RISKS AND CHALLENGES OF HAZARDOUS WASTE MANAGEMENT: REVIEWS AND CASE STUDIES

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Risks and Challenges of Hazardous Waste Management: Reviews and Case Studies

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Graphical Abstract

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FOREWORD

Interest in solid and hazardous waste management is relatively recent, *i.e.*, in the last three decades, and is driven by regulations in most countries. It began with industrial hazardous waste, followed by municipal solid waste, and subsequently by many other categories of waste. This book features chapters discussing the implications of healthcare waste management and their impact on groundwater and other parts of the environment, as well as principles of as sustainable management and its application in the reuse and recycling of such kind of waste. Moreover, it includes examples of waste to energy. It also covers topics such as life cycle assessment as a tool for developing healthcare integrated waste management systems and an overview of waste management rules, illustrating the importance of technological inputs in the development of regulatory frameworks. This subject matter should be examined with a global standpoint in order to bridge the knowledge gap. Different chapters analyze the management of healthcare waste around the globe and specifically in different countries where it is in a deplorable state and stands out as a major risk factor to the health of both healthcare workers and individuals/communities in and around the healthcare facilities. There is a need to institutionalize healthcare waste management as part of the overall management system of a particular healthcare facility. In addition, healthcare waste management needs to intervene at other higher levels *i.e.* district, regional and national levels such that these levels will be positioned to provide the necessary or required support to facility and community levels in all matters related to healthcare waste management. The significant support expected from the national, regional and district levels includes, among others, the development of the required policies, legal/regulatory framework and ensures adequate budgetary allocations to meet healthcare waste management input requirements.

In this scenario, it is important to point out that medical care plays a vital role in our life and health. Still, the waste generated from medical activities represents a real problem of living nature and human world. For this reason, the appropriate methods for waste neutralization, recycling and disposal should be identified such management [1]. In particular, all processes should ensure both proper hospital hygiene and safety of health care workers and communities. Among biomedical waste, some chemical and pharmaceutical products that can cause poisoning by absorption through the skin or mucous membranes, by inhalation or by ingestion. Furthermore, they could provoke lesions of skin, eye, and respiratory mucosa. For example, chemical waste an or pharmaceuticals (such as antibiotics or other drugs, heavy metals, disinfectants and antiseptics) removed by the drainage system may cause toxic effects on ecosystems. Furthermore, the elimination of biomedical waste should be associated with safe waste management to protect the human health and the environment. Incineration of medical waste can be very dangerous since the plastic (containing chlorine) derived from such waste generates dioxin. Once formed, dioxin (that is carcinogenic) is able to bind to organic particles. Therefore, it is transported by wind and deposited on land and in water. The half-life of such compound is 25 to 100 years. Furthermore, dioxin it is able to link to nuclear DNA. Its formation is associated to potential cancer promoter, weak-delete immune response and other harmful effects on human health (such endometriosis, birth defects, low testosterone levels) and environment. Also, exposure to low dioxin concentrations causes negative effect on human health. The introduction of a sustainable system of biomedical waste management might allow to store a significant amount of hazardous biomedical waste in safe manner, and it will be possible to recover, treat, neutralize and recycle in terms of environmental protection. Therefore, waste recycling could play a crucial step in the reduction of earth resources. Furthermore, efficient health care waste management can be associated with the control of different diseases (hospital acquired infections), and reduction of community exposure to resistant bacteria. In addition, it could lead to the decrease of sepsis, and hepatitis transmission from dirty needles or uncleaned medical items. In this scenario, a sustainable management system of biomedical waste it is necessary to avoid the harm human health effects.

Furthermore, the coronavirus disease 2019 (COVID-19) pandemic has led to a great increse of medical and domestic waste. In this context, the safe managing of this waste plays a crucial role to successfully containing the disease. Therefore, the current pandemic brings a new challenge for medical waste management in every country.

In this context, some chapters of this book underline the relationship between adverse health effects due to waste management practices, in particular of hazardous waste, that potentially represent a public health issue in many countries because of growing waste production, inadequate waste management practices, lack of appropriate legislation and control systems, as well as of growing illegal hazardous waste transboundary movements [2, 3].

In this frame, various chapters describe different aspects on the occurrence and severity of health effects related to illegal waste disposal in Campania, an Italian region. Since 1980, this region has been characterized waste mismanagement [4 - 7], which led to the deterioration of land, as well as ground and surface water, also impacting air quality. In recent times, some oncologists, pathologists and toxicologists have reported that the continuous exposure of Campania citizens to toxic contaminants produced by the illegal dumping of waste in the region could become a big health issue. Furthermore, in these years, many grassroots movements against waste mismanagement are born in Campania. For example, in 2012, three main groupings of associations: Fires Coordination Committees, Campania Citizens for an Alternative Waste Management Plan, and Commons Net have created a social coalition called Stop Biocide [8]. Today, the citizens fight to obtain:

1. a better management of urban waste.
2. the remediation of the contaminated sites.
3. the halting of illegal waste trafficking.
4. a systematic health screening of the Campania population who live close to illegal dumping of toxic waste.

The faces of the children, who died and continue to die from cancer, represent the icons of biocide movement and they are shown during several demonstrations in the region. Furthermore, the movement has sent to the President of the Italian Republic and Pope Francis a lot of postcard with their faces printed on them to ask for direct intervention [9, 10].

Moreover, an article entitled "Triangle of death" linked to waste crisis, was published in The Lancet Oncology [11], and the authors reported a possible correlation between hazardous waste and high incidence of cancer in Naples and Caserta provinces. In this regard, people living close to illegal waste sited located in different municipalities of Naples and Caserta reported some adverse health effects. Many descriptive studies reported an early mortality rate (0–14 years) and congenital malformations. Furthermore, the cause-specific mortality and morbidity rates in Campania are very different when compared with the Italian national average. Future studies should be carried out to better understand the correlation between waste-related exposures and health profile of the Naples and Caserta provinces by analysis of mortality, hospital discharge records, cancer incidence, congenital malformations in newborns.

I recommend this book since it offers a broad look on the interaction between hazardous waste management and human health impacts. Through the chapters, it examines the way we affect and disrupt our health and the health of ecosystem around us. Now I believe that we have got to work together for the future. If we change now, we have an opportunity to decide what kind of world our children and our grand children and their children will grow up in.

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PREFACE

This book is written with the objective of providing all the essential information which are of utmost importance to hazardous waste management. The issues of environment protection have already spread far and wide and proper management of hazardous waste is one valuable contribution towards this global concern. The first chapters attempt to simplify the subject and to inculcate the valid concept of biomedical waste management effects.

From chapter one to three, the problems of healthcare waste management are discussed. Moreover, other authors illustrate some case studies of hazardous waste mismanagement that has caused a massive environmental damage in chapter four and five. Then, chapter six analyzes the emerging environmental and public health impacts of e-waste.

Finally, the last chapters describe the waste crisis in Campania. In this regard, the authors provide useful insight into single aspects of the waste system in Campania and their influences on human health impact.

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CHAPTER 1

Healthcare Waste: A Challenge for Best Management Practices in Developing Countries

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Abstract: Healthcare waste (HCW) is the waste generated by the activities of healthcare facilities, educational institutions and medical research which is harmful to both human and animal health. About 10 to 15% of HCW presents hazardous characteristics, including a broad range of materials from sharps, used needles and syringes to soiled-dressings, body fluids or wastes contaminated by chemical and/or containing a high concentration of microorganisms. Such kind of waste requires very specific treatment to ensure proper final disposal. Its generation depends on different factors such as the economic development of the country and the type of service provided by the above-mentioned institutions. In this context, HCW management (HCWM) is a public health and environmental concern worldwide, especially for non-developed countries. Furthermore, HCWM is a complex and challenging process that covers a wide variety of actions, including segregation, minimization, previous treatment, packaging, temporary storage, collection, internal transportation and external storage of HCW. The first priority in this waste management should be the segregation and reduction in order to decrease the contaminated solid waste and to ensure selective collection. Furthermore, a great part of HCW can be recycled. In order to encourage successful best management practices, the results of a GEF-funded national development report headed by the Ministry of Health of Argentina are hereby exposed including proposed actions for training, guidelines, supervision, appropriate utility supply, management support and specific regulations to face future challenges. Improvements in the management system through HCW indicators may prove failures in segregation procedures, showing an opportunity for continual advances. To reduce potential problems that expose the healthcare facility staff, patients and their attendants to the risk of serious health hazards, there should be sufficient resource allocation, periodic training and strict supervision by stakeholders. Institutional planning for an efficient HCWM will assure HCF to both save money and provide a safe environment for patients and healthcare personnel.

Keywords: Best management practices, Healthcare facility, Healthcare waste, Healthcare waste management.

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INTRODUCTION

As far as the WHO is concerned, let's remember that "by trying to achieve their goals of reducing health problems and eliminating potential risks to people's health, health services inevitably produce waste that can be dangerous on their own for health". Waste produced in the course of health-care activities has a greater potential for infection and injury than any other type of waste. Wherever waste is generated, safe and reliable methods for handling are therefore essential. Inadequate and inappropriate management of healthcare waste (HCW) can have serious public health consequences and a significant impact on the environment. Therefore, the proper management of HCW is a crucial component of environmental health protection" [1]. The rising demand for healthcare services in developing countries, at the world level, is causing a significantly high amount of HCW generation that requires both efficient management and proper disposal [2]. Special concern deserves limitations of healthcare facilities (HCF) –global denomination for places that provide healthcare, including hospitals, clinics, outpatient care centers, and specialized care centers, such as birthing centers and psychiatric care centers- to adequately segregate infectious or hazardous waste from ordinary domestic waste to treat this type of waste with proper technologies [3]. Healthcare waste management (HCWM) poses technical problems and is largely influenced by cultural, social and economic circumstances [1]. Developing countries need well-designed HCWM policies as well as a legislative framework and plans to achieve local implementation. Actions involved in the implementation of effective HCWM programs require multisectoral cooperation at all levels. The change has to be gradual and must be technically and financially sustainable in the long term.

Improving HCWM by enforcing knowledge and technical capacity for implementing and sustaining pollution-prevention measures, waste minimization and segregation practices are viable alternatives to the "business as usual" scenario. Developing countries need to adopt new strategies and treatment technologies that are affordable, that can be developed and serviced locally, requiring low-cost energy inputs, and are appropriate to HCF in urban and rural areas including, at worst, the need to operate at locations that may lack reliable electricity service and other utilities.

We will not discuss radioactive wastes since they are usually under strict rules and supervision established by the National Atomic Energy Organizations, aside from health authorities.

The remaining wastes can be grouped into two broad categories: bio-hazardous and chemicals, as summarized in Table **1**, which represent different types of risks as well as require different preventive actions.

Table 1. Hazardous healthcare waste categories.

Hazardous Healthcare Waste Categories		Descriptions and Examples
Bio - hazardous waste	Infectious	Waste suspected to contain pathogens and that poses a risk of disease transmission (*e.g.* waste contaminated with blood and other body fluids; laboratory cultures and microbiological stocks; waste including excreta and other materials that have been in contact with patients infected with highly infectious diseases in isolation wards)
	Pathological	Human tissues, organs or fluids; body parts; fetuses; unused blood products
	Sharps	Used or unused sharps (*e.g.* hypodermic, intravenous or other needles; auto-disable syringes; syringes with attached needles; infusion sets; scalpels; pipettes; knives; blades; broken glass)
Chemical waste	Chemical	Waste containing chemical substances (*e.g.* laboratory reagents; film developer; disinfectants that are expired or no longer needed; solvents; waste with high content of heavy metals, *e.g.* batteries; broken thermometers and blood-pressure gauges)
	Cytotoxic	Cytotoxic waste containing substances with genotoxic properties (*e.g.* waste containing cytostatic drugs; genotoxic chemicals)
	Pharmaceutical	Pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals

Source: Modified from WHO, 2015.

THE HEALTH-CARE CONTEXT

A WHO assessment conducted in 22 developing countries in 2002 showed that the proportion of HCF that do not use proper waste disposal methods ranged from 18% to 64% [4].

Probably for its more evident and immediate impact, greater attention has been given to bio-hazardous waste. Even in facilities properly managing their waste, healthcare workers are exposed through a mucosal cutaneous or percutaneous route to accidental contact with human blood and other potentially infectious biological materials while carrying out their occupational duties.

A significant portion of the infections arising from blood-borne pathogens may be due to injuries from contaminated sharp objects (needles, blades, *etc*.) injuries. Literature has reported that incidence rates of sharps injuries range from 1.4 to 9.5 per 100 healthcare workers, resulting in a weighted mean of 3.7/100 healthcare workers per year. Sharps injuries have been reported to be associated with infective disease transmissions from patients to healthcare workers resulting in

CHAPTER 2

A Review of the Knowledge, Attitude, and Practices of Healthcare Wastes Workers (HCWS) on Medical Waste in Developing Countries

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Abstract: Medical care activities can produce various types of risks (hazardous) wastes. Poor management of these wastes can lead to environmental pollution and health risks to healthcare personnel, patients, and the community at large. Adequate knowledge, attitudes, and practices of managing medical waste are vital. This paper reviews the main issues in medical waste management by healthcare workers in developing countries. Results from reviewed literature showed that in developing countries, Medical waste management is inefficient. Knowledge and awareness concerning safe medical waste management are inadequate as a result of lack of or absence of training for medical waste management personnel, absence of waste management and disposal systems, lack of safety equipment and immunization in most of the health centers. This paper concludes by recommending ways by which poor medical waste management can be ameliorated in healthcare centers.

Keywords: Attitudes, Awareness, Healthcare, Healthcare waste workers, Hospital, Knowledge of Medical waste.

INTRODUCTION

Medical center or hospital is where people go irrespective of their race, age, gender, and faith, to find a cure for their illnesses [1, 2]. Healthcare service delivery in medical centers generates hazardous waste known as 'Medical waste (MW), Clinical (CW), Healthcare (HCW) or Biomedical (BMW) wastes' [3], these terms are often been used synonymously. Lack of awareness regarding the dangers or risks associated with the refuse generated by health centers on mankind and the environment abound in the general population [4].

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Healthcare waste means all the waste generated in medical facilities, laboratories, and centers of research associated with healthcare procedures. Additionally, it includes veterinary centers and waste generated during healthcare undertaken in the home (healing procedure) [5, 6]. Healthcare facilities mostly are situated in the urban centers as such; healthcare wastes that are not correctly managed can cause dangerous infection and pose a potential threat to the nearby environment, health workers (doctors, nurses, paramedical personnel) patients and the public [7]. It was established that between 75% to 90% of the waste generated by hospitals is comparable to domestic or municipal waste usually called "non- risks waste," general healthcare waste" or "non- hazardous waste", while "risks waste" or "hazardous waste" constitute the remaining 10% to 25% [8 - 10] when these wastes are mingled together they become hazardous to mankind, animals and the environment. Reports suggest that in developing countries 80% of healthcare waste is jumbled together with general or domestic waste [11]. Globally, it is estimated that per year about 7 to 10,000,000,000 tons of waste is generated, out of this only, 2,000,000,000 tons are general solid waste, of which medical waste contributes but a small fraction [11, 12]. These developing countries include Nigeria, Ghana, South Africa, India, and Pakistan to mention a few [10, 13]. Additionally, it has been documented that, globally, around 5.2,000,000 persons (including 4,000,000 children) die each year from diseases associated with the waste [2, 14]. Inadequate medical waste management causes land, water, and air pollution, gradual increase and augmentation of vectors such as worms, insects, and rodents and may cause the out break of diseases like cholera and malaria [15]. Furthermore, injuries from contaminated sharps, needles and syringes may lead to the transmission of hepatitis, and *acquired immunodeficiency syndrome* AIDS [15 - 17]. Medical waste workers should tackle the hazards associated with their practices, by segregating the healthcare waste at the source of generation [18, 19]. Poor attitudes and practices of medical waste management staff put them in danger. Healthcare waste workers in developing nations usually cultivated the poor attitude in performing their tasks right from inception and often becomes hard for them to adjust. For this reason, it is necessary to address these amidst medical waste workers (MWW) [18, 20]. Furthermore, medical waste (MW) is the second most dangerous waste after nuclear; this means trained healthcare personnel are needed to properly dispose of it. Therefore, a sound knowledge, attitude, and safe practice of healthcare personnel regarding the management of this waste are necessary [21, 22].

PERSONNEL'S INVOLVED IN MEDICAL WASTE MANAGEMENT IN HEALTH CENTERS

According to the World Health Organization (WHO), medical waste workers most affected by medical waste include doctors, nurses, pharmacists, and other non-medical staff members. This is because they are routinely exposed to healthcare waste and risks from many fatal infections due to the indiscriminate management of waste. However, many of the affected healthcare workers are from third world countries where policies and systems to enforce management of health care waste are weak. It is approximated that more than five hundred healthcare workers lose their lives in sub-Saharan Africa yearly as a result of infection due to unsafe contact with medical waste. According to Nkonge Njagi A, *et al.*, [23] the personnel can be grouped into four cadres as follows:

a. **Medical practitioners:** this involves all categories of medical doctors, dentists, pharmacists, technologists, and clinical officers.
b. **Nurses:** this involves all categories of nurses in healthcare facilities.
c. **Laboratory technologists:** all cadres of technicians, technologists, and scientists are in this category.
d. **Hospital attendants:** this means all the attendants from the various wards and units including incinerator operators of the hospitals.

IMPORTANCE OF KNOWLEDGE, ATTITUDE, AND PRACTICES IN THE MANAGEMENT OF HEALTHCARE WASTE

Inadequate knowledge, attitude, and practices of handling (managing) medical waste can lead to nonsocomial infection (Hospital-acquired infection). Definitions of these concepts as given by [23, 24] as follows:

a. **Knowledge:** clear awareness or explicit information regarding the hazards associated with medical waste must be made known to medical waste personnel and how to safely dispose of the waste is vital.
b. **Attitude:** this means peoples behavior, *e.g.* disseminating information regarding the positive attitude towards the environment and the protection of health is vital.
c. **Practice:** this concerns the behavior of healthcare personnel *e.g.* do they use protective equipment, are they following the rules and regulations of safe medical waste management.

CLASSIFICATION OF HEALTHCARE WASTES

Medical waste is categorized into different types, namely: infectious waste, pathological waste, sharps, pharmaceutical waste, chemical waste, radioactive waste, cytotoxic agents and human or anatomical waste. Infectious waste contains pathogens (bacteria, viruses, parasites, or fungi) in sufficient concentration capable of transmitting a disease. Pathological waste consists of tissues, body organs or parts, and, body fluids. Sharps are objects that could cause cuts, or prick injuries, which may or may not be infected, such as, saws, needles, scalpels, broken glasses, *etc.* Pharmaceutical waste includes pharmaceutical products, drugs, and medicinal chemicals that are expired, spilled, or returned from patient wards, or are to be discarded because they are no longer needed. The chemical

CHAPTER 3

Blood Exposure Accidents: Knowledge and Evaluation of Health Professional in the Emergency Pavilion of the Hospital of Batna City

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Abstract: Blood Exposure Accidents (BEA) are a real risk to personnel health, particularly in developing countries. The objective of this study is to assess the knowledge and attitudes of health personnel on BEA, know the existing safety equipment and its application by the staff, and propose improvements to have an effective protection prevention system. We have, therefore, conducted a survey during the month of May 2019 in order to assess the current situation. A previously developed questionnaire was provided to health personnel who had direct daily contact with patients. The results showed a good knowledge of the risk and indicate that accidents involving exposure to blood are frequent and can result in serious consequences, including infection with hepatitis B and C viruses, as well as human immunodeficiency virus (HIV), they may be due to neglect of preventive measures, lack of contact with occupational medicine, work overload…*etc.* Blood Exposure Accidents are still a concern in our community. There is a high rate of needle stick injuries in daily hospital practice. Then information tools are needed both training for staff with regard to BEA, can reduce the severity of exposure.

Keywords: Accidents of blood exposure, Health personnel, Infection, Knowledge, Practice, Protection health, Risk.

INTRODUCTION

Health establishment, like any organization, has a heavy responsibility towards the personnel it employs who are likely to be affected by an occupational accident or disease related to working conditions (presence of pathogens, use of sensitive technologies or devices, *etc.*).The risk of contracting the work-related illness is therefore high due to the use of toxic substances, exposure to infectious diseases or accidents of blood exposure.

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Blood Exposure Accidents (BEA) involve a risk of transmission of infectious agents and concern all germs carried by the blood. Many bacterial, viral, and parasitic infections can be transmitted to the personnel. Healthcare workers (HCWs) are exposed to blood and body fluids due to occupational accidents, which can result from percutaneous injury (needle stick or other sharps injury), mucocutaneous injury (splashes of blood or other body fluids into the eyes, nose or mouth) or blood contact with damaged skin [1]. Healthcare Workers (HCWs) are at risk for occupational exposure to blood borne pathogens, including hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV). In 2012, RAISIN(Réseau d'Alerte, d'Investigation et de Surveillance des Infections Nosocomiales, in English: Alert, Investigation and Surveillance Network for Nosocomial Infections) found that the major risk from exposure to blood and body fluids is shown in descending order by HBV in 30%, HCV in 3% and HIV in 0.3% [2]. The risk of accidental contact with the blood and body fluids is especially increased in the following situations: while taking blood samples, during intravenous cannulation, intramuscular or subcutaneous injection, recapping of already used needle(s), surgery – especially during wound closure, and during clean up and transportation of waste materials [3].

In industrialized countries, accidents due by a sting are in the majority of contamination and accidental seroconversions with HBV and HCV principally involve nurses (47%) and laboratory workers (22%) [4]. In particular, Badidi *et al.* have carried out a survey among the health professionals in two hospital structures of Lubumbashi to evaluate their knowledge and practices in front of the Exposure Accidents to Blood (during May 2013). The study reported that 81.3% of health professionals had a good knowledge of the risk of contamination three HBV, HCV, and HIV. Furthermore, authors found that accidents rate of blood exposure were 21.6%. 61.2% during vaccination against hepatitis B. The accidents happened during recapping of needle. The authors concluded that it was necessary to increase the education and awareness of health professionals to reduce these kinds of incidents [4]. However, a study conducted in West Africa estimated the incidence of BEA at1.8/surgeon/year, 0.6/nurse/year and 0.3/physician/year [5].

A study in India showed the highest incidence of occupational exposure among nurses [6]. It has been reported that nurses experience the majority of needle-stick injuries in the world including half of the exposures that occur in the US [7, 8] and 70% of exposures occurring in Canada [9].

Other studies in Algeria showed that the number of BEA is still unknown, due in particular to the absence of a continuous monitoring system for this type of accident in our healthcare facilities and even to the under-reporting of the accident by HCWs. Only a study conducted out over two years (January 2005 – December 2006) shows that the incidence of BEA was 44 accidents reported in 2005 and 64 in 2006. Needlestick injuries represented 81% of cases [10]. These infections are preventable through infection control measures, which significantly reduce the risk of HIV and Hepatitis transmission among health workers [11].

In the hospital of Batna, few actions have been carried out so far in the prevention of the accident of exposure to blood (safety equipment, personal protective equipment, sharps collectors…*etc.*). Therefore, the aim of this study was to evaluate the knowledge, attitudes and practices of staff working at the Emergency Department of the University Hospital of Batna city in front of the exposure accidents to blood. The Emergency Department is selected on the basis of the nature of the care provided and the large number of staff who are victims of BEA.

DEFINITIONS OF HEALTHCARE PERSONNEL (HCP) AND BEA

HealthCare workers(HCWs) refers to all paid and unpaid persons working in healthcare settings who have the potential for exposure to infectious materials, including body substances (*e.g.*, blood, tissue, and specific body fluids), contaminated medical supplies and equipment, and contaminated environmental surfaces. HCWs might include but are not limited to emergency medical service personnel, dental personnel, laboratory personnel, autopsy personnel, nurses, nursing assistants, physicians, technicians, therapists, pharmacists, students and trainees, contractual staff not employed by the healthcare facility, and persons not directly involved in patient care but potentially exposed to blood and body fluids (*e.g.*, clerical, dietary, housekeeping, security, maintenance, and volunteer personnel) [12].

The term accident implies "exposure of a health care worker (HCW) to blood or body fluids through percutaneous lesions or through the introduction of the blood or a body fluid by way of the mucous membrane or skin lesions" [13]. Blood Exposure Accidents (BEA) are defined as the unintended contact with blood and or body fluids mixed with blood during a medical intervention. It carries the risk of infection by numerous blood-borne viruses [13, 14]. Exposures occur through needle sticks or cuts from other sharp instruments contaminated with an infected patient's blood or through contact of the eye, nose, mouth, or skin with a patient's blood [15].

CHAPTER 4

Hazardous Waste Management in India: Risks and Challenges Associated with Hazardous Waste

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Abstract: Today, there are major environmental challenges associated with hazardous waste management in India. In this regard, hazardous production is increasing rapidly and it's required proper management to be improving the future of India. In this context, the Indian government's policy and legislation are not working properly on Hazardous Waste Management (HWM), thereby triggering enormous public health issues. The effective Hazardous waste (HW) treatment practices are of paramount importance to protect human health, and in addition, this is a social responsibility for the safety of the future generation. This chapter reviews the current situation on the rules and regulations of HWM and policy to adopt new successful approaches and techniques that are used worldwide to address this issue in India. Current systems in India cannot cope with the volumes of waste generated by an increasing urban population because of the lack of adequate infrastructure but these challenges will allow to transforming barriers in good opportunities for sustainable growth.

Keywords: Biomedical hazardous waste, Hazardous waste management, India, Municipal hazardous solid waste, Urbanization.

INTRODUCTION

Many developing countries such as India are facing many difficulties in the management of hazardous waste with related health problems such as cancer, diabetes and other infectious diseases. Currently, in India, continuous industrialization happens, therefore, a higher amount of hazardous waste is pro-

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duced because of poor management systems and lack of adoption of technologies to overcome this problem.

The first example of this situation is an accident at India's Bhopal plant, methyl isocyanate (MIC) gas leak accident, which is the responsible of the Union Carbide Corporation of the USA. The deaths of at least 2,000 citizens resulted from operational accidents, structural defects, repair deficiencies, training shortages, and safety-threatening economic steps, according to current and former staff, business scientific records, and the Chief Scientist of the Indian Government [1].

Currently, in India, manufacturing operations, farming and agro-factories, medical facilities, shopping centers, households, and the informal sector are the primary sources of hazardous solid waste, but they are neither recognized nor regulated by the Indian government. Hazardous waste has been described as "any material, including domestic and radioactive waste, which, due to its quantity and/or corrosive, reactive, ignitable, poisonous and contagious characteristics, can cause harmful environmental and human health consequences. This material is non-degradable, highly toxic, and even lethal at very low concentrations. It can be biologically magnified and poses potential risks to human health [2].

Approximately 90% of residual waste is currently dumped instead of properly landfilled [3, 4]. In this case, the more successful proactive HWM must be followed immediately. To do this, a new management structure and hazardous waste disposal systems had to be implemented. These days, the HWM program is an inefficient and hazardous waste has a negative impact on public health, the atmosphere, and the economy [5]. India's Ministry of Environment and Forests (MOEF) is enforcing Hazardous Waste Management laws and managing rules [6], despite the fact that enforcement is variable and restricted. This chapter introduces the new obstacle, challenges, and possibilities associated with the development of a new scenario for hazardous waste management in India.

HAZARDOUS WASTE MANAGEMENT IN INDIA

At this moment, the lack of infrastructure and the limitation of governmental and non-governmental bodies that regulate and manage hazardous waste in India's various cities has resulted in ineffective management [7, 8, 16]. Waste contractors collecting hazardous waste from various industries are mostly poorly equipped to handle radiated, carcinogenic chemicals, heavy metals, industrial oils, lubricants, grease, untrained and poorly paid, and India's high-temperature treatment infrastructure is inadequate [9, 10, 16]. Burning of agricultural biomass residue or crop residue burning (CRB), landfill burning is still very common disposal practices contributing to damage to human health and the environment. Currently, India's urban states such as Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu face problems with rising levels of hazardous waste [11 - 13, 16]. Gujarat state contributes to one of India's fastest-growing industrial development areas, with high quantities of chemicals, petrochemicals, pharmaceuticals, drugs, pesticides, fertilizers, textiles, and paper factories. Untreated waste from these industries is generally the major cause of the state's pollution. Therefore, the Gujarat state is one of India's highest producers of hazardous waste. Untreated waste from these industries is generally the primary cause of the state's pollution.

Recent data indicates that India generates about 51.1 MMT of waste annually, with about 7.46 MMT of hazardous waste generated from 43,936 industries [12, 16]. About 0.69 MMT (9%) is incinerated, 3.41 MMT (46%) is landfilled and 3.35 MMT (45%) is recycled. Gujarat is one of India's states that produces the highest quantity of hazardous waste such as 7751 hazardous waste producing small and large industries contributing to about 28.76% of India's waste generation. More than 70% of all industrial hazardous waste from thermal power plants, which is generated by coal ash [14 - 16].

Ineffective management of solid waste is a major problem in India, particularly in urban centers [64, 65]. Through 2050, around 50 percent of India's population is expected to live in urban areas, and waste production is expected to grow through 5 percent every year [66, 67]. About 101 million metric tons (MMT), 164 MMT and 436 MMT per year are waste projected to appear by 2021, 2031 and 2050, respectively. The rise in the production of solid waste is primarily due to economic development, population growth and changing lifestyles (Fig. **1**).

Municipal solid waste, which is toxic and more hazardous, is often easily collected, transported, stored, and discarded or dumped without treatment or treatment. As a result, a considerable amount of waste remains unattended at recycling centers, roadsides and river banks, with many small and large manufacturing units disposing of their waste mostly in open areas and adjacent to water sources, resulting in environmental pollution and threats to public health [65]. Therefore, despite significant socio-economic advances, solid hazardous waste management systems have remained relatively unchanged and are inefficient in India. 3Rs (reduce, reuse and recycle) are scarcely used, despite being part of the country's policy framework. Several new legislation have been introduced by the Ministry of Environment and Forestry (MoEF & CC) to address some of these issues.

CHAPTER 5

The E-waste Situation in India and Health Impact on Population

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Abstract: The chapter provides a brief vision into the perception of E-waste, its production in India, along with the ecological and health issues involved in it. The condition is startling because India produces around two million tonnes of E-waste per year, and practically all of it gets into the natural segment due to the lack of any substitute existing at present. Particularly, cosmopolitan cities like Mumbai, Delhi, and Bangalore are at higher risk of environmental contamination because of E-waste. Personnel in the E-waste dumping segment are ill-protected. They disassemble E-waste, regularly with hands, in awful situations. Nearly 26,000 workers are working in scrap-yards at Delhi itself, where 15 000 to 25 000 tonnes E-waste is moved annually, with PCs alone contributing to 25% of E-waste. Additional E-waste scrap-yards are present in Chennai, Mumbai, Bangalore, Firozabad, and Meerut. The dangerous elements present in E-waste comprise considerable amounts of chromium, cadmium, lead and other fire-resistant plastics. Cathode-ray components and tubes with great lead content are very hazardous for health. Huffing or handling such materials and being in contact with these on a daily basis, may harm the nervous system, brain, kidneys, lungs and also the reproductive system. Functioning in poorly ventilated and bounded areas without practical knowledge and masks leads to contact with hazardous chemicals. The absence of experience made the people endanger their environment and health. There is a dire need for progress in E-waste management encompassing technical development, operative strategy, protecting procedures for the employees involved in E-waste dumping.

Keywords: Cathode-ray components, Contamination, Cosmopolitan, Dangerous, Disassemble, Dumping, E-waste, Ecology, Elements, Environment, Fire-resistant plastics, Harm, Hazardous, Health impact, India, Nature, Population, Production, Scrap-yards, Workers.

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INTRODUCTION

A wide range of wastes is imported as well as produced in India, namely E-waste, municipal waste, and dangerous industrial waste. The amount of wastes produced has symbolised a consistently expanding danger for the general well-being of the population. More than eighty-eight fundamentally dirtied manufacturing zones have been recognised by the Central Pollution Control Board (CPCB). Pollutants from these zones taint water streams and dirty groundwater in numerous spots. Studies have additionally demonstrated that crop yields are polluted through modern effluents, yet the size of this effect is still not recognised [1].

To the extent E-wastes is concerned, it has developed as one of the fastest developing waste streams in the current scenario. PCs and hardware gears are planned without giving proper consideration to the downstream impacts and the simplicity of reusing. For whatever length of time, the electronic items contain a combination of dangerous synthetic concoctions and are planned without reusing approaches, they would be representing a risk to the general well-being of the population. As electronic items are at present comprised, E-waste reusing activities in any nation will create contaminating deposits and releases [2]. India has more than one million out-dated PCs with manufacturers, including around 1 051 tonnes of electronic pieces each year. India generates around two million tonnes of E-waste every year. E-wastes now marks more than 71 per cent of landfill. When the developing countries like India begin fixing and authorising severer enactment on trans-limit developments of E-wastes, developed countries consider it difficult to stay away from the concern of reusing and transfer. Nonetheless, exchange bans will turn out to be progressively immaterial in taking care of the issue of E-waste. Also, it is estimated that by 2030, the developing countries would produce double the amount of E-wastes than the developed countries.

Thinking about the future situation, it is rudimentary that the safe managing of E-waste is carried out in a sorted out way. In New Delhi, after the Mayapuri radiation release episode in April, 2010 the administration had issued rules and warnings to all the heads of emergency clinics, medicinal focuses, demonstrative focuses and restorative labs utilising radioactive hardware and consumables for their sheltered transfer. Unexpectedly, underneath the Atomic Energy Regulatory Board (AERB) mandates, the standards recommending Nitti gritty rules with respect to the medicinal introduction, potential presentation, individual observing, quality control, and radiological well-being of officials exist. It is projected that all over India, about five hundred thousand people work in the recycling of E-waste. These occurrences feature the need for an immediate disaster convention, potent guidelines, and inspection mechanism to guarantee that the standards are met. It additionally requires the administrative framework to take into consideration the insurance of labourers. There must be appropriate rights for residents to take a lawful plan of action for harms caused to their well-being, condition and property.

INTERNATIONAL TRADE OF HAZARDOUS WASTES

Amongst the comprehensive understandings, Basel Convention has the most far-reaching global ecological concurrence on hazardous and diverse wastes. It was embraced during 1989 and came in power during 1992 to secure the well-being of humans and the earth against the antagonistic impacts arising because of the development and transfer of unsafe E-wastes [3]. Initially, it didn't specify E-wastes, yet afterward, it tended to the concerns of E-wastes alongside part of the bargain at Basel Agreement in late 2006. As of now, E-wastes from cell phones consisting of Polychlorinated Biphenyls (PCBs) are utilised in manufacturing units as heat transfer liquids in capacitors and transformers. A significant number of global E-wastes that are sent out in this manner, are in opposition to the Basel Convention.

Increasing Unlawful E-Waste Trades

As global exchange streams extend and great residential checks elevate the expenses of risky wastes transfer in developed countries, chances and motivating forces for unlawful dealing of wastes will keep on growing.

Numerous examinations have affirmed and uncovered the peril presented by numerous wastes, their harmfulness, cancer-causing nature, and different attributes hurtful to the human well-being and condition. This mindfulness has been the premise of global activity, prompting the fixing of laws and guidelines. This has thus set off expansion at the expense of risky waste transfer through more secure methods convincing numerous countries to scan for all the more financially reasonable methods for arranging E-waste. Therefore, many developed countries, which can go around the national enactments, send out risky wastes including E-wastes to developing countries, which neither are having information of hazardous nature, nor the ability to dispose of the E-wastes securely. For example, in the US, a PC recycler is used for filtering the approaching E-waste materials before selling them to particular representatives. Apart from this, the E-wastes are auctioned off in mass with no partition at all. E-waste facilitating is a forceful and aggressive business, and purchasers for a wide range of E-waste in the Asian market are frequently accessible [4].

CHAPTER 6

Hazardous Waste Management and Geological Aspects in Campania (A Case Study)

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Abstract: The environmental situation is very complex, in Italy, and in particular, in some areas (Naples and Caserta provinces) of the Campania region that have experienced numerous problems correlated with hazardous waste management. In particular, an area of Naples province has been referred to "Land of Fire" (LoF) (or Terra dei fuochi-TdF) for the open burning of uncollected trash, including chemical and other potentially hazardous waste. Different academic publications and the national press have reported this dramatic situation. Findings from several articles suggest that the toxic wastes dumping is destroying this land and in addition, it is seriously damaging the health of the local population. Moreover, the high anthropization of these provinces in association with the simultaneous presence and interaction of extremely active volcanic, tectonic and morpho-dynamic phenomena increases the environmental risk in this territory. In this scenario, the Ministry of Italian Health commissioned epidemiological and geological studies to evaluate both contaminations of soil due to illegal dumps and the health risks on the population in Campania. This chapter aims to examine the epidemiological data considering a geochemical/environmental perspective to better understand the correlation between the incidence of different diseases (such as some cancers type) and the distribution patterns of contaminants.

Keywords: Anthropic pollution, Geology of Campania, Geological risks, Waste.

INTRODUCTION

Recent scientific studies have focused on the relationship between geology factors and human health to better evaluate the geological-environmental effects associated with the distribution of pathologies in living beings. Indeed, some reports observed that particular diseases were more widespread in some geographical areas than in others. In particular, heavily urbanised areas are under constant environmental stress due to human overcrowding and poor waste management. The acquisition of fundamental scientific knowledge of geological,

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environmental, chemical and medical nature is essential to understand the cause-and-effect relationship between environmental factors and health problems. Therefore, the in-depth knowledge of all chemical-physical-biological components of a territory and the assessment of possible variations due to pollution are basic components to monitor the territorial resources. Moreover, the characterization of these components can allow the development of a new conception of industrial and anthropic activities, taking into account the serious consequences on the environment and the organisms.The adverse impact of the environment on human health and the development of diseases including cancer [1 - 4] are shown by the combination of epidemiological studies and environmental geochemical investigations. In particular, environmental geochemical studies can determine the sources of pollutants, their behaviour and other characteristics. For this reason, environmental geochemical research can be used to demonstrate the risk for human health due to pollution. For example, numerous studies concluded that long-term exposure to high levels of substances (containing As, Ni, Cr, Cu, Cd) can cause different kinds of diseases such as cancer [5 - 7]. Manganese exposure can induce Parkinson's disease, while elevated levels of Arsenic (As) in waters and sediments can cause skin, bladder and lung cancer. The International Agency for Research on Cancer (IARC) has classified arsenic and arsenic compounds as carcinogenic to humansand has also stated that arsenic in drinking-water is carcinogenic to humans. Other adverse health effects that may be associated with long-term ingestion of inorganic arsenic include developmental effects, diabetes, pulmonary disease, and cardiovascular disease. Arsenic is also associated with adverse pregnancy outcomes and infant mortality, with impacts on child health [8], and exposure in utero and in early childhood is linked to increased mortality in young adults due to multiple cancers, lung disease, heart attacks, and kidney failure [9]. Numerous studies have demonstrated the negative impacts of arsenic exposure on cognitive development, intelligence, and memory [10 - 14]. Based on the data from the geochemical studies, it is possible to monitor the quality of soils and water to avoid that highly toxic heavy metals can enter the food chain.

NOTES ON GEOLOGY, GEOMORPHOLOGY AND HYDRO-GEOLOGY OF CAMPANIA (ITALY)

Campania region is located in Southern Italy, between the Tyrrhenian Sea to the West and the Apennine mountain chain to the East. There are five provinces of the region: Napoli, Salerno, Caserta, Avellino and Benevento. The region has a population density of 429 inhabitants/km^2, an (ISTAT, 2015), and more than 50% of the population concentrated in the Naples metropolitan area (Figs. **1**-**3**).

Fig. (1). Map of Italy (division: regions) (https://www.maps4office.com/nuts-region-map-italy/).

Fig. (2). Campania Region, southern Italy. (https://italiots.files.wordpress.com/2011/01/italia.jpg).

CHAPTER 7

Environmental and Human Health Issues in Campania Region Italy

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Abstract: Waste generation rates continue to grow around the world, creating a need for more comprehensive waste management strategies to meet sustainability needs. Uncontrolled disposal generates complex and challenging situation that involves the entire population. In particular, the illegal dumping and burning of toxic waste in Campania (Italy) has caused immense environmental damage and an increase in cancer rate among the population. Different epidemiological studies were commissioned by the Ministry of Health to assess the magnitude of contamination under an illegal dump in Campania and to evaluate the population health impact. The data and other available evidence testify the dramatic situation in Caserta and Naples provinces about the severe impairment of the environmental conditions in several places and increase of cancer incidence. For this reason, the Campania region is known, such as Triangle of Death" and "Land of Fires" (LoF) (or Terra dei fuochi-TdF), as reported both in academic publications and the national press. This chapter is aimed to provide the findings regarding human health and environmental contamination in this region.

Keywords: Campania, Hazardous waste, Illegal waste dumping, Land of fire, Population health.

RECENT HISTORY

At the opening of the judicial year on January 26, 2013, the late attorney general of Naples, Dr. Vittorio Martusciello had requested an investigation into the relationship between spills and tumor growth, focusing on the chronic environmental emergency that has been scourging Naples and province for years and on waste disposal and counterfeiting in the agro-food sector. The prosecutor

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also stated that he did not feel reassured about the correlation between aggression to the environment and cancer diseases as they would have expected in Rome (statements by the Minister of Health Balduzzi) [1]. In July 2012, the book "Campania, land of poisons" was presented, and it dealt the illegal spill of toxic waste that had led to an increase in cancer and birth defects [2]. We do not always know that all the substances contained in illegally spilled toxic waste, but the presence of some outlines the inevitable carcinogenic effects. It is very difficult to find the correlation between the incidence of cancer and environmental cases because of the lack of a regional cancer registry for mapping cancer mortality cases in Campania. Genetic damage, through the malfunctioning of the switches of the genes, can be caused by exposure to carcinogens with mutagenic action (which cause changes in the germinal DNA). Epigenetics is now dealing with all this as a new interpretation of the increased rate of cancers. Already in 2004, K. Senior and A. Mazza had explored the possible effects of environmental pollution on cancer-related deaths in the Nola area, publishing the results in the prestigious journal "The Lancet Oncology". The territories of Campania produce a greater quantity of waste than that of landfills and incinerators and, therefore, their non-disposal leads, inevitably, to an increase in the incidence of cancer cases [3]. In an epidemiological study published in 2009 by the scientific Journal Clinical and Experimental Cancer Research, the data obtained from the national archive of hospital discharge records for the period between 2000 and 2005 were analyzed: the number of breast cancer was greater than 40,000 cases compared to that reported by the official bodies with underestimated statistics of 26.5% and were also affected age groups between 25 and 44 years [4]. In 2011, the American Journal of Cancer Biology and Therapy published the scientific results of a research that highlighted a significant increase in cancer deaths and congenital malformations in the Campania region where toxic waste had been disposed (including arsenic, mercury, dioxins and furans) in an unsafe manner [5]. In this regard, 30 years of non-properly disposed waste cost a mortality rate equal to 9.2% more for men in North Naples and South Caserta. 12.4% more for women [6]. After the publication of "Campania, land of poisons", another paper reported the increased number of quadrantectomies of mammary tumors in female patients between 25 and 39 years and between 40 and 44 years, *i.e.* in pre-screening age [7]. At the end of 2013, another article, published in Cancer Biology and Therapy found the increased mortality between 1988 and 2009 in the metropolitan areas of Naples and Caserta for different kinds of cancer [8]. Therefore, it is possible to respond positively to the questions on the incidence of tumors and mortality in Campanian territories, being greater than the Italian average. Naturally, scientific rigor and a map of polluted sites are needed. We know of numerous carcinogens to which the pollution caused by dioxins is added, but the greatest danger is the pollution of the aquifer layer linked to illicit spills (heavy metals). After several interventions on the correlation between environmental pollution and cancer and the certainly affirmative answer to the question on the existence of an increase in the incidence of tumors linked to the disposal of toxic waste, amply demonstrated by scientific publications, we must point out that the situation of Irpinia and the rest of Campania is not different from that present in the land of fires (Naples and Caserta). At this point, we believe it is important to elaborate ISTAT (Istituto Nazionale di Statistica) data on life expectancy, with a comparison between the Campania provinces and the Italian average. In this regard, in 1992, the Italian average of life expectancy (males) was 74 years, while in 2010, it became 79.4 years. In Campania, it has gone from 73.2 to 77.8 years, therefore from a minus 0.8 to a doubling of less 1.6 (Table **1**). Furthermore, the risks associated with exposure to asbestos were evaluated at the Isochimica of Avellino to avoid asbestos contamination of other people. The data in Campania on increased mortality due to cancer are scary (when compared to other regions) because, in this region, there is a very serious environmental compromise [2].

Table 1. Life Expectation (ISTAT data).

Years of Average Life in Campania				
MALE	**1992**	**DIFFERENCE**	**2010**	**DIFFERENCE**
ITALY	74.0	0	79.4	0
CAMPANIA	73.2	-0.8	77.8	-1.6
AVELLINO	75	+1.0	79.2	-0.2
BENEVENTO	74.8	+0.8	79.0	-0.4
CASERTA	72.2	-1.8	77.4	-2.0
NAPLES	72.3	-1.7	77.2	-2.2
SALERNO	74.6	+0.6	78.5	-0.9

The abusive spills of urban and industrial waste remain, especially in the suburbs, starting from the fast roads, in the entry ramps, a stone's throw from the virtuous municipalities of waste sorting, under each bridge, in every night. The acrid smoke that you breathe on the highway as you cross the boundary of the boundless suburb of Naples is more eloquent than any sign [2]. The uncontrolled fires and the burial of heavy metals, asbestos, cadmium, continue as if nothing had happened, in our region, in particular in the area of the Aversa where they continue to pollute aquifers layers and agricultural products [2]. The latest data available on the emissions register is managed by ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) and date back to a few years ago. They are the following and concern only emissions into the atmosphere: the industry contributes to PM 10 emissions for 26%, 70% of sulfur oxides, 23% nitrogen

CHAPTER 8

A Case Study on Grassroots Environmentalism for Health and Sustainability in the Land of Fires (Italy)

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Abstract: This chapter provides a reassessment of the waste 'crises' in the so-called Land of Fires in Italy and highlights the contribution of local social mobilizations in advancing environmental justice and sustainability concerns. It is based on the long-term collaboration between a social scientist and two activists, and it draws from a dialogue of academic and activist knowledge in the tradition of Environmental Justice organizations and scholarship. Our contention is that local communities and ecologies of this area have borne the brunt of the socio-environmental costs of waste disposal and industrial production. This translated into risks of contamination for the residents, suffering threats to health and stigmatization. To this state of affairs, local grassroots environmental movements answered by confederating into a regional coalition that arranged on November 16, 2013, one of the biggest environmental justice demonstrations in Italian history, spurring the intervention of the State *via* legislation and resources. The coalition was also instrumental in the elaboration of the Pact for the Land of Fires, a programmatic commitment to end illegal waste disposal that defined the obligations for the institutional and civil society signatories. Finally, we show how the experience of activists is systematized and coordinated today through the initiative of the Civic Observers, an association of citizens that monitors environmental crimes and conditions in cooperation with public officials.

Keywords: Cancer, Civic observers, Environmental justice, Grassroots environmentalism, Hazardous waste, Organized crime, Waste management.

INTRODUCTION

This chapter chronicles the key turning points of grassroots environmental organizing during the conflicts around waste management in the so-called Land of Fires of Campania region in Southern Italy, a phenomenon that has not received

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enough attention so far. Moving from a reassessment of the waste ‘crises’ that traversed this region during the last two decades, our aim is to debunk reductionist readings of local communities’ protests and proposals – frequent in mainstream renderings of environmental activism in Italy and elsewhere – by showing their actual contribution to health security, environmental governance and more sustainable human-environment relations. The chapter is the result of a long-term collaboration between one social scientist and two experienced activists, and it draws from a dialogue of academic and activist knowledge in the tradition of Environmental Justice organizations and scholarship [1 - 3].

The recent history of Campania cannot be grasped without due consideration of the longstanding social conflicts that emerged around waste (mis)management. Snapshots from Naples, the capital city, flooded by its municipal waste and reports of hazardous waste illegally disposed of proliferated in the news from about 2003 onwards [4]. International commentators, as well as Italian analysts, were bewildered. Mainstream media boiled down such a complex issue as the result of two main factors. Firstly, the inability of local communities to perform sorting and recycling of garbage associated with a reiteration of the NIMBY syndrome [5]. Secondly, the role played by organized crime groups hijacking the government’s efforts towards a resolution of the management stall while driving people’s protests [6, 7]. Particularly in the international media, the reference to “pre-existing ideas about Naples as an aberrant city on the margins of a 'normal' Europe” for deciphering the waste crisis, as Dines [4] argues in relation to British press, prevented an understanding of the complexities of the political, economic and administrative backgrounds while relying on, and reinforcing, dismissive stereotypes about southern Italian people.

These explanations hinted at alleged essential characteristics that would exclude southern Italians from civilized people. Such ‘naturalization’ of discontent was instrumental to the depoliticization of government’s plans, paving the way for the violent repression of people’s protests [8]. Additionally, by focusing on the *urban* side of the waste crisis – framed as a public order issue tainting Italy’s reputation – political élites failed to promptly address the troubling reality of illegal disposal and burning of *hazardous* waste. Here, we offer a different diagnosis of the waste issue and provide insights into the role of the local grassroots mobilizations in advancing environmental justice and sustainability concerns. These insights are based on a doctoral dissertation on grassroots environmentalism in Campania by De Rosa [9] and on the personal and political experiences of Righetti and Martuscelli as key organizers of social mobilizations and grassroots advocacy. In our diagnosis, grassroots environmentalism in Campania constituted barriers to socioecological exploitation and elaborated more effective and sustainable paths. In the next section, we set the stage through an account of the waste ‘crises’ based on the merging of scientific scrutiny and the point of view of those who self-organized on the ground. Then, in the third section, we delve into the formation of the regional coalition *Stop Biocide.* In the fourth section, we present an initiative aimed towards environmental monitoring and public health put forward by the *Civic Observers for Environment and Health* and their role within the institutional framework of the *Pact for the Land of Fires.* In the fifth section, we describe the rise and the tasks of the *Civic Observers of Campania*, before advancing our conclusions.

THE WASTED LAND

Campania's conflicts around waste played out mostly in the plain between Naples and Caserta, within the ancient *Campania Felix*, as the Romans called it. This area gained the appellation of *Terra dei Fuochi,* Land of Fires, given by activists to denounce the frequent uncontrolled fires of hazardous waste next to fertile cultivated fields [10]. Two processes revolving around the commodification of waste materials, and impacting negatively local socio-environmental conditions, dominated the recent history of this area. Firstly, the setting up of the Regional Urban Waste Management Plan through a special government agency operating under the framework of the 'waste emergency'. Secondly, the illegal trafficking and dumping of hazardous waste in improper landfills and agricultural areas organized by a criminal alliance of industrial managers, public officials, landowners and mafia groups [11, 12]. The complex interrelations between these processes almost make clear boundaries between legal and illegal practices of waste management disappear. This is best exemplified by the observable reduction of spaces of democratic confrontation on environmental governance [13]. In practice, these processes have shifted onto local communities and ecologies, the socio-environmental costs of waste disposal and manufacturing industrial activities, producing in turn risks of contamination affecting the health of local populations and causing the reduction, and stigmatization, of cultivated lands [14].

In 1994, the Italian government declared a 'waste emergency' in Campania. Contextually, it established the normative framework of the 'emergency regime'. From that point on, a Commissioner with extraordinary powers was invested with the task of supervising the implementation of the plan. The official motivation of the emergency was to increase controls and hasten operations. However, turning all private landfills into public ones for dissociating waste management from organized crime proved useless when the implementation and management of the waste cycle were assigned to a private company able to perform subcontracting without accountability. By 2009, when the emergency was officially ended, not only were the initial objectives not achieved, but also an increase in unequal

CHAPTER 9

The Outbreak of the Pandemic of Coronavirus Disease 2019 and its Impact on Medical Waste Management

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Abstract: Today, the global outbreak of the pandemic of coronavirus disease 2019 has the potential to wreak a serious impact on human health and to further trigger a global crisis. A great repercussion of this pandemic is occurring on sustainable medical waste management practices with a profound impact. On the one hand, medical waste management companies need to be ready to assist countries worldwide as they seek to manage the great volumes of infectious material; on the other hand, the use of gloves and face masks is increasing among population to stop the spread of the novel coronavirus. In addition to potentially being a biohazard, face masks and gloves can increase the plastic pollution if the disposal directions are not proper. Therefore, the current pandemic of the novel coronavirus poses new challenges regarding the management of medical waste practices above all for health measures for employees, proper waste treatment requirements.

The aim of this review is to collect data on the different systems and solutions implemented worldwide to manage municipal waste in the current situation.

Keywords: COVID-19, Face mask, Gloves, Healthcare waste, Pandemic.

THE CURRENT HISTORY OF THE COVID-19 CORONAVIRUS

Until less than 20 years ago, coronaviruses represented a viral family that caused 10 to 30% of colds during the winter. In 2002, the SARS (Severe Acute Respiratory Syndrome) coronavirus (SARS-CoV) affected 8 thousand individuals in China, causing about 10% of mortality. SARS-CoV-like viruses were detected

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in palm civets and a raccoon dog from wild-animal markets in the Guangdong Province of China, and for this reason, it is possible that these animals could transmit the infection to human being. In 2012, Middle East respiratory syndrome (MERS), a viral respiratory disease caused by a novel coronavirus (Middle East respiratory syndrome coronavirus, or MERSCoV) that was first identified in Saudi Arabia and caused the outbreak I in 2015. In December 2019, a new coronavirus appeared in Wuhan (a province of Hubei), called COVID-19 (Coronavirus Disease 2019), which after passing into exotic animals, infected humans with marked virulence leading to the spread of a mysterious pneumonia [1]. The fundamental rules during the epidemics are those to isolate patients and to carry out the quarantine such as during the typhoid fever of Athens of 430 bc, the plague of Manzoni memory, 1600 ac and the Spanish flu of 1918, that caused more victims than the just-ended First World War. Although China has seen the SARS, the country was not able to predict that the epidemic would be morphed into a “major public health event. In this regard, the lockdown in Wuhan was declared with a delay of almost a month compared to the first cases, as well as the communication to the WHO (World Health Organization) happened after the first communication of Public Health Emergency of International Concern (PHEIC).

Furthermore, samples from the throat and nasal swabs derived from possibly infected people were sent to public health agencies to detect the virus with rapid tests. Naturally, it is important to identify the proteins produced by the viral RNA for the synthesis of specific antigens and antiviral drugs. In this context, the vaccine development will take time for safe treatment in human being. In Italy, specifically, Lombardy and Veneto regions have been affected by the coronavirus epidemic from the end of January 2020. Here, it was difficult to stop the disease because the transmission of the virus occurred, such as that of the flu virus. Furthermore, many people had symptoms, but they were not aware of being exposed to the virus. The coronavirus respiratory syndrome was moderate for the majority of cases, but many cases had reported “mild” pneumonia, according to the Chinese Center for Disease Control and Prevention statement made at the end of February after the observation of about 90 thousand cases. Moreover, 14% of confirmed cases had serious pneumonia and dyspnoea, while 5% of the patients had a pulmonary collapse, a septic shock and a deficiency of several organs (2.3% of the total). Specifically, several articles reported numerous symptoms, including fever, cough, and general malaise and occasional diarrhea in the majority of cases [2]. Patients with severe COVID-19 develop acute respiratory distress syndrome and acute lung injury, leading to morbidity and mortality caused by damage to the alveolar lumen with inflammation and pneumonia [3 - 5]. A retrospective study of 522 patients showed that 82.1% of COVID-19 cases displayed low circulating lymphocyte counts. The authors found that 499 cases had low lymphocyte count recorded. In particular, the counts of total T cells, CD4+, and CD8+ were significantly lower in the intensive care unit (ICU) patients than Non-ICU patients. Such result could suggest that there was a profound T cell loss in COVID-19 disease [6]. Furthermore, the authors demonstrated that patients over 60 years old have very low T cell numbers, indicating that TNF-α might be directly involved in inducing T cell loss in these patients. Furthermore, the authors observed that the CD8 T and CD4 T cells have higher levels of PD-1 (exhaustion markers) in ICU patients when compared with non-ICU patients [6]. Generally, the coronaviruses cause symptoms, mostly colds during the winter [7]. Today, people infected by this new COVID-19 developed severe forms, above all, if they had previous diseases or in the elderly. Less than 1% of healthy subjects died of this new SARS, while cardio patients were 10.5%, diabetics 7.3% and patients with chronic respiratory diseases, hypertension or cancer 6%. The different coronaviruses strains vary in clinical severity when they infect the human species: the classic cold coronaviruses are 229E, NL63, OC43 and HKU1. The three coronaviruses that have proven dangerous for human life were MERS-CoV, SARS-CoV and the last SARS-CoV2 which was able to kill more individuals than the other two associated with the speed of the pathological transmission for a greater number of people. One possible reason for this event is that this virus is able to link with the Angiotensin-converting enzyme 2 (ACE receptor) that is present on the ciliated epithelial cells of the upper and lower respiratory tract and in alveolar type II pneumocytes. In this way, the COVID-19 into these cells, like the primitive SARS coronavirus (2002-03) with a high affinity for the ACE receptor [7]. Although different studies showed a 76% identity in the amino acid sequence between SARS-CoV and Sars-CoV2 [8], the affinity of Sars-Cov-2 towards this receptor is 10–20- fold higher than that of SARS- CoV2 In this regard, the binding between the spike protein and ACE2 occurs through proteolytic cleavage of ACE2 by transmembrane serine protease 2 (TMPRSS2). After this linking, the enzyme converts angiotensin I into angiotensin1-9, which in turn is converted to angiotensin1-7 that acts on the Mas receptor (a G protein-coupled receptor). Specifically, this receptor is expressed in a variety of cell lineages in many tissues relevant to cardiovascular disease (including type 2 alveolar epithelial cells), to modestly lower blood pressure through vasodilation and by promoting kidney sodium and water excretion but also to attenuate inflammation through the production of nitric oxide 3. Many authors supposed that the viral entry through the binding of the SARS- CoV-2 spike protein to ACE2 could suppress ACE2 expression. This process could lead to elevated internalization and shedding of ACE2 from the cell surface, that in turn could increase levels of angiotensin II (Ang II). Such protein binds its receptor AT1 (AT1R), causing an inflammatory response in the lungs and potentially triggering direct parenchymal injury. Furthermore, ACE2 receptors are expressed in the heart (endothelium of coronary arteries, myocytes fibroblasts,

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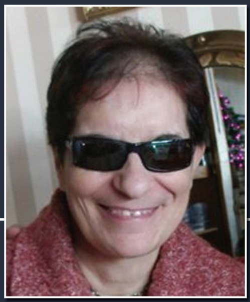

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