CHAPTER 1

INTRODUCTION

Many cities of the world are in a serious environmental crisis, which threatens the quality of life of its inhabitants. Many important environmental problems are not only confined to air, water or land systems but also involve interactions among systems (Glynn and Gary, 1996), as seen in Fig. 1.1.

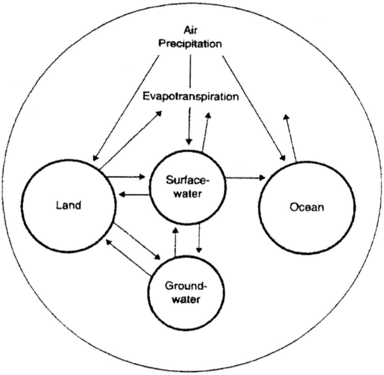

Fig. 1.1 Water-Air-Land interactions
(Source: Glynn and Gary, 1996)

The major problem which causes environmental problem is burgeoning population, which leads to a rapid increase in the demand for consumable goods, as well as, energy consumption (Holdgate *et al.*, 1983). The human population is growing at an alarming rate (Fig. 1.2).

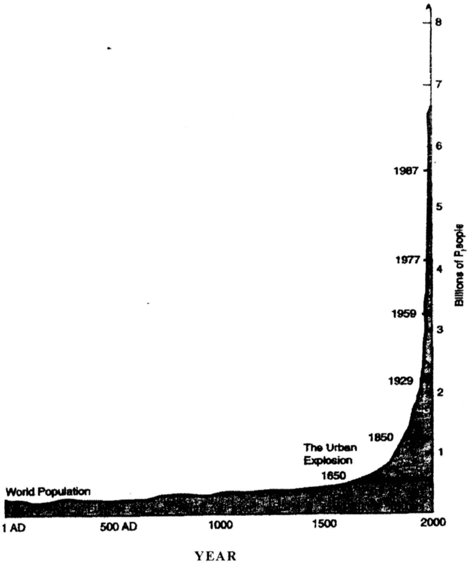

Fig. 1.2 Growth of world population over the last two millennia (Source: Glynn and Gary, 1996)

There are at present about 6 billion people on the face of the earth. In several non-industrialized countries, the present annual rate of population growth is about 3.5% per year and for the entire world, the population growth is almost 2% per year (United Nations, 1993). Worldwide trends in population growth has been outlined by Bramwell (1977). Figure 1.2 gives a graphic picture of the growth of world population over the last two millennia. The population in 1983 stood about 4.7 billion. It took about 500,000 years for the population to reach one billion by 1800AD, but to add a second billion it took only 130 years (1930). By 1960 and 1975, third and fourth billions were added, respectively.

As world population increased, the quantity of waste discharged into the environment also increased. The quantum and quality of waste generated became increasingly problematic. Also, with the Industrial revolution the number and size of urban areas increased at a frantic pace, and as a result the quantity and quality of wastes generated changed. Unfortunately, the problem is worsening as the variety and amount of pollutant discharged into the environment increased inexorably while the capacity of our air; water and land systems to assimilate waste is limited. One of the more serious environmental problems is the increasing complexity of urban solid waste (UNEP, 1991). Land is the final resting-place for the majority of our garbage and waste. Bulk of the municipal solid waste still ends up in the landfill together with some other wastes. Municipal solid waste was not a major problem until humans established concentrated urban settlements. Many countries of the world are in a solid waste management dilemma due to the inability or high cost to site new landfills and other municipal solid waste containment facilities. The primary environmental risks associated with the municipal landfills are due to the leachate and gases produced from the interaction of diverse waste components, rainwater, and organic degradation.

In addition to containing hazardous substances that originated from industrial or other non-municipal waste sources, landfills also receive toxin-containing garbage from homes and commercial premises. Common household products often contain chemicals that are neither benign nor biodegradable e.g. the dyes and inks in paper and the pesticides and fertilizers in yard clippings are examples of some toxin which are hidden in products that are seemingly harmless and often labeled "biodegradable." Other landfilled household and office items which contribute to hazardous substances, include oven cleaner, batteries, mothballs, spot removers, laundry detergents and other solvents, degreasers and paints, plastics vinyl chloride, polyethylene etc. Heavy metals such as mercury, lead and cadmium are also common toxic constituents in some household and office items that are disposed of with municipal waste. In 1989, an estimated 709 tonnes of mercury were deposited in municipal landfills (US EPA, 1992). Heavy metals found in common household items are-

1) Lead in consumer electronics items (television sets, radios, etc.), glass, ceramics, plastics, brass, bronze, used oil.
2) Cadmium in nickel-cadmium batteries, plastics, consumer electronics, appliances (dishwashers, washing machines, etc.), pigments, glass, ceramics, rubber, used oil.
3) Mercury in batteries, light bulbs, paints residues, thermometers, pigments from inks and plastics (US EPA, 1989).

The quantity of leachate produced from a landfill is a function of site surface hydrology, the presence of ground waters and many other factors, which affect infiltration of surface water into landfill. Many factors interact to produce variable quantity of leachate (Ronald and James, 1994). These factors are annual precipitation, runoff, infiltration, evaporation, transpiration, waste composition, waste density, initial moisture content and depth of the landfill (Fig.1.3).

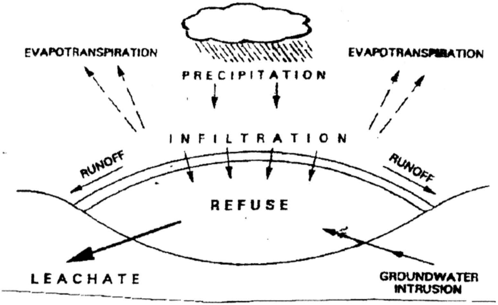

Fig. 1.3 Schematic diagram of the primary sources of production of sanitary landfill leachate
(Source: Ronald and James 1994)

The stabilization of solid wastes placed in a sanitary landfill and the quality of leachate are principally the result of physical, chemical, and biological processes. Additional variables are water movements, macronutrients, micronutrients, and the presence or absence of inhibitory elements and compounds. Landfill leachates from municipal solid wastes contain high concentrations of organic and inorganic chemicals. The inorganic ions include chlorides and sulfites, and metals such as iron, calcium, manganese, zinc etc. In the past it was generally believed that leaching from waste was completely attenuated (purified) by soil and hence contamination of ground water was not an issue. However, with increasing concern for the environment landfills came under scrutiny. According to El-Fadel *et al.* (1997), groundwater pollution is the most significant concern arising from leachate migration. New-generation sanitary landfills use artificial and natural soil liner materials to reduce the seepage to the underlying hydrologic environment.

The municipal landfill at Sabak Bernam district was chosen for the present study. Agricultural activity is the main profession for the inhabitants in Sabak Bernam. Common plantations found in this area include coconut, rubber and palm oil. The site chosen for this project is 1.2 m higher than sea level (RSD Engineering Sdn. Bhd., 1980; and Cadence Kontrak Bina Sdn.Bhd., 1980, personal communication). The landfill operations began in 1993 and the landfill area is 10 acres. The site is located about 8 km away from Sungai Besar town (Fig. 1.4). It is estimated that the disposal site can be used until the year 2001(Alam Flora Sdn.Bld., 1998 personal communication).

The design of the Sabak Bernam landfill consists of natural clay liner and area method is used for filling up waste. Clay liners are more permeable to water than synthetic liners. The permeability of natural clay liners to organic chemicals is variable. It depends on the characteristic and concentration of the chemicals, degree of compaction, and other engineering properties of soil.

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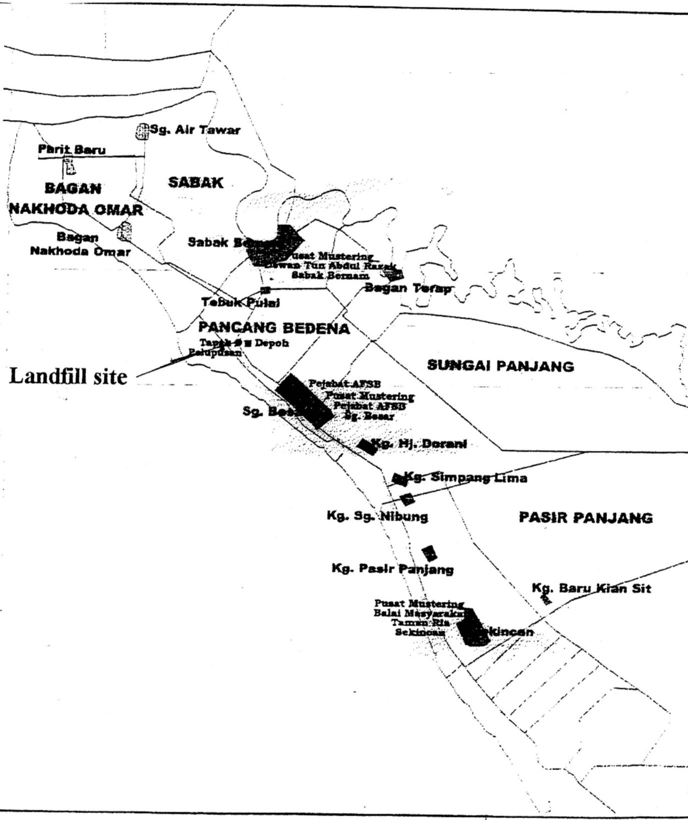
In this study soil and leachate investigations were performed to establish the contamination potential of the Sabak Bernam landfill. The study includes physical and chemical characterization of the soil at various depths and analysis of the leachate samples from the landfill.

The objectives of this study are-

1. to characterize soil samples from three different sites of Sabak Bernam landfill at different depths to study the heavy metal distribution in and around the landfill at different depths;
2. to characterize leachate samples from the landfill;
3. to determine the effect of soil pH and moisture content on heavy metal distribution, and
4. to determine the effect of soil particle size on heavy metal distribution.



igure: 1.4 Location map shows the Sabak Bernam Landfill site.

Scale: 1:300000

ey:

Road

acility

▲ Office

⊠ Depot

● Landfill

Zone

SB1

SB2

SB3

SB4

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