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RESEARCH ARTICLE

HOUSEHOLD HAZARDOUS WASTE MANAGEMENT: A REVIEW

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ABSTRACT

Household hazardous waste is hazardous waste generated by households in relatively small quantities (between 1% and 4% of municipal solid waste) and containing toxic or labeled toxic, flammable, reactive, explosive or corrosive chemicals such as automobile products, cleaning products, personal care products, maintenance products, unused medications, insecticides, garden pesticides, products containing heavy metals, photographic chemicals. Many of these wastes are regulated at the industrial level in larger quantities. However, the smaller, distinct quantities found in consumer products are relatively less regulated. In addition, a lack of definition for this category of waste has been observed in many countries, both developed and developing. Moreover, there are potential health and environmental risks that result from inappropriate use and disposal of these wastes. Thus, this article reviews the current situation with regard to the management of household hazardous waste.

INTRODUCTION

Household hazardous waste (HHW) is waste generated by households, not used or discarded, containing toxic chemicals or labeled toxic, flammable, reactive, explosive or corrosive such as automobile products (motor oil, antifreeze, oil filter), household cleaning products (bleach, hydrochloric acid, formaldehyde, caustic soda, ammonia), personal care products (shampoo, shower gel, bubble bath, liquid soap, nail polish, nail polish remover, deodorant, relaxer), household cleaning products (solvent-based paint, thinner, dyestuff, resin, adhesive), unused medications, insecticides, garden pesticides, products containing heavy metals (battery, fluorescent lamp, electrical and electronic equipment), photographic chemicals (1,2,3,4). Thus, when a potentially hazardous household product is discarded (4) or no longer used (5), it becomes a HHW. A significant proportion of this waste is generated by the daily life of households (6) and is dumped together with non-hazardous waste (7). Many of these wastes are regulated at the industrial level in larger quantities; however, the smaller and distinct quantities found in consumer products are relatively unregulated (8). The lack of a definition for HHW has been observed in different countries (9).

HHW can also present health risks. Indeed, certain products such as medicines, household products and cosmetics are involved in domestic accidents (10). Accidents related to HHW often involve injuries, poisoning or burns (11). HHW hazards also affect waste collectors and recyclers (1). In addition, a variety of variables influence the production of HHW, including income levels, household size, ethnicity and age (12), consumption patterns and urban lifestyles (13), and inappropriate disposal practices (14). The objective of this paper is to review the current situation in HHW management, showing some lessons on how to encourage behavioural changes towards more sustainable lifestyles

DEFINITION OF HOUSEHOLD HAZARDOUS WASTE

HHW is a subcomponent of hazardous waste and a complex waste category due to its inherent chemical and physical characteristics (15). They include small quantities of household hazardous materials that a household wishes to dispose of. Contaminants such as heavy metals are generally present even if they are found in small quantities in a range of household wastes. They are mainly concentrated in a few products such as used batteries, discarded light bulbs and tubes and mercury thermometers (16), solvents from paint residues (17), aromatic

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hydrocarbons and many other aggressive and carcinogenic organic and inorganic components such as phthalates, parabens, dodecyl and sodium sulphate, phosphates, and halogenated hydrocarbon derivatives (18). According to Trembley (19), chemicals used in many household products can cause health and environmental harm if improperly used, stored or disposed of. The U.S. Environmental Protection Agency - USEPA (20) defines HHWs as residual household products containing flammable, reactive, explosive, corrosive or toxic components such as paints, cleaners, oils, batteries and pesticides that require special care during disposal. Thus, any product with a warning or cautionary statement, whether toxic, flammable, corrosive, reactive or explosive, is considered hazardous. The term HHW is also used to describe hazardous waste found in the municipal waste stream (4) and that may apply to HHW (21). According to Gendebien (22), HHW has the potential to increase the hazardous properties of municipal solid waste (MSW) in dumping areas by creating a high polluting potential due to the presence of highly concentrated toxic residues in the leachate. In European legislation, there is currently no precise definition of HHW or household hazardous chemicals. However, the term "hazardous substance" has been defined in Directive 67/548/EEC (as amended) as explosive, oxidizing, highly flammable, flammable, toxic, harmful, irritating, dangerous to the environment, mutagenic, toxic to reproduction, dangerous to the environment, corrosive, carcinogenic, etc. (22).

HHW vary in form. Some of them are in the form of liquid, solid, pasty or gaseous form in various containers (can, cardboard, aerosol, jars...) making their treatment and management a little bit complex (23, 3). A list of household products classified according to one or more hazardous properties is given in Table 1. The African context is marked either by the diversity of definitions or by the absence of harmonized definitions of what constitutes a HHW (2). Moreover, there is little information available and data on HHW in Sub-Saharan Africa (24). This is the case in Senegal, where the 2001 Environment Code does not specifically mention hazardous waste generated by households. Rather, Article L44 of the code refers to harmful and dangerous chemical substances as substances that, because of their toxicity, radioactivity, destructive power in the environment and their concentration in biological chains, present or are likely to present a danger to humans, the natural environment or its surroundings when they are produced, imported into the national territory or disposed of in the environment. The lack of consistent and coherent definition makes it difficult to develop methods and tools to update data and trends on HHW, their sources and fate, and their serious threats to the natural environment and public health (2). To address this gap, it seems important to know the properties and sources of HHW.

PROPERTIES AND SOURCES OF HOUSEHOLD HAZARDOUS WASTE

HHW is any waste generated from daily domestic life that contains substances potentially harmful to human health and the environment (2). According to the EPA - Ireland's Environment guide (25), waste may have one or more of the following hazardous properties:

) explosive: waste capable of producing gas at such a temperature, pressure and rapidity that it can cause damage to the environment;

) oxidizer: waste that can cause or contribute to the combustion of other materials;

) flammable: waste that burns easily;

) irritating: waste that may cause skin irritation or eye damage ;

) toxic: waste that may cause toxicity to certain target organs or may cause acute toxic effects by aspiration ;

) acute toxic: waste that may cause acute toxic effects after oral or dermal administration or inhalation exposure;

) carcinogenic: waste that causes cancer or increases its incidence ;

) corrosive: waste that can cause skin burns;

) infectious: waste containing viable microorganisms or their toxins;

) toxic to reproduction (sexual and fertility function);

) mutagenic: waste that can cause a genetic mutation in a cell;

) acute toxic gas release: waste that releases acute toxic gases on contact with water or an acid;

) sensitizer: waste that contains one or more substances known to have sensitizing effects on the skin or respiratory organs;

) ecotoxic: waste that presents or may present immediate or delayed risks for one or more sectors of the environment ;

) waste likely to contain a hazardous property listed above that is not directly displayed by the original waste.

The guide also identifies some household products that are sources of HHW. These include aerosol cans, batteries, home and garden chemicals, automobile products, paints and do-it-yourself products and Waste Electrical and Electronic Equipment (WEEE). In the context of HHW, the term "aerosol" describes the different types of products packaged pressurized containers non reusable by households. On the other hand, automobile batteries and batteries such as alcalin and carbon-zinc batteries, mercuric oxide, silver oxide and zinc air, and lithium found in toys, cell phones, remote controls and button cells used in cameras, watches, contain substances that are harmful to the environment. As far as household and garden chemicals are concerned, they can be presented in full or partially empty containers. These are:

) toxic waste: pesticides (herbicides, insecticides and fungicides), weed killers, old medicines, old mercury thermometers and lawn care chemicals;

) less toxic household hazardous waste: detergents, disinfectants and surface cleaners;

) corrosive wastes: chlorine bleach, peroxides, hypochlorites and some fertilizers;

) flammable waste including solvents such as acetone some drain cleaners, some floor and furniture lacquers, and alcohols.

Automobile products include flammable and toxic substances such as gasoline, diesel, brake fluid, transmission fluid, antifreeze and rust remover. For paints and do-it-yourself products, formulations have evolved considerably in recent years, with the elimination/reduction of the heavy metals used and the evolution towards water-based paints containing lower concentrations of volatile organic components or substance. Many paint strippers based on solvents, paint thinners (such as

turpentine) and wood, conservation agents are also flammable and toxic. Fluorescent tubes and energy-saving compact fluorescent lamps contain sodium and mercury and may also contain lead, cadmium and other heavy metals (25). Furthermore, as the population grows, the consumption of products that cause the production of HHW will increase (24).

PRODUCTION OF HOUSEHOLD HAZARDOUS WASTE: QUANTITIES AND TYPES

Increasing economic modernization, rapid urbanization, population growth and living standards have created new needs, with the use of new products resulting in the generation of large quantities of municipal solid waste worldwide. For example, in Mexico, it has been observed that new types of unregistered household waste are being generated as a result of technological development, many of which are hazardous (5). Thus, when household hazardous products are disposed of, an HHW stream is created (26). HHW represents only a small fraction of total household waste and an even smaller amount of MSW. This amount varies from country to country and can also vary within the same country depending on many factors (socio-economic and environmental). The percentage is generally between 1% and 4% of MSW (11, 7). As an example, according to Rojas-Valencia (5) the amount of HHW represents 1.15% of the total MSW in Mexico, 1% in the United Kingdom and 1.33% in Spain. A study conducted in the city of Suzhou, China, indicated a HHW production rate of 6.16 g/person/day, which represented 2.23% of the MSW flow (6). In Iran, in the city of Amirkola, the average production of this type of waste was 75.6 kg/day, which represented about 0.3% of the MSW (27). On the other hand, most developing countries, particularly in Africa, do not have national databases on the production of HHW (2). However, in Senegal, the share of HHW in the average composition of household and similar waste (estimated at 2,324,4919.60 t/year for the country as a whole) is 1%, i.e. 1,6772.85 t/year (28).

Regarding the types of waste, Edokpayi (24) identifies six (06) classes of HHW: automobile products, home improvement products, health and beauty products, pesticides, household cleaning products, and various items (see Table 2). Among these different classes, there are differences from one country to another. For example, according to Gu (6) the main classes of products contributing to the HHW flow in China were cleaning products (21.33%), medicines (17.67%), personal care products (15.19%), hobby and educational waste (10.17%), household cleaning products (10.97%) and batteries (11.14%), gardening products (2.7%), car maintenance products (2.67%) and various products (8.18%) (6). In Indonesia the main types of hazardous wastes include cleaning products (24%), personal care products (37%), automobile maintenance products (11%), paints and similar products (12%), pesticides and insecticides (4%), and various products (12%) (29). Differences in the composition of HHW may be due to the use of different methodologies, separation and collection processes (5). According to the same author, most studies on the generation of HHW refer to the total amount found in MSW streams and very few studies estimate waste directly from households. These variations may also occur in different parts of the same country and can be explained on the basis of different facts (7).

For example, the HHW generation stream in Suzhou, China, highlighted other sets of variables, such as local customs and

culture, consumption patterns and urban lifestyles (6). Regardless of their nature or quantity, HHW can have various effects on the environment and the health of populations.

ENVIRONMENTAL AND HEALTH RISKS

Many household products contain the same chemicals as industrial waste and can cause environmental pollution (13) and health risks. The EPA - Ireland's Environment guide (25), identifies for certain household products, proven risks. According to this guide, empty aerosols, after use, may contain significant residual quantities of their original contents which may be dangerous, flammable or toxic. Aerosols also contain a propellant, which may be flammable, such as butane. Batteries contribute to the production of many potentially hazardous components or substances in the MSW stream, including zinc, lead, nickelalkaline, manganese, cadmium, silver and mercury. Contact with these components or substances can cause skin and eye irritation.

Contact with the substance of household chemicals such as detergents, laundry detergents, chlorine bleach, peroxides, garden chemicals and pesticides with skin and eyes is toxic. Risks associated with automobile products such as antifreeze include fire, explosion and toxic effects. Paints, solvents and thinners are toxic if swallowed. The main dangers come from old paints and lacquers which may contain a wide range of flammable, harmful, toxic and carcinogenic organic solvents. Fluorescent tubes and energy-saving light bulbs contain mercury in small amounts that, if the bulbs are broken, can be released as a vapor. Mercury is toxic, and short-term exposure to high concentrations of mercury vapor can have harmful effects on the nervous, digestive and respiratory systems, as well as the kidneys (25).

In addition, cases of de-conditioning, in which a hazardous product is transferred to another container (usually a food bottle), are often also a source of risk in households with young children and the elderly (30). Thus, depending on the degree of risk and other health determinants, one can contract or develop a certain discomfort that can lead to disease. For example cleaning sprays may contain disinfectants, amines, pinene, or limonene. These are sensitizers that may play a role in bronchial symptoms (31). Moreover, the collection and separation of household waste can be the source of risks of biological contamination or infection, allergies, respiratory diseases (1).

Table 3 presents some household products and their hazardous components, as well as potential health risks. On the other hand, the entry of hazardous household products into the environment occurs at the time of their use and disposal (24). They can contaminate septic tanks or wastewater treatment systems if discharged into sewers or toilets (2), or enter groundwater (deep wells), surface water (shallow wells and rivers) (32). In Senegal, according to the United Nations Department of Economic and Social Affairs (33), between December 2007 and February 2008, eighteen (18) deaths of children between the ages of zero and six (06) were recorded in the municipality of Thiaroye Sur Mer. Investigations conducted between March 2008 and June 2008 showed that these deaths were due to contamination of the neighborhood by lead from the informal activity of exploiting used automobile batteries and sieving the soil to collect lead oxide, which is a hazardous waste.

Table 1: Examples of Potentially Hazardous Chemicals Found in Households (4)

Product	Ingredient	Hazardous property
Oven and cleaners	Sodium hydroxide and/or ammonium hydroxide (ammonia), and possibly methylene chloride	Very corrosive and can cause death if ingested, burns skin and eyes
Drain cleaners	Concentrated sodium hydroxide (can be solid or in aqueous solution of 50% m/m), or hydrochloric acid or sulphuric acid (up to 70% m/m)	Very corrosive and can cause death if ingested, burns skin and eyes
Household bleach	Sodium or calcium hyperchlorite in concentrations up to 10% m/m, or hydrogen peroxide	Can burn skin and eyes
Toiletbowl cleaners	Hydrochloric acid or sodium hyperchlorite and if coloured blue can contain chromium compounds	Very corrosive and can cause death if ingested, burns skin and eyes
Mould and mildewcleaners	Sodium hyperchlorite and formaldehyde	Very corrosive and can cause death if ingested, burns skin and eyes
Other cleaning products	Ammonium hydroxide (ammonia) and ethanol, chlorinated phenols and complex phosphates	Harmful if ingested and can cause burns to the skin and eyes
Air fresheners	Formaldehyde or phenol	Harmful if ingested and can cause burns to the skin and eyes
Pesticides	Organophosphates and chlorinated compounds such as chlorinated pyrethrums	Death on ingestion
Pharmaceuticals	Cytotoxic/cytostatic, antibiotics	Carcinogenic, teratogenic, risk of overdose, etc..
Paints and related products	Alcohol, glycols, ethers, ketones, toluene, xylene, acetone, esters, ketones, petroleum distillates, and solvents	Organic compounds can cause lung and kidney damage
Anti-freeze	Ethylene glycol	Fatal if swallowed. Affects the central nervous system
Pool chemicals	HCl and NaOCl	Very corrosive and can cause death if ingested, burns skin and eyes

Table 2. Classification of the household hazardous products (24)

Class	Hazardous products	Examples
I	Automobile products	Gasoline, motor oil, brake fluid, wiper fluid, hydraulic oil, and car batteries
II	Home improvement products	Paint (oil-based and latex), caulk, varnish, air freshener
III	Health and beauty products	Nail polish, finger nail polish remover, nail varnish, hair dye, bath salts/bubble bath, and skin creams
IV	Pesticides	Rat poison, flea killer, insecticide, fungicide, moth balls, ant poison, and herbicide
V	Household cleaners	Furniture polish, oven cleaner, toilet bowl cleaner, scouring agent, shoe polish, stain remover, disinfectant, and bleach
VI	Miscellaneous items	Fabric dyes, fluorescent tubes, low energy light bulbs, ink cartridge and toner, glue, antifreeze, and among others.

Table 3. Some examples of household products containing hazardous components and their health hazards (24)

Product type	Class	Hazardous components	Hazardous status	Potential health hazards
Antibacterial cleaner	V	Ammonia, detergents, lye	Toxic	Fumes can irritate eyes and lungs; can cause burns or rashes on skin; can produce deadly chloramine gas if mixed with chlorine-containing products
Hairdyes	III	Pigment ammonia	Toxic	Can cause burns or rashes on skin; can produce deadly chloramine gas if mixed with chlorine-containing products
Skin creams	III	Heavy metals	Toxic	Can cause nerve and kidney damage; is thought to cause cancer
Glue	VI	Xylene, toluene	Flammable toxic	Irritation of eyes, mucous membrane, and skin; effects reproductive system; probable human carcinogen of medium carcinogenic hazard
Paints	II	Ketones	Flammable toxic	Respiratory system damage
		Aromatic hydrocarbon	Flammable toxic	Carcinogenic; irritates skin, eyes, nose and throat; respiratory system damage
		Mineral spirits	Flammable toxic	Irritates skin, eyes, nose and throat; respiratory system damage
Air fresheners and deodorizers	II	Formaldehyde	Toxic flammable	Carcinogen; irritates eyes, nose, throat, and skin; nervous, digestive, respiratory system damage
Bleach	V	Sodium hypochlorite	Corrosive toxic	Irritates and burns skin and eyes; nervous, respiratory, digestive system damage
Disinfectants	V	Sodium hypochlorite	Corrosive toxic	Irritates and burns skin and eyes; nervous, respiratory, digestive system damage

In addition, many chemicals are associated with acute and chronic human health problems and environmental damage. Although these associations are advanced but unproven, they are still of great concern (34). Despite the potential risks and impacts on health and the environment, people have not really become aware of the problem of household hazardous waste.

POPULATION'S PERCEPTION AND PRACTICES

Population growth has resulted in an increase in consumer products classified as HHW (32). According to Rojas-Valencia (5), the problem of solid household waste is aggravated by the unimpeded production induced by the consumption system. These authors further argue that the overvaluation of consumed products is due to both lack of knowledge and insensitivity, since many people are only concerned with acquiring things, without considering the impact of this attitude on the environment. Also, according to Al-Tamimi (11), people are not fully aware of the presence of hazardous and toxic materials in household waste and the threat they pose to their health and the environment.

Practices and behaviors

In terms of practices and behaviors, households often tend to purchase hazardous household products in quantities greater than the actual need. These products are, daily used by households and most often without reading pre-use warning labels that provide information on how to use, store and dispose of the products safely. Worldwide, several examples have been reported. In Eastern Europe, for example in the Czech Republic, despite considerable public awareness and education, about 2.047% of HHW have been found in MSW (7). In Western Europe, especially in Spain, communication campaigns aimed at making citizens aware of how to properly separate hazardous waste, and the existence of fixed and mobile recycling centers have shown that few citizens actually use these facilities (18% in four districts) (35). In Asia, a study conducted in Japan (36) showed that many people keep end-of-life batteries, fluorescent lamps, empty aerosols and other waste in their homes after use. The rate of retention ranged from 20% to 30%. In Africa, a study conducted by Edokpayi (24) in a few sub-Saharan African countries (Kenya, Nigeria and South Africa) showed that most people barely read the labels of the products they buy to follow the disposal procedure. Even those who do read the labels ignore manufacturers' instructions on how to dispose of these products. In addition, children often play with flammable substances at home or after improper disposal.

Changing practices and behaviors: Various solutions have been identified in the literature to encourage responsible practices and behaviors. Among these approaches, labelling, information, training and communication are the most frequently cited in the literature. According to Slack (4) and Asari (36), labelling of packaging and the provision of information would help households to identify potentially hazardous products. Indeed, according to Inglezakis (3), ordinary citizens need to develop a common knowledge of HHW and become aware of potential risks through local information and education initiatives. And for a better understanding, Amouei (27) and Lim-Wavde (37) suggest training households in the identification, separation, storage and transfer of HHW in the collection system. The latter authors also attest that information in the form of notification

or alerts on environmental quality can have an impact on households' perception of the quality of the environment in which they live. Indeed, according to Asari's work (36), when risk information was specifically presented in a questionnaire, people tended to show a more positive intention to participate in a collection and recycling system than those who did not receive such information. One of the prerequisites for encouraging responsible practices and behaviour is the establishment of an adequate regulatory framework.

REGULATORY FRAMEWORK

According to Van Engel (38), sound chemicals and waste management is an important component in achieving sustainable, inclusive and resilient human development and sustainable development goals. Thus, various conventions and agreements have been developed to address these concerns at the global, regional and sub-regional levels. At the global level, we find the Basel Convention, the Convention against the Use of Wax in Paint and the Globally Harmonized System (GHS) for the Classification and Labelling of Chemicals. The Basel Convention deals with the control of transboundary movements of hazardous wastes and their disposal. It was adopted on March 22, 1989 and prohibits the import and disposal of hazardous wastes from industrialized countries to developing countries. HHW are listed in Annex 1 and correspond to the following categories:

- J Y3: Waste of medicines and pharmaceuticals,
- J Y4: waste from biocides and plant protection products,
- J Y5: waste from wood preservation,
- J Y12: wastes from inks, dyestuff, pigments, paints, lacquers and varnishes,
- J Y16: wastes from photographic products and materials.

The Convention against the use of ceruse in painting is established by the International Labour Office. It prohibits ceruse, considered as a poison and formerly used in paint. To better inform users, the Economic and Social Council of the United Nations adopted the GHS for the classification and labelling of chemicals in 2002.

At the regional and sub-regional levels, several mechanisms have also been put in place. These are the Regional Convention on the Transboundary Movement of Hazardous Waste, the Waigani Convention and the Bamako Convention. In Central America, the Regional Convention on the Transboundary Movement of Hazardous Wastes was adopted in 1992 in Panama and has not yet entered into force. In South Pacific Region, the Waigani Convention was adopted in 1995 and entered into force in 2001. According to Agniel (39), it provides for the control of movements of hazardous waste generated by member states and prohibits the import into the territory of island member states of waste generated in other countries. In Africa, the Bamako Convention on the Ban on the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes was adopted by the Organization of African Unity in 1991 and came into force in 1999. It stipulates in its Annex 2 that collected household waste and residues from the incineration of household waste are identified as categories of waste requiring special consideration. Despite these different regulatory provisions at the global, regional and sub-regional levels, the general observation is that HHW are not really taken into account. In Europe, the term used to refer to HHW

is not clearly defined in European Union (EU) legislation and there are no explicit rules for the appropriate management of such waste (3). Also in Japan, the disposal of small quantities of HHW is not controlled (40) and in the United States (17). However, according to Inglezakis (3), fractions of HHW separated from the mixed household waste stream should be managed as hazardous waste and kept separate from mixed municipal waste.

In the African context, there is no coherent policy framework dealing specifically with the regulation of HHW, although most African countries have ratified and signed international conventions and regional agreements. At the sub-regional level, particularly in West Africa, ratified international and regional texts are not really transposed and integrated into national legal systems, particularly with regard to HHW. All of the aspects outlined above demonstrate the need for policies for handling HHW and an appropriate legal and regulatory framework governing the management of HHW.

HHW MANAGEMENT: COLLECTION, TRANSPORT AND DISPOSAL:

The management of HHW requires a protocol of actions that includes the reduction, storage, collection, transport, use, treatment and disposal of toxic and hazardous waste (16). Several examples of HHW management practices around the world are reported in the literature. In Indonesia, HHW management consists of separating hazardous waste either manually or automatically. To do so, the government has established a "take-back" program with manufacturers who produce products that may generate hazardous and toxic waste to provide storage and treatment facilities. The system was to allow owners to return used products to the respective manufacturing companies (16). Another study, this time in the city of Padang, Indonesia, on hazardous waste management included hazardous waste minimization and treatment activities with the 4R concept, i.e. Reduce, Reuse, Recycle and Recuperate. This minimization activity not only reduces the amount of waste generated, but also limits the generation of household solid hazardous waste and reduces the risk of mixing household solid hazardous waste with other wastes (29).

Similar programs have also been developed in Europe. Indeed, two relevant policy approaches have recently been introduced to promote waste transportation and recycling, namely extended producer responsibility and good product management (3). In Spain, on the other hand, the management of HHW by citizens is carried out through fixed and mobile recycling centers, which are usually under the control of local authorities (35). Household waste, even if not always toxic or hazardous in itself, can become a hazard if not collected or managed properly.

For example, in the United States, HHW collection programs have been implemented to improve the diversion of HHW from household garbage (37). Thus, despite their small volume, HHW must be collected separately and treated efficiently, avoiding the current practice of disposal in conventional dumping areas that may result in the release of potentially hazardous materials into the environment (3). According to Slack (4), disposal to sewers rather than as solid waste can also be used as a means of disposal of HHW, particularly household cleaners/detergents (and during use), pharmaceuticals, pesticides, paint related products, etc. (5). Government, producers and retailers should coordinate and

develop integrated citizen-friendly recycling systems to achieve effective collection and management of HHW (3).

The African context, particularly the underprivileged districts of developing countries, is marked by a low collection rate and uncontrolled illegal dumping (41). Moreover, as a general rule, there is no waste separation. Indeed, most inhabitants mix all the components of household waste, including HHW. Pre-collection is usually done manually by door-to-door collection by carters. According to Edokpayi (24), common household waste management and treatment methods include open burning, incineration, and dumping. According to the same author, there has been relatively little interest and less progress in reducing HHW and there is a lack of data and information on the quantities of HHW scattered throughout the region and no one knows what is being disposed of, what was disposed of a few decades ago and how it was disposed of. As a result, the generation of HHW is subject to uncertainty due to the lack of a coherent and effective waste management system (2).

Conclusion

In developing countries such as Senegal, users are not aware of the danger and environmental consequences of inappropriate use and disposal of HHW. Research is needed to identify low-cost solutions and implement policies for handling HHW. Above all, this requires the establishment of an appropriate legal and regulatory framework governing the management of HHW.

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GLOSSARY OF ABBREVIATIONS

4R: Reduce, Reuse, Recycle and Recuperate
EEC: European Economic Community
EPA: Ireland's Environment : Environmental Protection Agency of Ireland
EU: European Union
GHS: Globally Harmonized System
HHW: Household hazardous waste
MSW: Municipal solid waste
UNEP: United Nations Environment Program
USEPA: United States Environmental Protection Agency
WEEE: Waste electrical and electronic equipment

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