# Alleviation of Environmental Health Impacts of Solid Waste – The Ecosystem Approach

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**Abstract**

*This study examines environmental health and safety problems associated with urban solid waste management and provides a set of interventions options using the ecosystem approach. In particular, it investigates the health problems faced by child waste-pickers of Dhaka City, who collect recyclable and reusable items from garbage bins and landfill sites. The study tracks down these problems with the help of an impact-pathway based analysis. It then develops a set of intervention options through extensive multi-stakeholder consultations and interviews. The recommendations formed thereby have been presented in an impact-intervention matrix. The intervention matrix addresses each part of the impact-pathway from source to health impacts, and explores a range of policy tools to devise 'integrative' and 'sustainable' interventions. Based on urgency, ease of implementation and resource requirements, the paper also indicates tentative time-frames these interventions.*

**Keywords**: Solid waste; Health impact; Intervention matrix; Ecosystem approach

## Introduction

Dhaka City, the capital of Bangladesh with a population of about 10 million, is growing at a rate of 3.72% per year. Nearly 70% of this population lives in the jurisdiction of the Dhaka City Corporation (DCC) that covers an area of 360 sq. km. On average, 4,000-4,500 tons of solid waste is generated everyday in the City, with a per capita contribution of about 0.5 kg per day (Islam 2003).

The waste stream fraction of Dhaka city is 46.8% domestic, 21.8% street sweeping, 19.2% commercial, 12.9% industrial and 0.5% clinical (MMI 1991). Analysis of physical composition of mixed waste shows that the primary component is food waste (70.12%), and about 80% of the municipal solid waste is of organic origin and biodegradable. Of the remaining 20%, about 10% is paper, plastic, rubber and leather; the remaining part is contributed by metals, glass, ceramic, cloth and so on.

The DCC collects and disposes approximately 50% of the solid waste, most of which is taken to Matuail, a 70-acre 'open dump' used as the primary landfill site for Dhaka since 1994. Around 16% of the solid waste is recycled, mostly by the informal sector (households, hawkers, waste pickers).

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A significant 50% is discarded into streets, drains, ditches, canals and open spaces (ADB 1998, DCC 1999). The cycle of generation, disposal and recycling of solid waste in Dhaka City is shown in Fig. 1.

At present, there is no separate collection or disposal system in Dhaka for clinical waste. Everyday, an estimated 200 tons of clinical waste and another 5000 tons of industrial waste are generated within the city, almost all of which are disposed in the same garbage bins used for household waste and eventually disposed in the landfill sites. As a result, the residents of Dhaka are being exposed to the additional health risks from contaminated, toxic, or hazardous clinical and industrial wastes on daily basis.

Such inadequate and unsafe solid waste management practices have immediate and inescapable consequences: filthy streets littered with garbage, scavengers scouring garbage bins, and human waste pickers handling waste without any precaution. In addition, indiscriminate solid waste dumping clogs up drains and fills up water bodies leading to drainage congestion and water logging. Mosquitoes breed in these stagnant waters, and spread deadly diseases such as malaria and dengue. Thus, the absence of a comprehensive solid waste management system poses major environmental health risks to the residents of major urban centres in Bangladesh.

In this backdrop, this paper presents an in-depth assessment of the environmental health risks faced by the child waste-pickers of Dhaka based on a comparative epidemiological study. It then presents a set of intervention options identified through extensive consultative sessions and summarizes those in the form of an impact-intervention matrix.

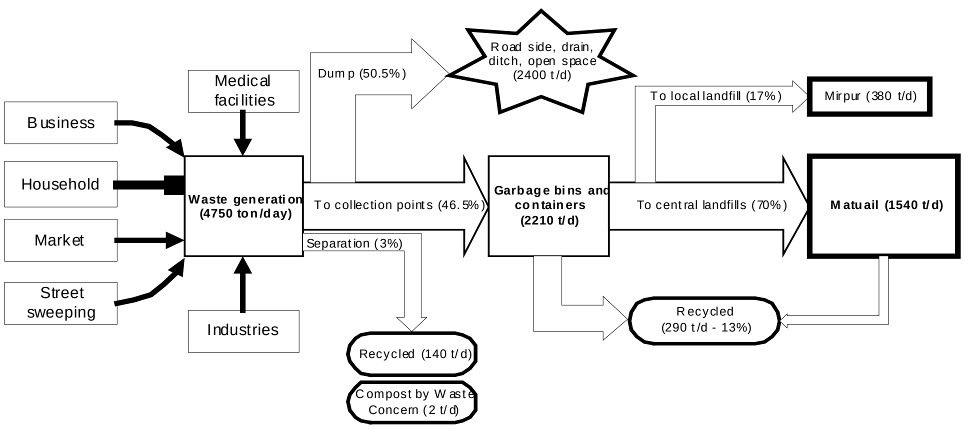


**Fig. 1** Waste generation, disposal and recycling in Dhaka (adopted from Memon 2002)

## Methodology

The study is primarily based on information collected through field survey, interview of key informants, and multi-stakeholder roundtable sessions. The health impacts have been assessed through a comparative epidemiological study, where two groups, each comprised of 75 children, were randomly selected, interviewed and physically examination by experienced paediatricians. The exposed group (waste pickers) worked at the central landfill at Matuail; the control group (non-waste pickers) came from a different neighbourhood with similar socio-economic background. The type and extent of health and safety concerns faced by the child waste-pickers have been identified and estimated using point and prevalence rates. The extent of additional health risk faced by the waste-pickers vis-à-vis the control group has been examined by employing descriptive statistics and multiple regression technique to statistically capture the influence of risk and confounding factors.

Options to alleviate the health impacts have been explored as per the 'ecosystem approach.' First, the impacts have been linked to the corresponding stressors and sources, and the results have been summarized in an 'impact-pathway' table. Possible intervention options to minimize these impacts have been identified through in-depth analysis of system components and extensive stakeholder interview and consultation. The 'hard' (material flow and technology) and 'soft' (social, economic, legal, institutional) options for dealing with the problems have been compiled and prioritized through two seminar-cum-roundtable sessions. Summary of these sessions have been presented in the 'Impact-Intervention Matrix' that reflects the collective assessment and recommendations of over 100 representatives from all stakeholder groups.

## Environmental Health Impacts

The present mode of solid waste management by the DCC poses a number of environmental health risks. First, the city does not have separate waste disposal systems for clinical and industrial wastes. Everyday, some 500 hospitals, clinics and pathological laboratories generate 200 tons of waste, about 15% to 20% of which are extremely hazardous that include infectious waste, pathological waste, sharps, and a small amount of pharmaceutical and chemical wastes (Rahman et al. 1999). Moreover, several thousand industries located within the city (including the 'hot-spots' at Hazaribagh and Tejgaon) generate hazardous solid wastes that contain corrosives, toxic chemicals and heavy metals. Both clinical and industrial wastes are dumped in municipal landfill sites or in open fields and ditches exposing the city residents to unknown health hazards.

Second, about half of the solid waste generated in the city – some 2,250 tons a day- is not collected at all, which may include some medical and industrial wastes. Often, wastes are not collected on time and seen rolling on the streets attracting scavengers and unwanted biota.

Third, the most serious health risks are faced by the human scavengers: around 6000 to 8000 of them work in the streets and at landfill sites as waste pickers. A preliminary survey indicates that nearly 50% of them are children under the age of 15, and about half of them are girls. Due to their marginal and impoverished social status, these child-workers are compelled to work in the most unhygienic conditions without having access to most basic amenities such as drinking water and sanitation at workplace.

The cumulative health impacts of all these threats on the city population are unknown – no study has so far been conducted to scientifically link these risks with health impacts. However, a number of recent studies have examined the occupation health hazards faced by the waste pickers of Dhaka, who worked in the streets or at the Matuail landfill site (Khanam 2000, Shamshad 2003, Parveen & Faisal 2005). Shamshad (2003), and Parveen & Faisal (2005) have identified stressors and sources corresponding to the health and safety impacts (Table 1). The waste pickers face a whole range of health risks: from minor on-site problems such as insect bite to major health concerns such as bronchitis, hepatitis, and physical injury.

It was found that in most cases, no medication is used or doctor consulted. The waste pickers resort to over-the-counter medicine or take a day-off only if the ailments become grave and debilitating.

**Table 1** Impact pathway of common health problems

| Health problem | Stressor | Source |
|---|---|---|
| Allergy, skin disease | All types of waste | All waste sources |
| Headache, dizziness, nausea | Pungent smell | Exposed organic waste |
| Cuts and bruises, tetanus, gangrene, physical injury | Sharp / pointed objects, heavy machineries | Hospitals and health centres, households, landfill machineries |
| Asthma, bronchitis, eye irritation / infection | Dust, fume, smoke | Burning of plastic, tire, incineration, wind |
| Pain, inflammation, infection | Insect bites | Bare foot/hand |
| Worms, diarrhoea, dysentery, cholera | Drinking water, dirty hand or utensils | Lack of sanitation; poor personal hygiene |
| Malaria, dengue, meningitis | Mosquito bite | Pool of stagnant water, garbage pile, landfill |
| TB, bronchitis, hepatitis | Contaminates / clinical waste | Hospitals and health centres |
| Sore, infection, metabolic disorders, cancer | Frequent exposure to toxic chemicals, radioactive materials | Industrial or clinical waste |

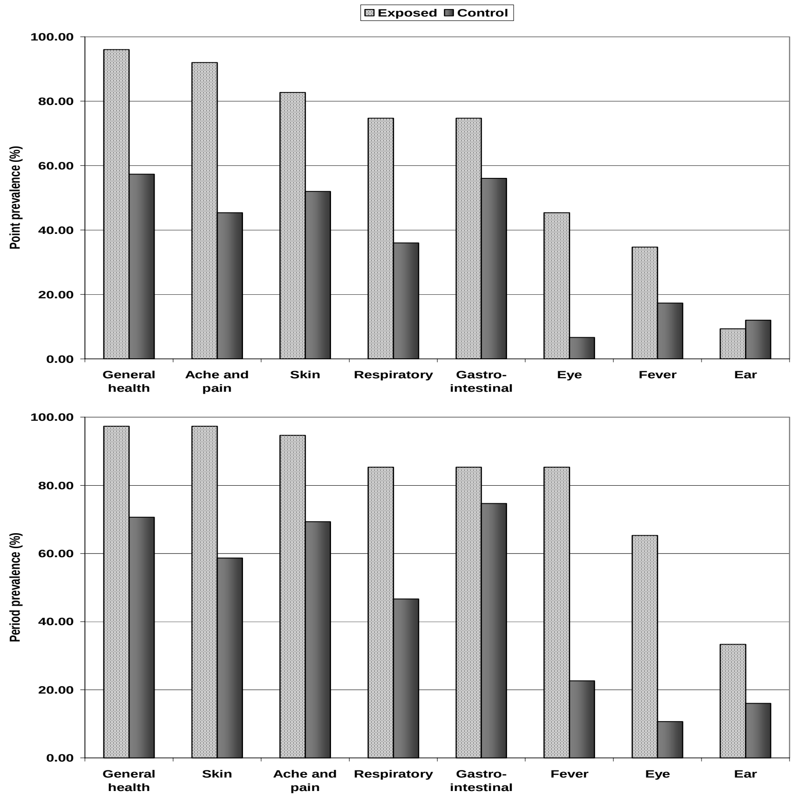


**Fig. 2** Point and period prevalence rates for the exposed and control groups

Parveen & Faisal (2005) have further extended these findings by conducting a comparative epidemiological study of the health impacts using 'exposed' and 'control' groups. By comparing point and period prevalence rates of different health problems faced by these groups, they show that the child waste-pickers of Dhaka suffer significantly more compared to the 'non-waste picking' control group (Fig. 2). It is evident from Fig. 2 that at the time of the survey, child waste-pickers suffered from 30% more skin problems, 40% more eye, respiratory and general health problems, 47% more aches and pains, and 20% more gastro-intestinal ailments. The difference is even greater if period prevalence rates for skin and eye related problems are compared. The most significant difference is noted for fever – 62% more waste pickers suffered from some kind of fever during a six-month period prior to this survey compared to the control group.

By employing the multiple regression technique, Parveen & Faisal (2005) also show that there are statistically significant association between the point and period morbidity indices (cumulative frequency of all health problems as reported by the respondents) and the risk factor – waste picking. This confirms the generally held view that a significant part of the health problems affecting the waste pickers are due to their hazardous occupation, and the rest of the impacts are outcomes of other socio-economic and environmental factors.

Table 2 shows the statistical associations between the point morbidity index and the confounding and risk factors: age, gender, monthly family expenditure, family size, and group of the respondent. The regression coefficients and t-statistics support a number of important conclusions: (i) the exposed group is much more vulnerable to health problems than the control group; (ii) younger children tend to suffer more from health problems compared to older ones; (iii) girls suffer from more health problems compared to boys; (iv) morbidity is positively correlated to family size (crowding); and, (v) morbidity is negatively correlated to family expenditure (better nutritional and health care). The overall goodness of fit of the linear multiple regression model is satisfactory as indicated by $R^2$=0.69 and F=64.42 for a combined sample size of 150. Another linear model suggested similar relationship between the period morbidity index and the above-mentioned set of dependent variables.

**Table 2** Statistical association between point morbidity index and risk/confounding factors

| **Model Variables** | **Std. Coefficients** | | **t** | **Sig.** |
|---|---|---|---|---|
| | **β** | **Std. Error** | | |
| (Constant) | 6.274 | 1.665 | 3.768 | .000 |
| Group | 0.717 | 0.620 | 14.002 | .000 |
| Gender | 0.138 | 0.564 | 2.970 | .003 |
| Age | -0.150 | 0.107 | -3.116 | .002 |
| Family size | 0.153 | 0.218 | 2.562 | .011 |
| Family expenditure | -0.107 | 0.000 | -1.841 | .068 |

*Note*: Dependent Variable: Point morbidity index. $R^2$=0.691, F=64.424, N=150.

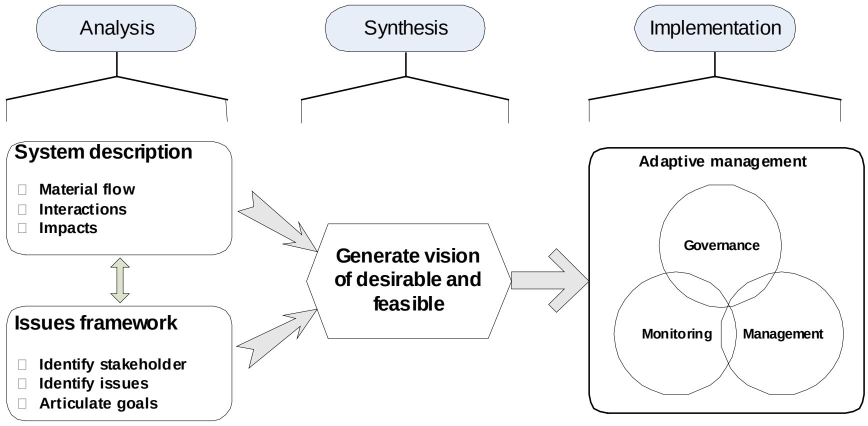


**Fig. 3** Schematic representation of the ecosystem approach (adapted from Kay et al. 1999, NESH 2005).

**Alleviation of Impacts**

***Ecosystem Approach***

The ecosystem approach to human health requires an understanding of the complex interplay between the society and the environment shared by a group of people (Feola & Bazzani 2001, Forget & Lebel 2001). It begins with an analysis of the system, which is comprised of 'system description' and formation of the 'issues framework.' Thus, at the analysis level, both 'hard' and 'soft' system components and interactions between these components are taken into account. Once results from system analysis are available, the process goes through two additional phases: synthesis and implementation. Ecosystem approach requires full stakeholder consultation at all stages. Further, it is essential to have a monitoring and feedback component in the last leg of the process. This is to ensure that the entire process remains 'alive' and 'adaptive' to changes in system components and interactions. This entire process has been schematically shown in Fig. 3.

This approach has been employed in this study to identify and quantify the health impacts (analysis) and to generate a set of intervention options through extensive consultation with the stakeholders (synthesis). Note that implementation of the intervention options would require a general consensus at the policy level as well as commitment of a significant amount of time and resources on part of the stakeholders. As such, the 'implementation' part is beyond the scope of this study; perhaps a follow-up study may attempt to elaborate on this part.

***Intervention Options***

A simplistic and drastic approach to solving most of the health problems endured by the child waste-pickers would be to remove them from the streets and the landfill site in Dhaka. However, this is neither possible nor desirable due to social and economic reasons. In fact, it would be unethical to displace the waste pickers without providing them with an alternative livelihood. The presence of waste pickers and the informal recycling sector in the city are indications of a lack of 'holistic' solid waste management plan. Thus, the possible intervention options should not be centred on the garbage bins or landfill sites; rather a broad or urban ecosystem approach is needed to ensure that the issues are dealt with in an integrated and sustainable manner.

With this purpose in mind, a number of key informants were interviewed and feedback collected through two sessions of multi-stakeholder consultations. All major stakeholders including representatives from Dhaka City Corporation (DCC), private waste management organizations, NGOs, the RAJUK, urban planners and the civil society participated in these events. On both occasions, keynote papers were presented by experts, followed by roundtable sessions. This approach has allowed identification and synthesis of a series of intervention options pertaining to the entire cycle of waste generation to disposal. The key interventions options along with the suggested time-frame for implementation have been summarized in Table 3 in the form of an impact-intervention matrix.

It is evident from the impact-intervention matrix that a whole range of technical, socio-economic, environmental, regulatory and institutional interventions would be needed to provide a sustainable solution to the problem of urban solid waste management. Note that the interventions presented in the matrix are not comprehensive enough to fully address all the issues. Rather, these options have come out as the most important and essential ones during the roundtable sessions and one-to-one interview with the key informants and experts.

The interventions suggested in the matrix collectively incorporate the ecosystem approach, which is both integrated and sustainable. For example, both 'hard' and 'soft' options have been provided for each segment of the impact-path way, thereby ensuring an integrated approach. At the same time, a range of policy tools have been utilized to ensure that the resulting system evolves as socially, economically and environmentally sustainable over time. Regarding priority and order of implementation, the interventions have been grouped into short term (one to two years), medium term (three to five years) and long term (more than five years).

**Concluding Remarks**

This study has identified the most important set of intervention options for integrated and sustainable management of urban solid waste. These interventions, when implemented, would alleviate the environmental health and safety risks presently faced by the waste pickers of Dhaka City in particular, and the residents in general. Although additional study would be needed to prepare a detailed 'blue print' for implementation, certain measures, particularly the short term ones, may be introduced immediately without incurring much cost or difficulty. Some such measures have already been introduced, e.g., community-based waste collection, awareness campaigns by NGOs and limited health services for the waste pickers. Some other options, on the other hand, are likely to be very challenging, e.g., introducing at-source separation of waste, full-cost based waste service fee, and formalization of the recycling sector. Successful adoption of these measures would require major ‘social engineering’ efforts to sensitize all stakeholder groups and induce a cultural shift in the way solid waste has been dealt with in Bangladesh for decades.

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**Table 3** Impact-intervention matrix

| | Interventions → | Institutional | Techncial | Socioeconomic | Environmental | Regulatory |
|---|---|---|---|---|---|---|
| **Source** | Household<br>Market and business<br>Industry<br>Medical facilities<br>Street sweeping | Community-based waste collection (S) | Separation of organic and inorganic waste (L) | Market-based collection fee proportional to waste volume (M) | Composting from organic waste; reduce, reuse, recycling (M) | New anti-littering law with steep penalty (M) |
| **Stressors** | Hazardous chemicals<br>Pathogens<br>Sharp objects<br>Odor | Separate system for clinical and industrial waste (L) | Incinerator, autoclave, dispenser (M) | Awareness campaign (S) | Separate site for hazardous waste (M) | Enforcement of pollution laws (L) |
| **Media** | Land (solid waste)<br>Air (odor and dust)<br>Water (leachate) | Timely collection and disposal of waste (S) | Sanitary landfill (M-L) | Awareness campaign (S) | Removal of street-side bins; setting up collection depots (L) | Law banning ‘open dump’ landfill in major cities (M) |
| **Vector & reservoir** | Insects, flies<br>Mice<br>Birds<br>Cats and dogs<br>Waste pickers | Timely collection and disposal of waste (S) | Sanitary landfill (M-L) | Alternative livelihood for waste pickers (M-L) | Removal of street-side bins; setting up collection depots (L) | Law banning ‘open dump’ landfill in major cities (M) |
| **Receptors** | Waste pickers<br>Family members<br>Neighbors<br>Reusable materials traders | Formalize the recycling sector (M-L) | Sanitary landfill (M-L) | Alternative livelihood for waste pickers; incentive for recycling (M-L) | Water supply, sanitary latrine (S) | Regulatory support for the recycling industry |
| **Health impacts** | Diseases<br>Cuts and bruises<br>Discomfort<br>Accident | Community health center and free treatment (S) | Sandal, mask, cap, picking rod (S) | Awareness campaign on personal safety & hygiene (S) | Water supply, sanitary latrine (S) | Pro-poor health policy (M) |

*Note*: S = short term (1-2 years); M = medium term (3-5 years); L = long term (more than 5 years).