# A CASE STUDY OF MUNICIPAL SOLID WASTE MANAGEMENT IN NEPAL COMPARED TO THE SITUATION IN THE EUROPEAN UNION AND SWEDEN

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## ABSTRACT

Nepal, situated in the Himalayan belt has a rapidly growing population together with high urbanisation rate. These factors are currently causing problems connected to municipal solid waste (MSW). E.g. leakage of hazardous substances to soil and surrounding aquatic systems, spread of odour and naturally unfamiliar materials to natural biotopes, all of which generate environmental damage and health problems. There are certain differences in waste generation and waste composition between urban areas of Nepal. In order to retrieve a broad picture of the current waste management situation, three population differentiated municipalities in different areas of the country were investigated. Studies of the MSW regarding composition and generation were conducted. Moreover, waste management in Nepal was compared with the basic waste management in the European Union (EU) and Sweden. Landfill sites (LFS) in Ghorahi Municipality, Pokhara Sub-metropolitan City and Kathmandu Metropolitan City were studied. Our studies show differences in waste composition, generation and management between the three locations. The differences are somewhat interconnected with population size and tourism. Cities with higher population and more tourism tend to have a higher generation and more diverse MSW. Nevertheless, the urban areas of Nepal are very much in need of a more structured waste management system, a system more alike the waste management of EU. Apart from structural problems, there are attitude and behavioural issues that needs to be dealt with. Further studies regarding social patterns, attitude and behaviour, as well as the economic flow of MSW, needs to be conducted in order to retrieve an even broader picture and understand important underlying issues.

## KEYWORDS

Solid waste, waste generation, waste composition

## 1 INTRODUCTION

Approximately half of the world population can be found in Asia. Moreover, more than half of the urban dwellers of the world also live in Asia. The significant projected population growth in Asia is expected to be accompanied by a massive urbanisation process. Currently,

migration from rural to urban areas in Asia is already occurring at a significant pace. Urban areas in Asia have expanded and will have to expand with an enormous rate in order to fulfil the essential needs of the growing population [4]. The generation and composition of the MSW tends to differ in correlation with socio-economic factors connected to urban areas, e.g. prosperity level [3]. Therefore, progressive and feasible MSW management is essential when MSW is generated even faster and with a dissimilar composition than before.

Nepal, situated in the Himalayan belt, is often divided into three different big regions characterised by their terrain. The so called hilly landscape constitute the major area of Nepal, followed by the mountain region and the low-landed Terai in the south. The majority of the people live in the Terai and the hilly region [13]. Even though the population living in urban areas of Nepal is quite small compared with urban areas in other developing countries, the urbanisation process in Nepal is currently drastic and the population in these areas is rapidly increasing [13]. Along with rapid population and urban growth rates, problems connected to MSW are increasing. Nepal consists of 58 municipalities with varying population size and living standards. Thus, the produced MSW differs both in terms of quantity and quality within the country .

This paper will concentrate on describing the current waste management situation of Nepal compared with MSW management in the EU and in Sweden, and give recommendations for further development. The MSW composition and generation in connection to three population differentiated municipalities will be studied. Further information regarding location, population size, growth rates, earlier studies conducted, MSW collection and sorting, connected to the three sites can be found elsewhere [10].

## 2 BACKGROUND

### 2.1 MSW Management in Nepal

Regarding the MSW management of Nepal, in the urban areas there are certain trends that can be seen as common. The sorting of MSW for re-use, re-cycling and energy recovery; domestically, industrially, commercially and institutionally, is only conducted when economical incentives are clearly recognized. That is if the waste in particular has a value for selling and can be re-used, re-cycled or recovered for energy. Objects of value are e.g. paper, metals, glass and plastics [14, 15]. Collectors bicycle around, on so called hawk cycles, from door to door in the cities in search for waste of value. The collectors can either be self-sufficient or connected to private scrap dealer’s shops, so called Kawadi shops [14].
Additionally, so called scavengers scavenge transfer stations, LFS, the streets, municipal containers and various places where MSW is deposited. The scavengers then sell their findings to Kawadi shops, from where the MSW either is sold within or in the vicinity of the municipality, or, as the major part is; finally sold to industries in India [14]. Both in rural and urban areas of Nepal, incineration of waste that has no obvious value, occur both sporadically and frequently without any energy recovery. Burning piles of waste can be seen along roads and riversides. Furthermore, inaccurate depositing of waste occurs along the river banks and even in the rivers, causing hazardous health and environmental problems in-situ as well as downstream [13].

### 2.2 MSW Management in the European Union

The MSW management, the sorting, the collection and the treatment of wastes, differs a lot within EU; still there are general similarities which all originate from the transposition of EU

directives down to national regulations. The Waste Framework Directive (Directive 2008/98/EC on Waste) was established 1975 and re-edited 2006 and 2008. The framework gives emphasis to the handling of waste expressing the importance of minimisation, the protection of the environment and human health, and requires each member state to establish and sustain waste management plans. In terms of waste handling, the framework especially gives emphasis to the waste hierarchy [7]. There are a number of subsequent directives, of which all are aligned with the principles of the waste hierarchy; reducing, re-using and re-cycling wastes before facilitating means to recover energy, and then finally disposal on LFS. The subsequent directives give focus to specific issues and waste streams, e.g. The Landfill Directive (99/31/EC), The Packaging and Packaging Waste Directive (94/62/EC), Directive on Incineration of Wastes (2000/76/EC) and The Integrated Pollution Prevention and Control Directive (96/61/EC) etc [7, 6].

Furthermore, EU has established policies and principles that are implemented or are being implemented into EU regulation [5]:

- **The Principle of Prevention** – '*to secure the conservation of nature and resources, waste generation must be minimized and avoided where possible (...)'*
- **The Precautionary Principle** – *'to secure a reduction in the impacts from waste on human health and the environment, especially to reduce the hazardous substances in waste (...)'*
- **The Polluter Pays Principle** – '*to make sure that those who generate waste or contaminate the environment should pay the full costs of their actions (...)'*
- **The Extended Producer Responsibility** – promoting extended responsibility of the manufacturers of a product to the entire life-cycle of that product, hence facilitating sustainable improvements both up-stream and down-stream
- **The Proximity Principle** – try to re-use, re-cycle or recover for energy as close as possible from the generation place of the wastes by establishing *'(...) adequate infrastructure'* and '*by establishing an integrated and adequate network of disposal facilities (...)'*
- **The Subsidiary Principle** – delegation of power to lower level of governance

In terms of waste generation per capita in EU, there are differences between and within countries. Socio-economic indicators like gross domestic product per capita, infant mortality rate, population density, tourist flows and unemployment rate, affect the generation of wastes. People that are categorized as having a very high prosperity level tend to generate more waste per capita. But regardless of prosperity level, people living in highly dense urban areas tend to generate more waste per capita then do people in rural or less dense urban areas [3].

### 2.3 MSW Management in Sweden

In Sweden the average waste generation per capita and day is about 1.4 kg. The quantities of waste have increased over the last few years with approximately 3-4% per year. During 2008, 97% of the household waste in Sweden was recovered and 3% was deposited on LFS. This is a large reduction compared with previous years. Within the category of recovery material, recycling make account for around 35%, incineration for energy recovery about 49% and biological treatment approximately 13%. In 75% of the Swedish municipalities the collection of household waste is managed by external private companies and the remaining 25% by local authorities. The collecting is mainly door-to-door systems or from larger containers where people live in apartment blocks [2]. In Sweden the recycling of paper covers 74% of all papers, paper packaging and corrugated cardboard. Furthermore, 67% of the metal packaging and 94% of the glass packaging was recycled in 2008 [2]. Waste incineration equals

approximately 20% of the total produced district heating in the country. In accordance with the waste hierarchy of EU, in Sweden MSW is only deposited on LFS in cases where no other option of reuse, recycling or any other energy recovery is feasible. The LFS are strictly regulated according to national guidelines. Producers have a responsibility to collect their specific refuse from products (e.g. glass, cans, packaging etc), and the municipality has the responsibility to collect from households. Additionally, the households have the responsibility to separate paper and packaging, glass, metal, batteries, electric and electronic, and bulky waste [2]. In Sweden the number of municipal recycling centres is increasing. These centres handle the waste fractions like bulky waste that is too large to be handled in bags or in bins in the regular collection system. Most of the recycling centres are also taking care of hazardous, electric and electronic, and garden waste as well as demolition materials. The recycling centres are handling approximately 154 kg of waste per capita and year. According to the Swedish interest organisation, Avfall Sverige, almost half of the Swedish municipalities have a collection system for separated organic waste. The organic waste is either used for composting or for biogas production. The remaining municipalities collect the organic waste in the mixed waste fraction later to be incinerated for energy recovery [2].

## 3 ALLOCATION AND DESCRIPTION OF THE LANDFILL SITES

### 3.1 Karaute Danda Sanitary Landfill Site – Ghorahi

The LFS is situated in the vicinity of Ghorahi municipality in the district of Dang southwest in the Terai region of Nepal. More accurately, in ward 9 approximately 1 km outside of the urban area of Ghorahi. The total area of the LFS is 20 ha, of which 1 ha is used for MSW management and the remaining area for plantations of various trees and other vegetation. The area used for final disposal has recently been increased within the property. Moreover, on the property there is a sorting platform on which a unit of nine employees sorts the MSW into fractions of paper and plastics [9].

### 3.2 Pokhara Landfill Site – Pokhara

Pokhara LFS is allocated approximately 6 km outside of PSMC in ward 18 in the vicinity of Seti River. The LFS was constructed 1997-2003 and has been in operation since 2004. The total area of the LFS is 10 ha, of which 4 ha are utilised for final disposal of MSW. Composting and treatment area (reed bed, leachate collection ditch, leachate treatment plant) make up for 2.25 ha. Buffer zone, roads and other infrastructure account for the remaining 3.75 ha. The composting area is currently not in use. The constructed wetland area and reed beds function as nutrient and contaminant traps for the effluent leachate water [9].

### 3.3 Sisdole Landfill Site – Kathmandu

The landfill site was partly constructed under supervision, both technical and economical, by Japan International Co-operation Agency in December 2005. The purpose of the Sisdole LFS was to serve as short-term disposal site while other options were investigated. The life span of the LFS was planned for 2-3 years [9]. At Sisdole LFS waste from KMC and Lalitpur Sub-metropolitan City (LSMC) is handled [11]. The LFS covers a total area of 15 ha of which 2 ha is the actual landfill area. 13 ha of the area are occupied by protection and buffer zones, access and internal services roads, administration facilities and leachate treatment plant [9].

## 4 METHODOLOGY

Literary studies were conducted along with field studies and interviews in Nepal during May and June 2009. Field studies were made at the three different LFS and transfer stations along with visits at local municipality offices where interviews with people operating at the different sites were conducted.
For composition studies at LFS a method modified for utilisation in Nepal by Dinesh Raj Manandhar based on the standardised method by [12] at the University of Central Florida was used. The method was previously used in Nepal in compositions studies conducted by [1].
On every LFS, approximately 260 kg of waste was collected from random incoming vehicles. The MSW was then collected and mixed in order to receive a representative product. 2-3 reductions were conducted as described as follows . 1st reduction; the whole sample collected was divided equally into four different piles, quadratic distributed on the ground upon which the two piles of one diagonal were removed. This procedure was carried out two or three times depending on the amount of the MSW collected (2nd and 3rd reduction). The remaining waste was then sorted according to the following fractions: Plastics, paper, glass, rubber and leather, textile, metal, construction/demolition waste and dust, organic, others (uncategorised wrapping paper etc.) The weight of each fraction was determined and the percentage of the total weight calculated.
During field studies interviews and notes were taken from staff members at the LFS concerning incoming vehicles loaded with MSW. The number of incoming vehicles and information about varying densities on MSW resulted in a quantification study. The information regarding densities was collected from [11]. Present population sizes were calculated from known and estimated populations and growth rates according to documents and information from local authorities.

## 5 RESULTS

### 5.1 Composition analyses of municipal solid waste

In *Figure 1* the results from the composition study is presented. The highest amount of organic matter was found on Karaute Danda Sanitary LFS (65.8%) followed by Sisdole LFS (61.9%) and Pokhara LFS (49.1%). Additionally, industrial and medical waste which should not end up on LFS was observed on all of the three LFS.

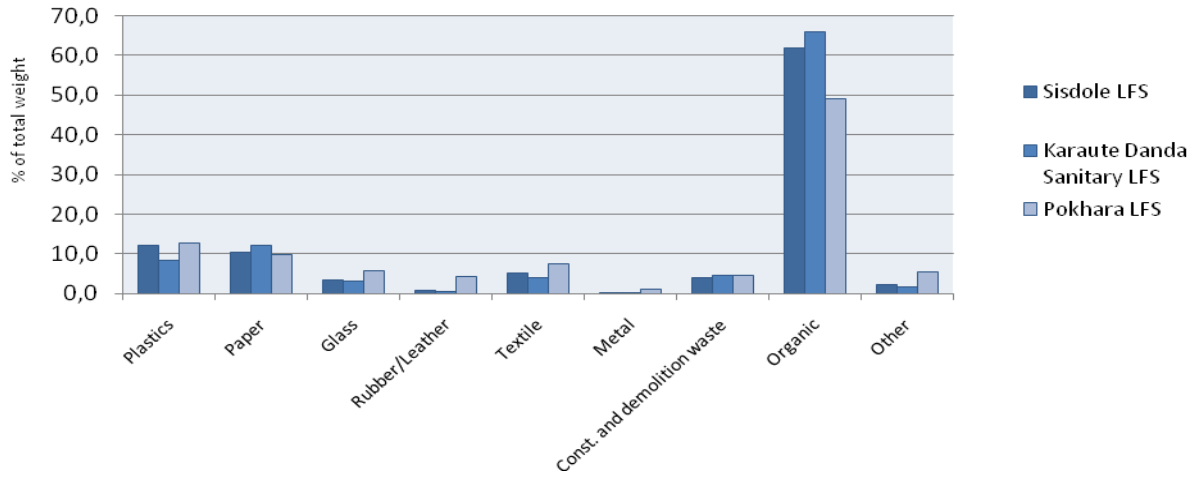


*Figure 1. Results from the composition study from the three studied LFS.*