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Hazardous waste generation, impact on environment and management: an observational survey of Udaipur, Rajasthan, India

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Abstract

Hazardous wastes may be found in different physical states such as gaseous, liquids and solids that are characterized by toxicity, ignitability, reactivity and corrosivity. These wastes can harm all kinds of living organisms including human beings, if they encounter these toxins buried in the soil and in groundwater that supplies drinking water. An observational survey on generation of hazardous wastes was done in Udaipur and its surrounding areas and to assess problems associated with hazardous waste disposal. Hazardous waste site selection was done keeping in view the slurry produced by marble processing industries, e-wastes, unauthorized solid waste dump yards and man-made reservoirs viz. Pichhola, Fatehsagar and Udaisagar lakes of the city, used as major drains for chemical and organic wastes. The present communication also deliberates on different techniques of minimizing various hazardous wastes for sustainable development. Results of personal observations during the survey are compiled to create an overall understanding of the strengths and weaknesses of the hazardous materials handling system.

Key words : Generation, Hazardous wastes, Impact on Environment, Udaipur, Rajasthan (India).

INTRODUCTION

Wastes causing prolonged damage to the biotic and abiotic components of environment generated as byproducts of various industries like paint manufacturing, farming, mining, construction, automotive garages, photo processing units, laboratories, hospitals, city septic systems, etc. are categorized under hazardous wastes. In India, these wastes have been reported to be 4.6 million tonnes /year[1]. Rajasthan has large marble and mineral deposits and is known for their extensive mining. Marble slurry is generated as a waste during the cutting and marble processing. In fact, slurry is indestructible and degrades soil qualities. When dried it causes air pollution and imposes health hazards. During rains, the slurry is drained into the perennial small to large sized reservoirs, thus affecting water quality and damaging aquatic life. The quality of surface water is also affected by toxic effluents that are generated from several chemical industries in the surrounding areas. Mining activities for extraction and manufacturing of metal products may result in a large amount of pollutants being released into the atmosphere as well as in the adjoining soils and waters [2].

Uncontrolled disposal of chemicals directly into the soil and small drains and canals increases the pollution load of the water bodies and causes alteration in pH, dissolved oxygen content and osmotic pressure [3]. Adverse environmental effects are associated with waste disposal activities like sewage sludge, dredged soil dumping, oil spills, as well as municipal and industrial waste water discharges. These wastes often contain contaminants such as chlorinated hydrocarbons, acids, alkalies, dyes etc. The flourishing tourism industry supports directly or indirectly the hotel industry around the lakes. Most of the hotels located on the lake slopes release all sorts of organic wastes and drain waste water into the lakes. The deposition of sediments and continuous organic loading affects the water retaining capacity of the lakes and also drastically disturbs the quality of water [4]. Residential and commercial garbage generated contains biodegradable wastes along with non-biodegradable hazardous wastes like plastics, glass, metals and inerts. These are disposed into unauthorized open dumping yards adversely affecting public health and environment.

Industrial growth and rapid urbanization has led to ever increasing dependence on electronic products. More usage results in increased generation of e-wastes. Three categories of e-wastes account for almost 90 % of the total waste generation which includes 42% of large household appliances, 34% ICT equipment and 14% consumer electronics [5]. There are no proper legislations regarding disposal of these wastes, therefore the toxic substances from e-wastes leach into the soil, water and air. In view of these, the present pilot survey was therefore undertaken to find out the various hazardous wastes generating sources in Udaipur city and its surrounding areas and to observe their disposal and management mechanisms.

MATERIAL AND METHODS

For the present study (January 2013 to June 2013), Udaipur and its surrounding areas were undertaken, as the city is surrounded by freshwater lakes that are sources of drinking water. The city of Udaipur has an area of 64 km^2 with a population of 30 lakhs.

STUDY DESIGN:

- Scoping exercise was taken-up soon after the survey contours were defined. The primary purpose of scoping was to identify the concerns and issues which may affect the survey results.
- During the survey, major generators in each segment viz., marble slurry, unauthorized dumping yards, e-wastes, chemical drains and organic wastes were located.
- Simultaneously, during the cross sectional survey, the local residents in and around these waste generating sources were interviewed for any health problems through an oral questionnaire.

- Pros and cons of the handling of hazardous waste materials were identified.

- Suggestions for reducing, recycling, recovering and reusing hazardous wastes are defined for the city.

STUDY POPULATION

- The total population size of the major affected areas under our scope of study was approximately 1.5 lakhs. The appropriate study population we worked out was sufficient at 0.2% (i.e. 300 subjects).

- **Exclusions**: Other than the workers and the residents directly exposed to these wastes were excluded.

RESULTS

By integrating the environmental impacts of industrialization and developmental activities in and around the city during the scoping exercise, the extent of hazardous waste generation caused due to the segments under consideration was found to be considerably high and its disposal measures were comparatively very low or mismanaged. A total no. of 52 potentially hazardous waste generating segments in Udaipur were found. Segment wise distribution of major hazardous waste generating units in Udaipur has been shown in Table. The major health problems reported by the workers and residents in the considered hazardous waste generating segments were respiratory tract disorders like asthma, nasal inflammation and chronic bronchitis due to occupational hazard of intense environmental marble dust in marble processing units and in chemical industries too. Stress and headache were common complaints around chemical and E- wastes dismantling and segregating units. Pollution caused in the lakes due to bathing, laundry and sewerage from the hotels and guest houses built near and around the lakes results in gastro-intestinal disorders among the people of the city as the water from these lakes is used as one of the major drinking water supplies for the city population. Nausea due to foul smells from unauthorized dumping yards and overflowing garbage bins was observed to be a common problem among people.

DISCUSSION

In Northern and Southern parts of Udaipur, about 250 marble processing units were observed and their byproduct, marble slurry was found to level the hills of Udaipur, thereby tampering with the ecology of the area. Mining and dumping of slurry has caused large scale land transformation, ponding and flooding of water and pollution (Fig. 1). The land transformations have blocked the catchment area of lakes, particularly the Roop Sagar Lake. The dumped slurry is posing a threat to flora and fauna of the region. Nearly 20% of the total weight of the marble processed results into marble slurry. About 50 percent of the mineral mined is wasted during its processing [6]. Solid waste dump yards produced unhygienic conditions for the people inhabiting in the surrounding areas. People in the Sukher area with maximum marble processing units were found to suffer with respiratory tract disorders due to inhalation of marble dust. The workers exposed to marble dust stand at an increased risk of suffering from asthma symptoms, bronchitis and impairment of lung function [7].Unengineered landfills were found to contaminate soil as well as ground water. In certain areas, land had become barren with loss of vegetation.

The canals and rivers supplying water to the major reservoirs of the city from the catchment areas are themselves polluted. Madar link canal that supplies water to Fatehsagar during rainy season is used as a dumping site for the rest of the year. When water flows from Madar, it carries the garbage along (Fig. 2). Fertilizers and pesticides from the fields situated near the Sisarma river are drained into its waters which enter the major reservoirs of the city namely Pichhola and Fatehsagar and are carried downstream. These chemicals spoil the quality of water by changing the physico-chemical properties of water of the lakes. About 27 chemical waste generating units were identified in and around Udaipur. Various industrial plants including drugs and pharmaceutical units located in Madri industrial area, distillery, fertilizer manufacturing units, particularly rock phosphate plants in Umarda and Jhamar kotda were found to discharge chemical effluents in the surrounding small drainages and into the soil directly. This contaminated soil is used for growing vegetables and fodder which when consumed, results in biomagnification of these chemicals. The metalliferous mining activities are the chief pollution sources of Zinc in soil. Large concentrations of Zinc in the soil have adverse effects on crops, livestock and humans [8].

Sewerage disposal and chemical wastes are being drained into the lakes of the city from the hotels built near and around the Fatehsagar and Pichhola lakes (Fig. 3). Sewerage disposal is causing eutrophication of the lakes. Dirty water from the nearby colonies is being directly drained into Fatehsagar lake. A high content of dissolved solid elements affect the density of water,

Table 1 : Segment wise distribution of major hazardous waste units in Udaipur city and its surrounding areas.

S. No.	Segments generating hazardous wastes	Units
1.	Marble slurry	250
2.	Chemicals	27
3.	E-wastes (dismantling & segregating units)	04
4.	Organic wastes from hotels / guest houses	162
5.	Unauthorized dumping yards	Innumerable

Fig.1 Marble slurry dumped in open fields

Fig.2 Polluted water entering Fatehsagar through Madar canal

Fig.3 Hotels along the banks of Lake Pichhola

Fig.4 Heavy growth of Eichchornia (Jal- Kumbhi in Pichhola)

Fig.5 Bathing & Laundry activities in Pichhola

Fig.6 Detergent Swan in River Ayad

influence osmoregulation of fresh water organisms as well as reduce solubility of gases. Dumping of organic wastes from hotels built around lakes and their sewerage is ruining the ecology of Fatehsagar and Pichhola lakes. The present survey shows 162 hotels, restaurants and several guest houses built around the major drinking water supplying lakes of the city. Earlier study has reported 73 Ghats (used for bathing and washing), 42 garbage spots, 45 drain spots and 118 open defecations spots, all of which release a shocking quantity of pollutants into the lakes [4]. The lakes are subjected to heavy organic contamination due to religious practices performed around lakesides. Many water bodies of the study area are polluted due to disposal of sewerage directly into surface drains or surface water body. Sewerage and other organic wastes are oxygen demanding wastes as they promote the growth of aerobic bacteria that decompose these wastes and deplete oxygen. Depletion of oxygen makes the aquatic ecosystems unsuitable for the aquatic organisms. Heavy growth of Eichhornia in the lakes of the city is an indication of polluted waters (Fig.4). Besides this, the polluted waters contain innumerable pathogens causing several diseases as hepatitis, cholera, typhoid, etc. Bathing and laundry activities are common around the large reservoirs (Fig.5) which are also sources of drinking water. The cleaning agents and detergents containing alkalies and acids create white foam called detergent swan (Fig.6). This acts as a stress factor for aquatic harvest and causes death of fishes and other organisms.

Unauthorised dumping yards were found to be innumerable. Most of the garbage waste is dumped in unauthorized low depressions in or around the city as filling material into the pits. Collection of waste by the municipalities was irregular and non effective. Segregation of waste was found to be rare. Mostly, it was left to be done by rag pickers who separate plastics and papers. Besides this, most of the biohazardous wastes from hospitals are also disposed in common landfill sites. Unsegregated wastes are burnt at the dumping sites generating toxic fumes, causing nausea, allergic asthma and bronchitis, etc. Certain improvements have to be made to ensure sanitary landfilling as this would continue to be the widely adopted measure of disposal of municipal wastes in India in the next few years [9, 10]. In larger towns and cities, the availability of land for waste disposal is very limited [11, 12]. Waste processing facilities are almost nonexistent and the burden on land filling is not minimized.

Disposing of e-waste in landfills has the potential to cause severe human and environmental health impacts. Four e-wastes segregating and dismantling units were found in Udaipur. Only 3% of total e-waste generated is properly recycled in India [13]. E-wastes handling is done with bare hands, without masks. The e-wastes containing monitors, motherboards, printer cartridges, cables, CDs, CFLs, tubelights, cellphones, household electric appliances, etc. are burnt in the open which release toxic chemicals such as mercury and lead polluting the environment. Health hazards due to these toxicants include damage to eyes and skin, respiratory irritation, pulmonary edema, circulatory failure, cancer and even death [13].

Some identified pros and cons of handling hazardous materials:

Different waste management handling methods include reuse, recycling, recovery, treatment and disposal of wastes. Each method has its own potentialities and limitations. The best place to separate waste materials for reuse and recycling is at the source of generation [14].

The pros have been identified as:

*All handling options economize resources and save landfill spaces. *Recycling may generate resources for new products, preserves virgin materials and energy. *Bioremediation and composting are cost effective that handle hazardous biodegradable wastes, reduce the spread of pathogens and eliminate transportation of wastes. *Engineered landfills are most suitable for disposal of different classified hazardous wastes. *Various waste treatment facilities minimize the volume and toxicity of wastes.

The cons of handling hazardous wastes include:

* Clean up cost of hazardous materials is quite much. *Recycling, reuse and disposal require segregation of wastes. *Exposure to hazardous chemicals leads to poisoning, skin rashes and disorders of lung, liver and kidney. *Landfill disposal requires transportation of wastes from generation site to an approved treatment, storage and disposal facility (TSDF). *Accidental spill during transport cause immediate or long term disaster. *Unskilled labour employed in handling hazardous wastes causes substantial health risks.

The following suggestions are recommended to minimize hazardous wastes:

- Marble slurry could be used as low cost binder, cheaper than the conventional cement and can be used in brick manufacturing. This can generate revenue for the enterprises; can replace clay, thereby reducing the load of slurry disposal and landfills. Bricks prepared with 5% marble dust have been found to replace the conventional brick making [15]. Marble slurry utilization in black cotton soil is one of the best ways to improve soil properties and to protect the environment up to some extent from the harmful effects of disposal of marble slurry in land and water [6]. Therefore, prevention measures should be effectively implemented for run-off from landfill area entering any lentic or lotic ecosystems.

- Chemical waste could be minimized by waste segregation, concentration and by altering the industrial processes so that the production of hazardous waste is reduced to a minimum. Prior to their disposal, the hazardous chemicals should be treated by chemical, physical, biological methods, incineration or solidification process. Acid and alkaline wastes produced should be first neutralized and the remaining waste should be degraded under controlled conditions. Use of chemical fertilizers and pesticides should be replaced by biofertilizers and biological methods of pest control should be employed.

- E-wastes discarded in the household garbage produce contaminated leachates that pollute the ground water and soil. Recycling is still low in Udaipur. Computer components can be dismantled and reused in assembling new computer products and lead, cadmium and beryllium could be reclaimed from them. Some computer components can be reduced to metals that can be reused in applications as varied as construction, flatware, and jewellery [16].

- Solid waste management could be done by simply burying the biodegradable wastes in lands away from residential areas. Landfill sites for solid waste dumping should have a double liner- High Density Poly Ethylene (HDPE) to prevent leakage into the soil. Nowadays, a barrier is installed along the foundation

of the landfill to prevent leaching of hazardous substances that may remain in the disposed waste [17]. Use of membrane technologies like reverse osmosis (RO), in a landfill leachate treatment chain has shown to be an indispensable means of achieving purification [18], hence membrane technologies should be adopted. Recovery of sorted materials by processing and transformation into reusable and recycled products should be done. Incineration, pyrolysis and gasification should be used for reducing the solid wastes [19].

CONCLUSION

It is necessary to understand the links between environment and hazardous waste management in order to make choices for an integrated development that will be sustainably efficient with equitable access, as well as environmentally profound.

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