situation of generation and management of solid waste in developing countries. The specific objectives are as follows: 1. To search the current situation of solid waste generation in developing countries 2. To explore the various measures adopted for its management in the same countries.

Materials and Methods

To prepare this review article some literatures were studied. Some dozens of websites of agencies, books, printed and online journals were read thoroughly. From some important article searching engines like Google scholar, PubMed, Scopus, Joster, Science.gov etc. related articles were downloaded. By sorting them out, about 45 literatures were analyzed minutely. The literatures were organized, analyzed, evaluated, synthesized and summarized. This research was based on qualitative analysis. Hence it is qualitative research.

Results and Discussion

Solid waste management (SWM) is one of the major environmental issues in cities of many developing countries. Urban population growth and economic development lead to increasing generation of municipal solid waste (MSW). Unmanaged disposal of medical wastes from hospitals and clinics also contribute to pollution and public health hazards in the localities. Therefore, SWM has become a major concern for the developing countries. Some keys of solid waste issues in developing countries were listed by intergovernmental preparatory meeting for CSD 19 in UNO head quarter. They were uncontrolled population growth in urban centers, lack of legislation and policies for realistic, long-term planning, inadequate storage and limited collection, lack of proper disposal use of inappropriate technology and equipment, scavenging and insufficient knowledge of basic principles (Diaz, 2011).

Waste generation

Since the population levels increasing, economy is booming and rapid urbanization the solid waste generation rate in developing countries has been increasing (Minghua *et al.*, 2009). A research work showed that the total annual production of wastes in major 360 towns of India was estimated 68.8 million tons per year. The data pointed 50% increase in MSW generated within a decade since 2001. Relying to the outcome of that research it would be about 160.5 million tons per year by 2041 (Annepu, 2012). Tanmoy Karak and

other two researchers overviewed the waste production globally. They after reviewing the literature found that in the average the developed countries generate 521.95–759.2 kg/person/ year solid waste. The developing countries have the data of 109.5–525.6 Kg/person/year (Karak, 2012). They also estimated that municipal solid waste generation globally exceeds 2 billion tons per year in the near future. In the context of Asian developing countries, the waste production was estimated after reviewing the previous works by Yeni and friends. According to them the waste production rate was found in between 0.4-1.62 kg/capita/day. They analyzed the composition also and mentioned occurrence of biodegradable organic waste in range of 42 to 80.2%. They reported the increasing trend of plastic waste (Yeni and Yullinh, 2012).

According to the documents of World Bank the waste production rate has been increasing in Asian developing countries. It was estimated that 1.2 billion tons of municipal solid waste was generated in 2016 and by 2030 this figure is predicted to increase to 1.5 billion tons and it would be continued and reached to 1.9 billion tons by 2050 (World Bank, 2018). Today's population 7.7 billion with the existing increment rate will reach to 11.2 billion by the end of this century (UN, 2019). Hence the waste production directly relates to the population increase.

World Urbanization Prospects shows the number of urban people in developing Asia has increased tenfold since 1950, it was 246 million, has increased to 2.27 billion in 2018 (UNDESA, 2019). The larger developing country India produces about 133760 tonnes of municipal solid waste per day but not all collected to the management system (CPCB, 2000). It can be calculated that the waste generation per capita in India ranges from 0.17 kg/day/person in small towns to 0.62 kg per person per day in large cities (Kumar *et al.*, 2009). In the context of Nepal, a mountainous developing country, waste generation from the urban areas was about 3023 tons per day and the average per capita waste generation is 0.223 kg/person/day. The waste contained 70% degradable and 25% recyclable (Adhikari and Thapa 2010). The developing countries generate lower levels of waste per capita and such wastes contain higher proportion of organic materials in which the percentage of biodegradable exceed 50% (UNEP, 2005).

By reviewing the different sources like (Mbue *et al.*, 2015) it can be plotted that the amount of waste generation in some developing countries as Buenos Aires, Argentina 1.15 kg /capita/day, Mexico 1.38 kg /capita/day and Alexandria city, Egypt 1.2 kg/capita/day. Similarly, Hanoi, Vietnam 1.06, Tehran, Iran 0.88 Puerto Cabezas, Rabat, Morocco 0.76 Nairobi, Kenya 0.72, Nicaragua Tashkent, Uzbekistan 0.55, Cameroon 0.54 Kg /capita/day. The average of these country was 1.07 Kg/capita/day.

Another study has given an interesting data of waste production. According to that the Asian developing countries are mentioned here with their waste production rate. Bangladesh produces 0.25 kg/capita/day. Bhutan 0.54, China 0.80, India 0.28, Indonesia 0.90, Nepal 0.35, Pakistan 0.84, Philippines 0.67, Sri Lanka 0.83, Thailand 1.10 and Turkey produces 0.60 Kg /capita/day wastes. The average was about 0.65 Kg/capita/day. Similarly, the American developing countries generate the waste nearly to the same as Asian. For examples: Costa Rica -0.50 kg/capita/day, Ecuador 0.50 Carmen de los 0.50 Nicaragua 0.48 Masaya 0.40 Peru 0.47 Suriname 0.47 Kg/capita/day. Daily per capita waste generation in African developing countries was as following: Ethiopia 0.32 Kenya 0.50 Malawi 0.50 South-Africa 0.65 Emfuleni 0.60 Tanzania 0.50 Zambia 0.37 Kg/capita/day (Gurrero *et al.*, 2013). The average of the waste production was 0.49 Kg/Capita/day. The maximum waste production was in South- Africa and minimum in Zambia among the African countries.

Waste management system

Waste management is a challenging problem in developing countries. In the rural areas people throw the wastes in their agricultural field or make compost mixing with cow dung. They do not have any organized waste management system and rules. The Kitchen wastes are consumed by domesticated cattle. But the population and density of residential area are increasing in rural areas too. The agriculture and livestock farming both becoming more commercialize and professional. So in the future waste may be problem even in rural part. A researcher Bolton advised that for the proper and scientific management of solid wastes in large cities and rural areas like particular geographical regions, many technical and social innovations might be required (Bolton *et al.*, 2016). Comparatively to the rural area solid waste has been established as challenging issue in urban area.

Depending upon the many circumstances the chip and best waste management systems in developing countries are burning, dumping and filling the land field site. They are found in more unscientific ways. The waste management is neglected political issue. No leader shows the commitment for it. But politics inevitably play a large role in solid waste management systems. The functioning and governance of waste management systems are affected by the relationship between central and local governments and the role of party politics in local government administration (Schubeler, 1996). There is less allocation of budget for this purpose. Some researchers in different countries pointed out low budget in this sector. They found least budget for waste collection and management with respect to the per capita gross domestic product (GDP). For example, it was 0.82% for the Region of Umbria and 1.2% for the West Bank (Maria *et al.*, 2018). The waste management has two major parts: Collection and Disposal.

Collection

In the urban area there was lack of high technology and enough facility so no all people come to access to basic household solid waste collection services. According to Tchobanoglous and Kreith, 2002 most of their municipal solid waste management facilities were found irregular, insufficient, uncontrolled and unlined dumps and low-cost, unmanaged landfills, without leachate management system (Tchobanoglous and Kreith, 2002). In this world in the year of 2015, more than two billion people were without access to such services (UNEP and ISWA, 2015).

Most of the developing countries of Asia the waste collection rates were low, with only 44% of total production. In south Asia and pacific region, the collection rate was 71%. When they do not join to the collection service it is understood they dump the wastes haphazardly (World Bank, 2018). But, some countries like India, their city areas revealed more positive result. There was a finding that about 70–80% of generated solid waste was collected for the scientific management. Among the collected waste only 9% was treated through composting and rest was disposed in uncontrolled open landfills (Talyan *et al.*, 2007).

Some more literatures mentioned the problem in collection system. In Egypt, waste collection services covered less than 30% of urban and rural areas. It is clear that rest of the waste was not clearly managed. Okot-Okumu focused the research aiming to find the collection practice of wastes. According to that, mostly practiced collection system was door to door with vehicles (Okot-Okumu, 2012). Only 85% of total waste from urban and 30% from rural area was collected to the disposal system in Latin American and Caribbean

region. In Middle East and North Africa 90 % of produced waste was collected in urban area and 74% from rural site. In Southeast East Asia and Pacific region 77% of total production is collected from urban and 45% from rural communities (World Bank, 2018). In Israel the management system was found better because the collection services cover almost all area of country (IMEP, 2010).

Disposal practices

Not only in collection but in the disposal practice also, there is not proper system and access of all people. Waste management in developing countries is found variety. Out of collected waste in East Asia and Pacific region 46% were carried to landfill, 18% directly to open dump, 24% burning or incineration, 9% of wastes were sent to recycling and only 2% to composting. The data of American developing countries and Caribbean region were taken out. According to that, out of total collected wastes 68.5% were landfilled, 26.8% were dumped into uncontrolled sites, 4.5% recycled and less than 1% waste used composting (World Bank, 2018). If the wastes did not come to the organized management system, most of them go for burning. comparatively to the town in rural areas burning practice was mostly common (Ferronato and Torretta, 2019).

Dumping and Landfilling

Some other study in the field of developing countries showed the disposal situations of solid waste. That showed that among the collected, 8% was sent to compost plant and the rest is sent to dump sites scattered in Jordan and surrounding countries which raised the high risk to public health and the environment (METAP, 2004). This situation can be generalized in countries of the regions like Syria, Palestinian, Jordan, south-east Asian, African and American countries. In Israel there was good availability of landfill sites, 15 number in different parts of country. There were recycling plants also and about 23% of total generated waste were to be recycled (IMEP, 2010). In the Gulf Arab countries about 25% of the generated solid waste was carried to compost plant (UAE-MoE, 2006). From the municipal areas waste was transported to the landfill site but the landfill site operated then were not so scientific and based on health standards. One study showed that out of the largest 50 landfill sites in the world, 17 presented in Asia, which were causing major health risks and environmental pollution due to the insufficient sanitation (Waste Atlas, 2014).

India has adopted the represented disposal practices. Joshi and Ahmad listed out the practices which were open dumping, land filling, land filling to energy generating, thermal treatment, biological treatment like aerobic and anaerobic composting, vermi composting etc. (Joshi and Ahmad, 2016).

It can be generalized after reviewing some literatures almost 65 to 80% of collected municipal solid waste was managed into landfills in developing nations. The waste if analyzed in landfill site about 40 to 70% organic content might be recorded. Hence it is the method of choice in developing nations because it is the lowest cost disposal option. Not only in developing countries but mostly developed and industrial nation also still using this method of waste management (Agamuthu, 2013).

Landfill represents the only affordable solution in developing countries. It can be modified and made effective management system by raising public awareness and improving social and economic situation (Lavagnolo, 2018). Adhikari by completing his

work suggested that the landfill site was in common in Nepal and other developing countries but it should be more scientific, professional and well managed (Adhikari, 2010).

Incineration

It is the best way of waste management specially for hazardous waste. But it not in practiced commonly. India had made three incinerator plants in Delhi. In Timarpur-Okhla waste to Energy Plant was established in 1987. It was designed to incinerate 300 tons of municipal solid waste per day to generate 3.75 MW of electricity. Unfortunately, after an interval of time it was stopped. The plant ran for 21 days of trial operations before shutting down due to the poor quality of incoming waste. Gazipur Plant Projects the processing of 1,300 tons per day of municipal waste generated in the Trans Yamuna area and produced electricity. The Narela-Bawana waste to energy plant consumed 4000 tones wastes daily and recycled the materials (Kumar, 2013).

Composting

Composting is also better method of waste management but it is also not much common because of various factors. One factor is less amount of pure biodegradable and next lacking of composting plants. One research work found that 14 of the investigated cities of India did not have composting practices but other 21 had been practicing the compost of organic wastes. Some people make compost, either at the household level, or by the private sector or municipality (Gurreo *et al.*, 2013). Composting, which is a traditional yet sustainable and environment friendly way of managing solid waste is being neglected in Nepal and Nepal like developing country. Composting even in individual(private) level was the best possible option of waste management and it will reduce even small amount of waste to be managed (Lohani, 2017). In developing countries over 50 percent of an average city's municipal solid waste could be composted. Composting is a relatively simple process, helps nature and highly compatible with other types of recycling. But such practice was found less in the countries. Composting is sustainable method of waste management with many advantages like production of bio-fertilizers, reduction of environmental pollution, income generation and low investment and operational cost. Hence it was recommended all the developing countries to apply composting (Taiwan, 2011).

Another research regarding with the composting found that the maximum probability of composting but minimum public interest for this. The research emphasized that successful composting initiatives could arise from local capacity in developing countries but the lack of municipal integration and support it was vulnerable to external factors (Oberlin and Szanto, 2011).

Conclusion

This study aimed to explore the situation of solid waste generation and existing management practices in developing countries. This research article depended on the published literatures in different websites of agencies and it also based on qualitative analysis.

The study showed that low income of family or nation -less waste generation. This study found that the waste production varies from 0.25Kg to 1.38 kg /capita/ day in developing countries. In south south American countries, it was recorded 1.07 Kg/capita/day, in Asian countries 0.4 to 1.62 Kg/capita/day and in African region it was

found 0.49 Kg/capita/day. Globally only in developing countries 109.5 Kg to 525 .6Kg/capita/year waste was produced in average. The volume of waste generation from whole nations has been found increasing. The waste contains mostly biodegradable (50 to 80%). The collection system was very poor and from rural area only 10 to 20% waste comes in collecting system. In urban area the organized management system has been collecting 44 to 90% of total produced waste.

The common waste managements adopted in developing countries were open dumping, landfill site, composting, and incineration and open burning etc. In the east pacific region about 46% and in American countries 68.5% waste of total products is carried to landfill site. From 18 to 92% of waste were found to be dumping in open field or on the bank of river. The incineration is best tool for hazardous waste management but it is scarcely found. Since the waste contains higher proportion of organic matter it has high probability of composting. At least 50% of waste was compostable. In few countries, government has made composting plant but in the community level it is commonly found. Some landfill sites and incinerating plants have generated electricity, biogas, bricket etc.

In this review some research gaps were also pointed out. Among them waste management and biodiversity, roles of microorganisms, nematodes, annelids in management and other higher classed animals, biological methods of waste management, public participation in waste management, medicinal and other hazardous waste management etc. It can be recommended to the stake holders from an individual to government that for the waste management public awareness, peoples participation, application of reduction, reuse and recycling concept, waste management inside house premise, modernization and scientific management of solid wastes.

References

- Adhikari, R.C. (2010). Household solid waste production and its management in Biratnagar sub-metropolitan city. *Bibechana* (7): 21-25. DOI:10.3126/bibechana.v7i0.4039
- Adhikari, R.C. and D. Thapa 2010. *Categorization and classification of solid waste and its management in Nepal, Including Biratnagar*. The report submitted to Biratnagar sub metropolitan city.
- Agamuthu, P. 2013. Landfilling in developing countries. *Waste Management and Research* 31(1):1–2. DOI: 10.1177/0734242X12469169
- Annepu, R.K.(2012). *Sustainable Solid Waste Management in India*. A thesis Submitted in partial fulfillment of the requirements for the degree of Master of Science in Earth Resources Engineering Department of Earth and Environmental Engineering Fu Foundation School of Engineering and Applied Science Columbia University in the City of New York
- Bolton K.,B D. Mena & G. Schories (2016). *Sustainable management of solid waste*. In: *Taherzadeh MJ, Richards T, (eds). Resource Recovery to Approach Zero Municipal Waste*. CRC Press; USA. pp 23-40
- CPCB, (2000). Central pollution Control Board. *Management of municipal solid waste in Delhi*. See http://www.cpcb.nic.in/divisionsofheadoffice/pcp/MSW_Report.pdf. [Accessed on 27 June, 2018].

- Diaz, L.F.(2011). *Solid Waste Management in Developing Countries: Status, Perspectives & Capacity Building*. Intergovernmental Preparatory Meeting for CSD-19 United Nations Headquarters New York, USA.
- Ferronato, N.& V. Torretta.(2019). Waste Mismanagement in Developing Countries: A Review of Global Issues.*International Journal of Environmental Research & Public Health*. **16**:1060
- Guerrero L.A., G. Maas& W. Hogland .(2013). Solid waste management challenges for cities in developing countries. *Waste Manag.* **33(1)**: 220-32. DOI: 10.1016/j.wasman.2012.09.008. PMID: 23098815.
- Gupta, N., K.K. Yadav&V. Kumar. (2015). A review on current status of municipal solid waste management in India. *J. Environ. Sci.* **37**: 206–217
- Hamer, G.(2003). Solid waste treatment & disposal: effects on public health and environmental safety. *Biotechnology advances* **22**(1-2):71-79.
- IFC.(2014). Editorial Board/Aims and Scope. *Waste Management*.**34(3)**: DOI:10.1016/S0956-053X(14)00026-9
- IGI- Global.(2017). <https://www.igi-global.com/dictionary/cyber-capabilityframework/7401>. [Accessed on 2nd July 2019].
- IMEP.(2010). Israel Ministry of Environmental Protection. Solid Waste Management Division <http://www.sviva.gov.il/>. [Accessed on July 3, 2018].
- Joshi, R. & S. Ahmed.(2016). Status and challenges of municipal solid waste management in India: A review, *Cogent Environmental Science*. **2**:1,1139434, DOI: 10.1080/23311843.2016.1139434
- Karak, T., R.M. Bhagat & P. Bhattacharyya.(2012). Municipal Solid Waste Generation, Composition, and Management: The World Scenario, Critical Reviews. *Environmental Science and Technology* **42**:15, 1509-1630, DOI: 10.1080/10643389.2011.569871
- Kumar, A.(2013). Existing Situation of Municipal Solid Waste Management in NCT. *Research Forum: International Journal of Social Sciences***1(1)**; ISSN: 2348 4411 Delhi, India.
- Kumar, R., D. Bhattarai & S. Neupane.(2019). Designing solid waste collection strategy in small municipalities of developing countries using choice experiment. *Journal of Urban Management*. **8**:386-395.
- Kumar, S., H. Dhar., V. Nair, J.K Bhattacharyya, A.N. Vaidya & A.B. Akolkar.(2016). Characterization of municipal solid waste in high-altitude sub-tropical regions. *Environmental Technology*. **37** (20): 2627–2637. DOI:10.1080/09593330.2016.1158322
- Kumar, S.,J.K. Bhattacharyya, A.N. Vaidya, T. Chakrabarti, S. Devotta & A.B. Akolkar.(2009). Assessment of the status of municipal solid waste management in metro cities, state capitals, class I cities, and class II towns in India: an insight. *Waste Managment*.**29**:883–895. DOI:10.1016/j.wasman.2008.04.011.

- Lavagnolo, M.C.(2018). *Landfilling in Developing Countries*. Editor(s): Raffaello Cossu, Rainer Stegmann, Solid Waste Landfilling, Elsevier, 773-796, ISBN 9780128183366. DOI: <https://doi.org/10.1016/B978-0-12-407721-8.00036-X>.
- Lewis, H. (2009). *Centenary history of waste and waste managers in London and south east England*. Pp7.Chartered Institution of Wastes Management. London
- Lohani, R. (2017). Composting: A Better Solution for Managing Nepal’s Increasing Solid Waste. *Journal of the Institute of Engineering* **13(1)**: 215-220© TUTA/IOE/PCU Nepal.
- Maria F.D., E. Lovat and C. Marco.(2018). Waste Mangement in Developed and Developing Countries: The Case Study of Umbrica(Italy) and the West Bank(Palestine).*Detritus* **3**: 171-180.DOI:10.31025/2611-4135/2018.13690
- Mbue I.N., D. Bitondo & A.B. Roland.(2015). Municipal solid waste generation, composition, and management in the Douala municipality, Cameroon. *Journal of Environment and Waste Management*, 24:91-101
- METAP.(2004). *Regional Solid Waste Management Project in Mashreq and Maghreb Countries, Jordan*. M. E. T. A. Programme.
- Minghua Z., F. Xiumin, A. Rovetta, H. Qichang, F. Vicentini, L. Bingkai, A. Giusti & L. Yi.(2009). Municipal solid waste management in Pudong New Area, China. *Journal of Waste Management* **29**: 1227–1233.
- Oberlin A. S. & G.L. Szanto.(2011). Community level composting in a developing country: case study of Kiwodet, Tanzania. *Waste Management and Research*,**29(10)**, 1071–1077. DOI: 10.1177/0734242X11402871
- Okot-Okumu, J.(2012). Solid waste management in African Cities-East Africa. *Waste management-An integrated vision*. DOI: 10.5772/50241
- Rao, C.S.(1985). Study of solid waste management for environment pollution control Engineering, Wiley Eastern limited, Delhi,India.
- Reddy, P.J. (2011). *Municipal solid waste management in Netherlands*: CRC Press/Balkema.
- Schubeler, P.(1996). Conceptual framework for municipal solid waste management in low-income countries. In: Wehrle, K., Christen, J. (Eds.), St. Gallen Switzerland: UNDP/UNCHS/World Bank/SDC Collaborative Programme on Municipal Solid Waste Management in Low-Income Countries.
- Sharma, P., K. Dhanwantri & S. Mehta.(2014). *Municipal solid waste generation, composition and management in India*. Bulletin of Amity School of Architecture and Planning, Hariyana Gurgaon India.**4(1)**: 49 -54
- Sullivan, O. and S.M. Sheffrin.(2003). *Economics: Principles in Action*. Upper Saddle River, New Jersey 07458: Pearson Prentice Hall. p. 471. ISBN 978-0-13-063085-8.
- Taiwo, A.(2011). Composting as sustainable waste management in developing countries. *Journal of environmental science and technology* **4(2)** 93-102. ISSN 1994 7887. DoI: 10.3923/jest.2011.93.102

- Talyan V., R.P. Dhiya, & T.R. Shreekrishan.(2008). State of municipal solid waste management in Delhi, the capital of India. *Waste Management* **28**. 1276–1287
- Tchobanoglous, T., G. George, K. Frank & M. Williams.(2002). Introduction, Chapter 1, in Tchobanoglous, George and Frank Keith, (eds.). *Handbook of Solid Waste Management*, McGraw-Hill.
- UAEMOE.(2006). Initial National Communication to the United Nations Framework Convention on Climate Change, United Arab Emirates.
- UNCTD .(2018). <https://unctadstat.unctad.org/en/classifications.html> [Accessed on 30 June, 2019]
- UNDESA 2019. United Nations Department of Economic and Social Affairs World Urbanization Prospects: The 2018 Revision. New York: United Nations. <https://population.un.org/wup/Publications/Files/WUP2018-Report>.
- UNEP – ISWA.(2015).United Nations Environment Programme and International Solid Waste Association (ISWA). *Global Waste Management Outlook. Osaka, Japan: UNEP and ISWA.* <http://web.unep.org/ietc/what-we-do/global-waste-managementoutlook-gwmo>.
- UNEP.(2005).Solid Waste Management." United Nations Environment Programme. Chapter III: Waste Quantities and Characteristics, 31-38. http://www.unep.or.jp/Ietc/Publications/spc/Solid_Waste_Management/index.asp [Accessed on 2nd July 2019]
- UNESAPD.(2019).United Nations, Department of Economic and Social Affairs, Population Division.World Population Prospects: Highlights (ST/ESA/SER.A/423)
- UNSTATS.(2018).United Nations Statistics Division Environment Statistics.unstats.un.org. Accessed on 27 June 2019.
- Waste Atlas.(2014). Waste Atlas: The World's 50 Biggest Dumpsites 2014 Report. D-waste.com <http://nswai.com/docs/World's20> [Accessed 28 June 2018]
- World Bank.(2018). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. Washington, DC: World Bank.
- Yeny D.& T. Yulinah.(2012). Solid Waste Management in Asian Developing Countries: Challenges and Opportunities. *Journal of Applied Environmental and Biological Sciences*. Department of Environmental Engineering, Sepuluh Nopember Institute of Technology, Campus ITS Jalan AR Hakim Sukolilo, Surabaya 60111, Indonesia.