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Chemical safety and governance in Brazil

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Abstract

Chemical safety is recognized in Agenda 21(UNCED — Rio 92), as one of the most serious problems to be faced worldwide being a problem not just of governability, restricted more to the role of states and governments, but of governance at the national and international levels. It poses greater challenges for countries like Brazil where the issues of democracy, security, sustainability and equity, which are fundamental to governance, are merely incipient and still far from solved. Taking as references the analysis of four cases in the Brazilian context, we illustrate the situation from less densely populated areas (as in the cases of mercury use by gold miners in the Amazon and pesticides in agricultural producing areas), through medium-sized towns (as in the accident with cesium 137 in Goiânia), to the major urban and industrial centers (as in the cases of lead from battery renovators and benzene in the oil and steel industries and oil refineries). What can be seen is a situation where problems connected with chemical safety have grown in intensity and extent far more than the capacity to deal with them. In industrializing countries, the formulation of chemical safety policies must take into account not only the complexity and uncertainties involved in understanding the problems, but also the aspects relating to the different modes and levels of vulnerability. This is necessary in order to attempt to build better contextualized and more participatory knowledge and decision-making processes at the local and global levels, which we take as basic prerequisites for governance. © 2001 Published by Elsevier Science B.V.

Keywords: Chemical safety; Governance; Vulnerability; Brazil

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1. Introduction

One of the aims of the United Nations Conference on the Environment and Development (UNCED), held in Rio de Janeiro (Brazil) in 1992, was to establish common principles and commitments among the various nations to guide sustainable development of the global community. This conference resulted in Agenda 21. Since the countries that face the greatest threats to sustainability are generally those with least institutional and financial capacity to meet them, Agenda 21 recognized that, in order to fulfill the aims and proposals set out, national and international efforts would have to be significantly strengthened [1]. This would include a responsibility on the part of the industrialized countries to cooperate with the industrializing countries to enable them to solve their environmental and sustainability problems, and a careful review of priorities and budgets designed to enable local economies progressively to internalize the costs of environmental protection [2,3].

It is exactly in this context that chemical safety, which is understood to be a set of strategies to control and prevent the adverse effects on human beings and the environment resulting from the production, storage, transport, handling and disposal of chemicals, is central to in Agenda 21. [1] Chemical safety is recognized as one of the many serious, essential problems to be faced worldwide, for which it is necessary to expand collaboration not only with governments, but also with countless other non-governmental actors, for example, industries, trade unions, consumers, non-governmental organizations (NGOs), professional associations and scientific institutions. This makes it a problem not just of governability, restricted more to the role of states and governments, but one of governance at the national and international levels.

As asserted by the report of the Commission on Global Governance (GCG), the major challenge facing our generation is to mobilize the power of people collectively to make life in the 21st century more democratic, more secure, more sustainable and equitable. This entails a need for nations and the world community to assume a collective responsibility that derives from this need on these issues that are intrinsically interrelated and where security ceases to be for states, but rather, and as a priority, for people. Chemical safety, understood as one of the many important aspects for health, life and environmental protection with regard to present and future threats, figures in this context as an issue of governance at the global and local level and not one restricted to governments and intergovernmental relations. It poses a still greater challenge for countries like Brazil where the issues of democracy, security, sustainability and equity, which are fundamental to governance, are merely incipient and still far from solved.

[1] The United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, requested the creation of an international strategy of the environmentally sound management of toxic chemicals. In Chapter 19, of Agenda 21, six programme areas are listed: (a) expanding and accelerating international assessment of chemical risks; (b) harmonization of classification and labeling of chemicals; (c) information exchange on toxic chemicals and chemical risks; (d) establishment of risk reduction programmes; (e) strengthening of national capabilities and capacities for management of chemicals; (f) prevention of illegal international traffic in toxic and dangerous products.

2. Chemical safety and governance in a context of complexity and vulnerability

Although scientific opinion is far from unanimous as to the gravity and extent of problems arising from risks of chemical origin, there is a consensus that they are of unprecedented kind and dimensions, and moreover are a threat to our ecosystems and to present and future generations. In many cases, these potential problems require urgent decisions, particularly when they involve global risks such as the greenhouse effect or reduction of the ozone layer. The same is true in acute situations such as toxic emissions or detection of high levels of exposure affecting certain population groups and areas over long periods [2,4].

There are two conceptual aspects of special importance to discussing the interface between chemical safety and governance, particularly in the context of the industrializing countries. The first aspect has to do with the complexity of chemical risks and the second, with the vulnerability of certain regions, societies and populations, expressed as their greater fragility which leaves them more exposed in meeting the risks.

The notion of complexity applied to chemical risks implies that chemical risk assessments cannot be reduced to isolated components, as occurs with traditional scientific approaches, because this entails considerable losses in understanding the problems and, consequently, in formulating strategies to prevent and control such risks. As noted by Weinberg [5], there are complex problems that the traditional approaches of science may manage to describe, but not to solve in terms of modeling and control. Notable are those problems relating to chemical pollution, ranging from global risks like the greenhouse effect to risks resulting from chronic or unsystematic exposure to relatively low doses. For Weinberg [5], assessment of such risks requires approaches that go beyond the existing, dominant disciplinary approaches, which would constitute a way of dealing with the uncertainties connected with the problem.

According to Funtowicz and Ravetz [4], the uncertainties connected with chemical risks may be technical in origin, relating to the inexactitude of data and analyses. This uncertainty may be managed by utilizing appropriate standardized routines developed by particular fields of science. These uncertanties may also be methodological, relating to the unreliability of data and involving more complex and important aspects of the information, such as values and reliability.

Finally, they may be epistemological, relating to the margins of ignorance of scientific knowledge itself, as when irremediable uncertainties lie at the heart of the problem. Any number of cases involving real exposure and contamination of certain populations or areas may be considered to raise epistemological uncertainties, and this is a universal concern.

Industrializing countries, in addition to epistemological uncertainties, face heightened technical and methodological uncertainties, as a result of two interrelated factors. The first factor is that the great majority of the dominant scientific approaches are formulated in the technical and scientific context of the industrialized countries, particularly Western Europe and the USA. This situation is quite different from that of the industrializing countries. The second fact is that the situation in most of the industrializing countries is not only different, but precarious in terms of the economic, technical and human resources available for monitoring and evaluating problems connected with chemical risks. These two aspects make it difficult to extrapolate directly from given technical and scientific outcomes produced in given circumstances in the industrialized countries to other contexts or situations, particularly when public policies are involved.

In order then to confront the uncertainties inherent in our present scientific mode of evaluating risks of chemical origin and to understand the problem more broadly and systemically, it is necessary to integrate the multiple, simultaneous factors of different natures that constitute chemical risks. With this perspective, global and local production, transportation, trade, storage, disposal and safety policies, as well as the directions given to chemical technology development, will be seen to be interacting, simultaneously and inextricably, with the emissions of chemicals that affect soils, waters, the atmosphere and the food chain. These emissions, mediated by chemical reactions and social, cultural, economic and power relations, result both in the various levels of contamination of human beings and ecosystems and in the various levels of capacity for social responses to the problem. This means that decision-making processes on chemical risks with a view to governance cannot be carried out solely on the basis of limited technical and scientific predictions. Rather, they must include considerations of the countless other aspects mentioned, as well as the inherent values and interests at stake, to complement the policy dimension [6].

The recommendations of the previous paragraph constitute the ideal and necessary path to confronting the complexity and uncertainty factors in problems of chemical origin today. However, for this system to be even minimally workable, particularly in the context of the industrializing countries, the concept of vulnerability must be taken into consideration. This concept is useful in specifying what additional difficulties certain societies, regions and populations face in terms of chemical safety. It is based on disaster studies, which have shown why risk events or situations have totally different consequences in countries of Latin America, Africa and Asia from those of similar magnitude in North America or Europe [7]. This consequence is the result of the greater difficulty certain population groups or societies encounter in anticipating, surviving, withstanding and recovering from the impacts caused by such events or situations. Horlick-Jones [8], for example, defines vulnerability as a unifying concept based on systems theory: erosion of a system's resilience to perturbations generated by the interaction of a complex socio-technical system vulnerable to failure with a vulnerable population within a socio-economic environment.

To us, vulnerability should be subdivided into two interrelated parts. The first part, population vulnerability, relates to the existence of population groups that are vulnerable according to their characteristics in terms of social, political and economic status, ethnicity, gender, disability, age, etc. and derives mainly from various forms and levels of social exclusion [9,10]. The second part of vulnerability is institutional vulnerability, which has to do with deficiencies in how society functions in terms of policies, decision-making processes and institutions that have some role to play with regard to risk events and situations, either in preventing or controlling them [11]. Visible examples of this vulnerability are the lack of legislation and compliance, of technical and human resources, or even an imbalance of forces in the decision-making processes. For example, when the interests of socially dominant groups, very often involving the very actors that generated the risks, override those of the populations and workers exposed to risks. The latter are excluded from access to information and decisions vital for a comprehensive and effective risk management [12].

The concept of vulnerability to chemical risks in industrializing countries can also be associated with other issues. The first issue is the concept of coupling for studying mixed technological and societal systems with different sorts of uncertainty at different stages of risk assessment and management [13–15]. The second issue arises from discussions of different decision-making processes in different societies, involving the acceptability and regulation of chemical risks [16,17]. The international division of hazards and the double standards between industrialized and industrializing countries [18] and discussions of environmental justice [19] are also important issues relating to vulnerability.

At the international level, vulnerability should be understood as the outcome of a given country's place in the world economic system. This notion is linked to a view of the contemporary global economy as a system characterized by interdependence among countries, one where not only is the production of goods for a world market the main objective, but also requires the development of financial and technological exchanges [20,21]. In this interdependent system, each and every country has its function in the international division of labor, and this leads to an international division of benefits, as well as risks. Approximately 80% of global consumption of goods is restricted to a quarter of the world's population, most of it in the industrialized countries [20]. In India, for instance, per capita annual consumption of goods resulting from chemical technology was estimated at 1 kg, whilst in industrialized countries this figure is in the 30–40 kg range [22]. The positions are inverted where risks are concerned. In industrializing countries, less elaborate measures for protecting the environment, human health and safety have been an important item in global economic negotiations, although not always explicitly, and these have often led to an unfair international division of risks [12,18,23].

Given the characteristics of industrializing countries, the concept of vulnerability becomes an important and transdisciplinary concept calling for the integrated efforts of a range of specialists (social scientists, economists, geographers, engineers, toxicologists and others) and methods (qualitative and quantitative) in mapping risk situations in geographical and social domains. This co-operative effort provides a basis for interpreting the social and technical system and for developing alternative proposals that could not be generated by isolated methods taken from the normal sciences.

In industrializing countries, the formulation of chemical safety policies must take into account not only the complexity and uncertainties involved in understanding the problems, which are heightened by the diversity and precariousness of these countries. It must also consider aspects relating to the different modes and levels of vulnerability, in seeking to build better contextualized and more participatory knowledge and decision-making processes at the local and global levels, as basic prerequisites for governance.

3. The Brazilian context

Brazil is a large country, not only in terms of territory (it covers an area of approximately 8,500,000 km^2), population (more than 150,000,000 inhabitants) and economy (ranking among the 10 largest in the world), but also in terms of social aspects. It is among the countries with most unbalanced income distribution and environmental contradictions. Major ecological paradises in terms of socio-biodiversity, like the Amazon, are threatened daily by forest fires and the chemical pollution resulting from mining activities.

Brazil, along with other industrializing countries like India and Mexico, underwent a process of intensified economic growth in the 60 and 80 s. This was promoted by major external funding — Brazil is among the countries with the greatest foreign debt — which increased the participation by multinational industries in the industrialization process and led to strong state intervention in the economy. This growth was already being projected in the decade following the World War II, so that Brazilian industrial installations have undergone significant qualitative, and particularly quantitative, change at average growth rates higher than those of the industrialized or other industrializing countries. Over the period 1950–1980, the industrial sector's share of the GDP increased reaching approximately 40% in 1980. From then on, it went into decline. Agricultural activities contracted considerably over the same period, from 24 (1950) to 9% (1990) of the GDP. Among the constituent industrial segments, chemicals represented around 19% of Brazil's production in 1990 [24].

The model of economic development adopted was sustained by the lack of a democratic political system under a military dictatorship that lasted from 1964 to 1984. Also by major changes in society, which combined concentration of capital, exploitation of labor, and neglect or omission by public authorities in controlling and preventing chemical risks. All this resulted in rapid, disorderly industrialization along with an intense, uncontrolled process of urbanization, accompanied by large migratory flows from the countryside and poorer regions mainly into the major urban centers, all of which relegated social, human and environmental problems to the background [12,25]. The urban percentage of Brazil's total population increased from 31% in 1940 to 55% in 1970, and reached 75% in 1991, a figure close to those of the world's most urbanized countries (Japan 77% and USA 79%) [24].

One consequence of this process was that a large part of the newly urbanized population (poor, with little schooling and in search of employment and better living conditions) settled in the peripheral areas of the major urban centers. There, they lived in precarious conditions, very often in shanty towns and with no access to the basic goods and services of sanitation, health and education. Figures for 1990 show that, although nearly 89% of urban dwellers had running water, only 36% of Brazil's municipalities had proper water treatment facilities. Sewage disposal figures for 1989 show that only 47% of Brazil's municipalities had sewage collection networks and only 8% performed any kind of treatment of the material collected. Only 71% of Brazil's municipalities had garbage collection and in only 21% did collection cover the entire municipality. Thus, less than 50% of solid waste collected was disposed satisfactorily [26,27].

Education figures show that Brazil has around 21.5 million illiterates or people with less than 1-year schooling. Considering that another 24.5 million have less than 3-year schooling and 38 million, less than 7 years, Brazil's population in general can be said to lack formal education. This low level of schooling hinders knowledge of basic civil rights and facilitates exploitation, a situation aggravated by the economic difficulties of recent decades [24].

It must be stressed that these aspects, which contribute to increasing the vulnerability of certain population groups and regions to environmental problems, particularly those relating to chemical risks, result from the model of economic development. This system is inequitable by nature and forms an integral part of the international division of labor and risks. Low standards of environmental and health safety and protection are a feature of such unequal distribution not just at the international level, but also internally, within the countries of the peripheral economy, thus defining healthy, secure areas and unhealthy, insecure areas [12].

Over the last two decades, even with the re-democratization of Brazil, no far-reaching changes have occurred in the socio-economic structure of Brazilian society. Rates of income concentration and poverty continue to be high, although tending to decline slightly. High external indebtedness and a large public deficit have made it difficult for the Brazilian state to invest in improving institutional infrastructure directed to preventing and controlling chemical risks. There is a danger, in this context, that self-regulation policies with certification under ISO (series 9000 and 14,000) standards or voluntary programs like Responsible Care in the chemicals industry may improperly be relied on to substitute for absent public policies. The relative economic stagnation of the last two decades, allied to the structural unemployment of modern forms of development, is aggravating social exclusion and reducing the lobbying power of industrial workers, an important social pressure group on the issue of chemical risks [2] [28].

It is in this context that chemical safety problems are situated and interrelate with innumerable others, requiring that integrated, systemic scientific approaches be articulated with greater participation, given that reduced levels of all forms of social exclusion and vulnerability are prerequisites for effective governance.

4. Chemical safety and governance in Brazil

Brazil's acknowledged complexity is combined with its institutional vulnerability and the conditions of politics and citizenship that have obtained chiefly, since the 80 s. More recently the increasingly rapid process of economic globalization is fostering indiscriminate depredation of natural resources and causing archaic modes of production to coexist with technologically advanced modes. As a result, there are "epidemic" occurrences of situations that are significantly degrading the environment and having profound impact on the health of exposed populations, particularly population groups that are more vulnerable because of intense social exclusion.

At present, management of chemical safety in Brazil, whether by federal, state or municipal governments, is being performed inefficiently and with little integration between the various sectors and groups involved. The result is conflicts of competencies between government agencies, omissions and a lack of capability in terms of human and technical resources, particularly as regards protection for health and the environment. Although the legal framework available for chemical safety may be considered relatively vast, it is not viable in practice. This situation is a result of continuous dismantling of government agencies, partly as a result of discontinuities in public policies and a lack of financial resources, particularly for the environment and health sectors.

It should be remembered that it is among the main principles of governance that states and governments remain as the primary public institutions for responding constructively on issues affecting communities at the local and global levels [2]. The ability to do so must involve a capacity to control and make effective the resources necessary for governance to be performed, among them the involvement of the innumerable actors that can contribute

[2] It is important to note that the National Confederation of Chemical Workers have been playing an important role making (addressing) putting several questions about chemical pollution and chemical accidents in Brazil. The first International Seminar on Chemical Safety organized in Brazil was jointed promoted by the National Confederation of Chemical Workers and the Jorge Duprat Figueiredo Foundation for Labor Safety and Medicine. The results of this Seminar were published in [28].

to achieving results of common interest. However, much remains to be done in Brazil for chemical safety to be assured at its interface with governance, especially considering that in the present context the state is being continually dismantled and rendered incapable of controlling and preventing risks of chemical origin, thus constituting institutional vulnerability. This situation is aggravated by the fact that certain social groups are being exposed to chemicals in precarious social and environmental situations, thus constituting population vulnerability. The following cases illustrate this situation.

4.1. Gold prospecting and mercury in the Amazon

The Brazilian Amazon covers 4,990,520 km^2, representing 3/5 of Brazil's land area. Its population density is 3 inhabitants/km^2 (as contrasted to more than 250 inhabitants/km^2 in the more urbanized and industrialized states). It contains an ecosystem of enormous bio-diversity and planetary importance, as well as having fabulous mineral reserves. The introduction of modernization and major mining projects has resulted in widespread social and environmental conflicts and is producing endemic and epidemic diseases such as malaria and leishmaniasis [29].

Mining activities are causing intense environmental degradation and far-reaching social disorganization and exclusion, although mining is the industrial sector that provides the highest proportion of employment in the region (10.7%). The unskilled, mobile labor force is organized in nuclei around the mines and constitutes the interface of the modern economy with primitive forms of exploitation, represented in the case of mining by the gold fields [29]. Gold mining is the mining activity with greatest environmental impact, resulting in water pollution by heavy metals, mainly mercury and arsenic. The largest gold reserves and the most important gold mining activities are concentrated in the Amazon region. In 1990, there were 240,000 gold miners representing 80% of the gold miners in Brazil. Gold production had its boom in the 80 s (100 tonnes were produced in 1985), but has diminished in recent years as alluvial deposits have been worked out. Migration towards the gold fields, resulting largely from the lack of an agrarian reform policy, is a survival strategy for large numbers of workers with no land or stable employment, and a social and technological war is being waged between mechanized and manual mining. The gold mining activities are often illegal and generate other illegalities, such as violation of labor rights, slave labor, extremely high crime rates, and so on [29,30].

The techniques being used to extract gold are very rudimentary and employ large quantities of mercury (Hg). Mercury losses to the environment, in the form of metallic mercury, may be as high as 50% of the total amount used, part of which (15–50%) is discharged directly into the rivers and part (65–83%) released into the atmosphere [25,30]. Studies show that around 50–70 tonnes of elementary mercury are released into the environment per year; the figure for 1989 was 168 tonnes [31,32]. The result of this pollution is high rates of contamination of the air and of river water and sediments. Affected are the gold miners and smelting house workers as well as populations close to the gold fields and along rivers who are exposed by air and ingestion of fish contaminated with methyl mercury. A combination of factors make this region and the populations inhabiting it, which include indigenous groups, highly vulnerable to the predictable consequences of the Hg cycle. Among these: the complexity of the environment, combined with the capacity for bio-transformation of mercury into its more toxic form, methyl mercury, and the lack of scientific data on the behavior of mercury in tropical environments, which would enable risks to be better controlled. Global climate change (GCC) is expected to heighten the re-mobilization and bio-accumulation of this substance and to increase the risk of exposure because of growing emission from the so-called "chemical time bombs" [33].

4.2. Pesticides

Pesticide use has increased continuously and today annual consumption is estimated at between 2.5 and 3 million tonnes of these chemical agents at a cost of more than US$ 20 billion. The Brazilian market accounts for 50% of all sales of pesticide in Latin America and, according to figures from the National Association of Crop Protection Industries, sales of these compounds increased approximately 160% between 1991 (US$ 988 million) and 1998 (US$ 2.56 billion) [34]. At present, it is estimated that approximately 260,000 tonnes of pesticide are used annually on crops [35]. Widespread use of these substances has led to contamination not only of workers directly exposed, but also of the environment and families living in the vicinity. It must be stressed that the great majority of rural workers in Brazil have very little schooling, are marginalized from technology development policies and work in precarious conditions, without information or proper protective equipment. With the exception of major exporters, farming close to major urban centers is small-scale, subsistence farming, a family activity where parents and children all help with the work.

The impact of these substances on country folk in Brazil can be seen in Ministry of Health figures for 1996 when 8904 cases of poisoning by pesticide were recorded, of which 1892 (21.25%) occurred in rural areas [36]. These figures fail to reflect the real dimensions of the problem, however, because they come from Poison Control Centers located in urban centers and such centers either do not exist in several important agricultural producing areas or are difficult for many rural populations to access. This is so much so that studies in several agricultural zones in Brazil show that levels of human contamination may range from 3 to 10% of the total population of those areas. In some population groups, such as youngsters from 10 to 17 years old, indices of up to 17% have been encountered [37]. The estimated of individuals involved in agricultural production in Brazil in 1996 is approximately 18 million [37]. Applying a percentage of 3% in order to project the number of individuals contaminated by pesticide in Brazil, we obtain an overall estimate of approximately 540,000 contaminated individuals, leading to some 4000 deaths per year. The major reasons for the continued exposure to pesticide and the current high levels of human contamination are: (a) low levels of formal education, preventing even superficial understanding of safety information provided; (b) a lack of proper technical supervision; (c) the exploitative publicity practices of producer firms; (d) ignorance of effective, alternative growing techniques.

Environmental contamination by pesticide is not caused solely by handling, but is occasioned by the widest variety of reasons, among them waste from industrial production (HCH, HCB, etc.). Soils with contents of thousands of ppm of toxics have been encountered in sites contaminated by waste from pesticide production. For example, approximately 700 tonnes of waste from production of technical grade HCH at a former Ministry of Health plant for use in anti-malaria campaigns were abandoned in one area close to Rio de Janeiro in an area now inhabited by approximately 1500 people. The waste was found in all segments of the environment at extremely high levels [38]. Waters with contents of up to 80 ppb of anticholinesterase agents (organophosphates and carbamates) have been found in major agricultural producing areas [39].

The levels of contamination by pesticide that have been encountered in Brazil are highly significant from the point of view of human and environmental health and denote an absence of policies to control and prevent the risks caused particularly by the handling and disposal of these agents.

4.3. The Goiania accident

One of the most serious radiological accidents ever to have occurred, involving a radioactive chemical compound (cesium-137 chloride), took place at Goiania, Brazil, in late 1985 [40]. At that time, a private radiotherapy institute located at Goiania moved to new premises leaving unattended a cesium-137 teletherapy unit, without notifying the licensing authority as required. This unit contained approximately 17 g of cesium-137 chloride, a highly soluble inorganic salt of a radioactive isotope of cesium. Two people scavenging for scrap entered the vacated premises, removed the source assembly from the radiation head of the machine, took it home and tried to dismantle it. The source capsule was ruptured, resulting in both environmental and external irradiation and internal contamination of several persons. The remnants of the ruptured capsule were sold as scrap to a junkyard owner. He noticed that the source material glowed blue in the dark. Several people were fascinated by this phenomenon and, over a period of days, friends and relatives came to see the “glow”. Fragments of the source were distributed to several families. Some days later, a number of people showed gastrointestinal symptoms arising from their exposure to radiation. The symptoms were not initially recognized as caused by irradiation. Fortunately, one of these people connected the illness with the source capsule and took the remnants to the city public health department. A local physicist was the first to assess the scale of the accident and took action on his own initiative to evacuate two areas. At the same time the authorities were informed. This action triggered a chain of events which led to the discovery of the extent of the problem and resulted in subsequent mobilization of a major emergency response.

Many individuals suffered external and internal exposure and the emergency response had to deal with both this and major contamination throughout the city and beyond. In total, some 112,000 people were monitored, of whom 249 were found to be contaminated owing to the way they had handled the cesium chloride powder. Four people died within 4 weeks of admission to a hospital.

Seven main foci of contamination were identified, including the junkyards concerned. Aerial surveys were flown over 67 km^2. Of 159 houses monitored, 42 required decontamination. The decontamination program lasted 6 months, involved significant resources and produced some 35,000 m^3 of radioactive waste (3800 metal drums, 1400 metal boxes, 10 shipping containers and 6 concrete packing assemblies), which were transferred to a provisional disposal site at Abadia, a small city approximately 20 km from Goiania.

This episode demonstrates irresponsibility in the disposal even of radioactive controlled material by a medical doctor that is supposed to have adequate scientific grounding and should be aware of the related legal requirements. Also evident were the lack of control/inspection by the authorities responsible and the lack of information and/or widely recognized markers on materials that represent high risks. These problems were aggravated by a context of precarious conditions of living, education and work. Fortunately, this accident occurred in a relatively highly developed town which was able to identify the origin of the problems and take the initial measures required to minimize the consequences. On the other hand, this town is geographically distant from the centers that hold all the methodology for control of this type of risk; this is entailed major displacement of technical personnel and equipment. Although one might think that the small quantity of material involved in this accident should have facilitated the tasks of control and inspection, this was not the case. The failures we have described demonstrate a lack of overall control and prevention policy, and of emergency planning to deal with accidents of this type at the national level. Certainly, as regards control of this kind of material, this regrettable experience served to improve inspection, although the level control continues to be divorced from the necessary overall structural changes.

4.4. Lead from battery renovators

In Brazil, human and environmental contamination by lead varies considerably from region to region. The contribution by tetraethyl lead to contamination has been greatly reduced as this substance has not been used as gasoline antiknock additive in Brazil since the introduction of alcohol in 1986. The largest contribution in terms of lead contamination now comes from industry. Studies carried out in the Greater Rio de Janeiro region serve as an example for understanding the still great extent of today problems [41].

This region houses more than 40 foundries, battery factories or renovators, almost all of which are located in residential and commercial areas in neighborhoods inhabited by low-income populations. In these regions, the social, residential and basic sanitation conditions are generally far inferior to the desirable minimum. These small industries generally employ approximately 10 workers in production. These people are recruited from among the local population, are not trained in any way and have very little schooling (less than 5 years of formal schooling).

The production process used in these industries is simple but antiquated, and has caused contamination not only of workers and the internal environment, but also of the external environment of the surrounding property. Concentrations of up to 0.41 mg/m^3 of lead have been reported in the internal environment of these factories [41]. These figures are far in excess of those recommended by current Brazilian law as maximum permitted levels (0.10 mg/m^3). In all the facilities studied (foundries, factories and battery renovators), a significant percentage (approximately 50%) of the workers had blood lead levels in excess of the maximum biological rate permitted by Brazilian law (60 μg/dl) [41].

Environmental contamination caused by this segment of industry may be evaluated from the magnitude of lead concentrations found in dust collected outside and inside residences located close to these industries. Lead concentrations of up to 1840 (outside) and 114 μg/m^3 (inside) were found in residences located at 25 m from battery renovators. Concentration found at a distance of 50 m still higher than those observed in unpolluted environments [41].

Battery manufacturers and renovators, the great majority of which use inappropriate installations, constitute the sector responsible for the greatest problems encountered. These companies operate with high marginal costs and are not covered by economic incentive programs designed to improve environmental performance. Such programs are almost non-existent in Brazil, particularly for small enterprises. Moreover, small firms are not visited by inspection agencies. Even if the government were to prosecute these companies, this action could well precipitate a social crisis by possibly entailing the closure of many firms and subsequently increasing rates of unemployment.

In Brazil, the framework of both occupational and environmental law has sought to follow the legislation of other countries and generally provides the means necessary to control human exposure and environmental contamination. However, some failings may be found, such as the use of limiting values — the maximum permitted biological rate — imported from other legal systems to the situation in Brazil, regardless of any individual characteristics of its working population that might have a bearing on these values. In addition, the periodicity with which these legal instruments are reviewed is uncertain and episodic, and does not accompany scientific knowledge in any way whatever. Studies show that even at concentrations of 30 μg/dl — that is, far less than the levels established as tolerance limits — the presence of lead in the human organism already causes palpable, significant changes [41]. This situation, however, has produced no government move towards updating, or even discussing the need to update its legal instruments.

It is inadmissible that social and economic problems over which the government has ample control can be used to justify the present situation where population groups (workers living close to sources of pollution) are exposed to levels capable of causing health damage. It is interesting to note that the expense of restoring health is generally far higher than is required for effective control of working conditions and of contamination, and significantly greater than any financial gain that may accrue from these unhealthy, uncontrolled activities.

The foregoing discussion shows the fragility of government policies for control human contamination and of environmental pollution of workers and exposed population groups. In addition to an evident lack of political will to act firmly in this area, Brazil lacks specialized human resources, laboratories and strong public institutions capable of acting to solve environment problems, all of which makes the — already precarious — existing control instruments ineffective.

4.5. Benzene in the iron and steel and oil industries

In 1983, the Santos Metalworkers Union (Sindicato dos Trabalhadores Metalúrgicos de Santos) in Sao Paulo state denounced the existence of cases of leucopenia from occupational exposure to benzene among workers at the largest iron and steel works in Cubatao. Between 1983 and 1987, hundreds of workers were given leave of absence with a diagnosis of "benzenism", due to exposure to the coke oven gas resulting from the iron and steel process. The concentrations of benzene, toluene and xylene (BTX) in this gas could attain levels between 30 and 40 ppm. The subject caused repercussion nationwide and new cases were diagnosed, resulting in around 2000 workers laid off from their workplaces by 1992 in Sao Paulo state alone [42].

The reports on inspections carried out at the time by government agencies responsible for inspecting working and health conditions revealed that environmental contamination was affecting not only the workers engaged in primary risk activities, but also those in other sectors such as maintenance and industrial assembly. In parallel, discussion spread within the trade union movement and public institutions connected with social security, labor and health in the region's of Brazil's major iron and steel works. Subsequent to this process, "benzenism" began to be identified in other activities, mainly the petrochemical and oil industries. According to official 1993 figures, the industries that use benzene in Brazil involved some 58,447 direct employees and 116,635 subcontracted personnel, 35,634 of whom were directly exposed in their work process. There were no estimates as to the local populations potentially exposed [43].

In 1995, a government order, the Tripartite Benzene Agreement (O Acordo Tripartite do Benzene) defined the procedures for preventing workers from being exposed to benzene, and expanded workers' participation in this process. The regulations companies in the oil, petrochemicals, chemicals, metallurgical and sugar – alcohol sectors, workers and government agreed to set up a Permanent National Benzene Agreement Oversight Committee (Comissão Nacional Permanente de Acompanhamento do Acordo do Benzene). This agreement represented an important advance in terms of control over workers' safety and health conditions as regards occupational exposure to benzene, since it applies to all companies and industries that produce, transport, store, use or handle benzene or its liquid mixtures containing 1% or more by volume [42]. The agreement established the competencies of the different government agencies (health, labor and social security) and a timeframe for company compliance, differentiated for the metallurgical sector (2.5 ppm) and petrochemical/oil sector (1 ppm) and substitution in the sugar–alcohol sector. The first challenge it faced was to manage the risks in a universe of companies with different levels of technology and environmental exposure to benzene, which ranged from 0.1 to 2120 ppm.

The Permanent National Benzene Committee has been functioning for over 5 years but a number of problems persist. It is true that the negotiation process indicated that this is a possible avenue, and that measures to control and prevent risks connected with benzene are on the order of the day. It was a paradigmatic case of interaction among government, companies and workers whit a common goal at reducing and eliminating risks of a chemical origin in Brazil. Although problems still exist, the 'benzene agreement' is presently being used as a model for tripartite negotiation to control and prevent risks in the workplace, the greatest difficulty faced being the continuous dismantling of the state's regulatory role in Brazil.

4.6. Summary of chemical safety and governance in Brazil

The cases presented above illustrate the chemical safety situation in Brazil from less densely populated areas (as in the cases of mercury use by gold miners in the Amazon and pesticide in agricultural producing areas), through medium-sized towns (as in the accident with Cesium-137 in Goiania), to the major urban and industrial centers (as in the cases of lead from battery renovators and benzene in the oil and steel industries and oil refineries). What can be seen is a situation where problems connected with chemical safety have grown in intensity and extent far more than the capacity of the country to deal with them. It was not by chance that the development of chemical risk prevention and control strategies, including specific regulations, was limited, as this state of affairs is part of the model of development mentioned above. Although Brazil, like other countries in Latin America, has general legislation on chemicals, many of its environmental and occupational regulations have merely been copied or adapted from legislation and technical and scientific information existing in the industrialized countries. Very often however, the transferred norms and procedures are inadequate to or irrelevant for local conditions. This situation has been aggravated by the fact that many of the industrializing countries have few (if any) properly equipped laboratories with qualified personal. The impossibility to perform chemical and toxicological analyses, the difficulty to liaise with other laboratories and to rely on duly implemented quality control programs further limits their response capability.

Access to current, key information has improved in Brazil and in other industrializing countries, although the information, as we have mentioned, is only occasionally applicable to local problems. Nonetheless, there exists the aggravating circumstance that not always can local authorities rely on sufficiently qualified personnel to make the best use of the information. In this context, risk assessments in relation to health and the environment have been academic in nature, and have not entered into the decision-making processes. These issues are quite serious, as they considerably reduce the capacity of all parties involved to develop risk monitoring and management programs, to comply with the legislation and, consequently to implement national chemical safety programs [3].

The nature, magnitude and extent of the problems cannot be known completely. However, the cases presented here illustrate how, for decades, inappropriate or inadequate strategies to control and prevent the risks associated with the production, transportation, storage, handling and disposal of hazardous substances have harmed human beings and the environment.

5. Conclusion

As in other industrializing countries, in Brazil the state has embarked in a serious, dangerous process of deterioration, and is increasingly alienated from and indifferent to the public's needs and demands. In this context, it is urgent for its role to be redefined at each level and in all measures to do with chemical safety. Of particular importance are those areas with more direct responsibility for chemical safety, such as the institutions that directly provide health care to the public, as well as those which are responsible for environmental control and protection [3].

Chemical safety is one of the serious problems to be dealt with by countries like Brazil and poses the challenging task to constitute new societal arrangements at the global, regional, national and local levels, directed to a model of sustainable development. Chemical safety is not a decontextualized subject in a globalized world, where rich, affluent societies coexist with poor countries lacking resources and give origin to first, second and third class citizens and workers. The majority of the planet's population lives in precarious conditions and is excluded from the benefits of modernization/globalization. This same population, in its allotted role in the international division of work, is running the risks of a model of development, which is inequitable by its very nature and dynamics. Little attempt has been made in recent years to rectify the situation in this respect, largely due to economic constraints and stagnating or declining industrial production in the 1980s and 1990s. This resulted in a model of development based on spiraling external debt in most of the industrializing countries, particularly in Latin America, unfavorable international trade and faults in many countries' economic policies [44]. Although many indicators of social progress — infant mortality, education, life expectancy, nutrition — have improved significantly in terms of global averages, millions of people are still without drinking water and sanitation [2].

Governance at the global and local levels, based on democracy and equity, is fundamentally important for effective chemical safety programs to be implemented in the future. On the other hand, there is also the challenge of constituting, at the same time, a science in closer touch with the reality of the industrializing countries and based on integrated, participatory approaches addressed to reduce existing vulnerability. In our view, such approaches are pre-requisites for a contextualised governance, attentive to regional interests. New societal arrangements and a new science are the bases for constituting and expanding strategies for governance to confront the problem of chemical safety, particularly in countries like Brazil. Among our examples, the case that offers most insight in terms of possible proposals (the national benzene agreement) also represents an exception in terms of the situation in Brazil. Although the agreement was achieved under the influence of a social group (urban workers in the iron and steel, chemicals and petrochemicals industries) with great power of organization, it should represent an alternative to be pursued in other situations as well.

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