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Toxic substances and regulatory provisions in Gabon

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Abstract
The expansion of the chemical, pharmaceutical industry and the intrusion of technology in many branches of the economy and in daily life has caused the appearance and accumulation of new substances (toxic drugs) in the environment. This presence of new substances leads to considerable ecological losses and serious damage to health.
This work takes stock of the regulatory aspects, the safety standards of these substances and the state of knowledge on these products in Gabon.

Keywords: Toxic substances, endocrine disruptors, regulatory texts, state of knowledge

1. Introductions
The industrialization of Africa and Gabon in particular led to an expansion in the use of toxic substances. As a result, increasing attention is being paid to the risks to human health posed by contamination of the environment by persistent toxic substances (PTS). Persistent organic pollutants (POPS) have been identified as substances with harmful effects on ecosystems. These compounds persist for long periods in the abiotic and biotic compartments. They are transported over long distances from their source points by water or air and accumulate in organisms and humans *via* food chains. The health effects are gradually being evidenced in many species of animals, as shown by the decline in fertility in mink observed in the 1960s by breeders in the Great Lakes region of the USA. This decline in fertility has been attributed to bio-accumulated pollutants. The main sources of pollution due to human activities are: Fixed sources (industries, cities), mobile sources (transport equipment, bush fires) and diffuse sources (agriculture). From these sources, we witness the contamination of soils, water bodies, air and food chains. The strong suspicions that weigh on the role of environmental pollutants in certain human pathologies and the imbalances of ecosystems have generated strong societal demands for greater caution and a better ability to predict and manage risks, which requires better knowledge of the dangers.
In 1962, Rachel Carson highlighted the toxicity of dichlorodiphenyltrichloroethane (DDT) on the reproduction of birds. In Great Britain, the phenomenon of imposex is observed in male fish living downstream of a treatment plant [1]. Alteration of the reproductive system of wild alligators was discovered in Florida (United States) [2]. All these events led in the 1990s to awareness of the presence in the environment of endocrine disruptors, which are substances capable of interfering with the endocrine system. This is why urgent measures to reduce and/or eliminate the emission of PTS and POPS or their releases to protect human health and the environment have been taken by the United Nations Environment Program [3].
Africa is not spared the effects of endocrine disruptors either, as DDT continues to be used not only in the fight against the female Anopheles mosquito responsible for malaria, but also in market gardening.
Gabon is not exempt from the effects that POPS, PTS and endocrine disruptors can have on health. In recent years, a change in behavior has been observed in large cities: sometimes anarchic use of certain chemical substances such as pesticides, insecticides, herbicides by small market gardening farms; anarchic incineration of household and industrial waste dumps; an increasingly anarchic use of plastics containing certain chemical substances and a discharge into nature and watercourses of industrial products.
Are the Gabonese populations aware of the regulatory provisions aimed at reducing exposure to PTS? Are the Gabonese populations informed of the effects of these PTS and POPS?
For the present study, two objectives are retained, namely: the collection of regulatory texts

aimed at preserving human health and the environment from toxic substances and the taking into account of the representations of pupils on the subject, of regulatory texts, of toxic substances. toxic substances as well as the effects of these toxic substances.

2. Materials and Methods

Investigations focused on aspects aimed at limiting human and environmental exposure to toxic substances produced largely by human activities. Secondary education establishments, public administrations and companies served as a place for surveys on the basis of a questionnaire. The process for obtaining the texts was done through interviews with resource persons from ministries and through documentary research. The conduct of the research is done according to a collection of information under three approaches:

- Classic documentary research of international scientific publications;
- Direct contact with the main public bodies likely to produce the relevant regulatory texts;
- Making contact with the representations of students and professionals on the subject of toxic substances through a survey.

3. Results and Discussion

3.1 Regulations

First defined as a poison causing rapid death, the concept of toxic then evolved into the notion of sub-lethal effects resulting in diseases subtly inducing adverse effects on health. The toxicity of a product reflects the nature of the damage (cancerous or neurotoxic) likely to affect an exposed individual. The concept of toxicity therefore comes under the concept of danger [3]. Toxic substances legislation is a risk management instrument used to prohibit the manufacture, use, sale, offer for sale and import of toxic substances. These provisions are also intended to establish standards relating to the classification and labeling criteria for these substances and mixtures. Indeed, responsible conduct, as well as a reduction in their resource requirements or a careful selection of suppliers with regular checks on their supply chain to ensure that the principles of Corporate Social Responsibility (CSR) are respected, constitutes a support for sustainable development [4]. The regulations not only allow classification but also ensure the protection of people who may come into contact with these products. The environment is not left out in this protection (Tables 1). The classification makes it possible to define the different hazard classes and/or categories that substances and mixtures may present. The labeling of substances constitutes the first information, essential and concise. It provides the user with information on the dangers and on the precautions to be taken during use. The regulatory mechanisms are defined in terms of texts of laws, decrees, orders or circulars. In Gabon, these regulatory texts on toxic materials are identified according to several areas: agricultural, mining, medical and food.

The various surveys conducted in ministries, companies and public bodies show that the presence of toxic substances (pesticides, endocrine disruptors, biomedical, industrial, chemical and radioactive waste) is very real in the Gabonese environment, as evidenced by the numerous texts relating to this effect.

In the agricultural field, the massive use of pesticides, the supply through parallel circuits, and without precaution, is at the origin of the pollution not only of market gardening or food products, but also of the environment [5]. This presence of toxic substances poses the problem of risk assessment and management in our areas where populations are not always aware of their dangerousness and regulatory texts [6]. As a reference, we can cite the case of the management of siltation by the fine muddy of the Moulili watercourse polluted following the exploitation of manganese in Moanda in Gabon. The legal texts related to the mining code (Table 1) have enabled NGOs and parliamentarians to manage this risk. Essential principles must be taken into account for the assessment of these risks; identify the dangers and the people at risk, evaluate the risks and classify them in order of priority, determine the preventive measures, adopt protective and preventive measures through a priority scheme, specifying the role of each, the moment where a task needs to be accomplished, as well as the means allocated to the implementation of the measures, control and review [7].

Table 1: Regulatory provision according to sectors.

Sectors	Identified toxic substances	National regulations	International regulations
Agricultural	Pesticides (DDT, organic fertilizers, chemicals, NPK, urea, superphosphate) Contaminated foodstuff Products resulting from the burial or incineration of expired foodstuffs	Law nº16/93 of August 26, 1993, Relating to the protection and improvement of the environment Order nº00247/MAEDR/IG/IPP of March 12, 1996, On mandatory regulatory measures for the import of phytosanitary products in the Gabonese Republic	May 2001 Stockholm Convention on Persistent Organic Pollutants (POPs) Rotterdam Convention on the Prior Informed Consent Procedure for Certain Chemicals and Pesticides in International Trade, which entered into force on 24 February 04
Medical	Waste at risk of infection (compresses, cottons stained with blood, expired drugs, biological liquids, etc.) Biological and assimilable waste (unsoiled plasters, plastics, sanitary napkins, infusion sets, etc.) Radioactive waste	Law nº16/93 of August 26, 1993, Relating to the protection and improvement of the environment	International health regulations applied with the support of the WHO
Mining	Metals in aqueous effluents, Used oils	Law nº16/93 of August 26, 1993, relating to the protection and improvement of the	Basel Convention

	Mineral separation chemicals…	environment Law nº5/2000 of October 12, 2000, On the Gabonese mining code Decree nº000543/PR/MEFEPEPN setting the system for classified installations Order nº0376/MEDDPNPGCN/SG/CNAP, Regulating the conditions for obtaining consent for the cross-border transfer of hazardous waste for the import and export of chemicals for industrial use in the Gabonese Republic	
DGCC	In foodstuffs pesticides, sulphites, iodine, lead, cadmium, nitrite, microorganism	Law nº16/93 of August 26, 1993. Relative to the protection and improvement of the environment Law of 7/77 of December 15, 1977, relating to the establishment of a phyto sanitary police in the Gabonese Republic Ordinance 50/78 of August 21, 1978, Controlling the quality of products and foodstuffs and phyto sanitary products in the Gabonese Republic Decree nº00032/PR/MSP, Fixing the conditions of production, importation and marketing of edible salts of January 22, 2004 Order nº0013407/MEFEPPN/SG/DGPA, February 19, 2007, Fixing the sampling plans, the methods of analysis and the levels to be respected for sulphites in fishery and aquaculture products	Regulation (EC) nº178/2002, laying down the general principles and general requirements of food law Establishing the European Food Safety Authority and laying down the procedures relating to food safety

3.2 Representations of students and professionals regarding toxic substances

Chemicals exist everywhere. They are of origins different (domestic, industrial, agricultural or urban) and are of different natures: metals, hydrocarbons, solvents, detergents, pharmaceutical products. Some of these toxic substances are likely to present a health risk and have harmful effects on the environment. The state of knowledge of the effects of toxic products assessed among young schoolchildren and professionals shows a lower level of protection for the latter (Table 2). These chemicals are the source of air and water pollution for 28% and 29% of pupils respectively (Table 2).

These pollutions are found both in the professional environment and in the home. In Africa, Asia, and America, the degree of exposure to household air pollution is significantly higher than the threshold of acceptability in industrialized countries [8]. For example, the average daily particulate level in a home in a developing country is two to twenty times higher than the maximum threshold set by the United States Environmental Protection Agency [9].

This survey reveals that 90% of the pupils know the toxic products among which they quoted: Tobacco, pesticides, sachets, carbon monoxide (CO), deodorant, fertilizers, chemical products, gasoline, drugs. Among the compounds mentioned by the pupils, the fumes from biomass are not mentioned. However, it appears that exposure to biomass smoke increases the likelihood of developing a wide range of diseases. It is estimated that household air pollution is responsible for 4% of the global disease burden [8]. The effects of toxic products are known to 74% of the pupils. They cite as effects: asphyxia, cancers, pollution of their environment, destruction of fauna and flora, heart disease and death. For 77% of students, the organs affected by toxic products are: Liver, lungs, heart, breasts, genitals.

Observation in urban areas and interviews conducted in Libreville show that many companies dump waste from their activities into the waterways that cross the city. However, some of the substances spilled are toxic and can be endocrine disruptors [10]. The level of involvement of populations in the field of toxic substances shows that it is urgent to develop and promote local scientific expertise and corporate social responsibility (CSR). CSR or optional contribution of the private economy to sustainable development, must lead companies to an obligation of transparency in social and environmental matters by making information available, to an educational effort, but also to the verification of the information they provide by independent bodies Scheneider [4]. Failure to comply with this mechanism should be sanctioned [11].

With regard to the knowledge and role of hormones, 86% admit having already heard of hormones. 57% know the mode of action of hormones. The best known hormones are the sex hormones (testosterone, estrogen, progesterone), then come thyroxine, insulin and glucagon and finally triiodothyronine and inhibin.

Barely 4% of students admit having heard of endocrine disruptors, while 96% admit they have never heard of endocrine disruptors. None of the respondents know about natural endocrine disruptors. Only 8% of those surveyed know about chemical endocrine disruptors, among which we have: drugs, pills and pesticides. Barely 8% know the effects of endocrine disruptors on the endocrine glands, among which we note: the modification of hormone production, the dysfunction of organs and the cessation of hormone production. We note the same percentage in relation to the origin of endocrine disruptors which is linked

to poor diet, contact with toxic products. For 36% of pupils, absorption is the way allowing the entry of disruptive substances into the body; for 33% this entry is by inhalation; while for 21% it is ingestion which constitutes this entry route and finally for 10% it is the trans -placental route which is the entry route for endocrine disruptors into the body. 18% are convinced of being exposed to endocrine disruptors while 82% say they are not exposed to endocrine disruptors.

Doelker, Balmer, and Poiger claim that these products are responsible for many evils, according to these authors, these products alter the reproduction of seals; change sex in fish and alligators; disrupt the development of sex organs and parenting behaviors in birds; lower the immune system of marine mammals; decrease sperm production [12]. These products also cause precocious puberty, premature births, fetal growth retardation, testicular, prostate or breast tumors, reduced intellectual functions and memory in humans. However, these observations, which are attributed or attempted to be attributed to toxic substances and endocrine disruptors, have not yet been conclusively demonstrated scientifically. However, our study shows that 92% of respondents have never heard of endocrine disruptors, which implies that they cannot even take precautions (Table 2).

Regarding the representation of Bisphenol A and its impact on organisms, only 28% of respondents seem to know that this compound is used in the manufacture of baby bottles (Table 2). Bisphenol A is an estrogen mimetic whose low-dose exposure causes changes in the male urogenital system, suggesting an increased risk of cancer in adults [13].

This compound also seems to have a certain impact: the development and functioning of the male reproductive system, the thyroid, the central nervous system and the immune system [14, 15].

The present work in the Gabonese environment does not allow for the moment to make the link between certain effects and toxic substances / endocrine disruptors. The levels of these substances in nature must therefore be subject to permanent monitoring and correlation studies carried out. The relationship between the dose of these substances and the effect produced is not linear. The effect may be stronger at low doses than at high doses. It is therefore the exposure period that is important, with particular sensitivity during the gestation period [16]. The vulnerable period or “window of exposure” which corresponds to the period of gestation and childhood can change under the influence of substances of a different nature. Toxic substances/endocrine disruptors exert synergistic and cumulative effects on each other, thus constituting a cocktail effect (Inserm, 2008). Expertise, based on the principle of separation between risk assessment and management, should therefore be represented by independent bodies. It would carry out expert missions in response to referrals from public authorities, NGOs or scientific associations while associating the fields of human and social sciences. This local expertise must also lead to the implementation of a prevention approach in which the actions to be carried out must concern companies, communities, villages, humans and the techniques used in a given environment [17]. The prevention approach responds to several issues (human, legal, economic and managerial and health). Health is a right for all, its preservation and protection are an obligation for the authorities.

Bio-detectors are living cells or organisms used to detect and quantify a potentially toxic substance in a sample. The assessment of the threat of toxic substances and endocrine disruptors on the waterways of Libreville can be done using bio-detectors. To reduce the effects of toxic substances, toxic waste or even endocrine disruptors in the environment, actions are possible and desirable on different axes and at all levels:

Support for research, synthesis of results, information and awareness of political decision-makers and the general public.

Control of point sources of pollution such as industrial effluents, discharges into the air from waste incineration plants, landfills (in particular those of chemical products): it is above all up to the State to intervene by means of laws , implementing regulations and control bodies; separate specific purification installations could be provided for certain factories or for hospitals.

With regard to diffuse sources of pollution, i.e. the use by agriculture of pesticides, herbicides, fungicides and the like, and the use by the population of medicines, body care products and hygiene, cleaning and disinfection products, action could be taken: By prohibiting or limiting the production, marketing and use of certain products; By developing alternative products that are free of disruptive and biodegradable effects and by reducing the export of waste as a financial gain.

Table 2: Opinions and knowledge of pupils on different subject of the study

	Theme	Item	% of positive responses
Declaration of students on pollution	Pollution	Water	28
		Air	29
	Pollution control actors	NGO	16.66
		Big Society	25
		People	23.33
		State	13.33
		International bodies	21.66
	You are informed of the pollution by:	Internet	45
		Television	11.66
		Radio	5
		School	20
	pesticides	Area of use: agricultural	58.33
		Health risk	61.66
	Under what conditions drugs are toxic	During self-medication	20
		When there is an overdose	38.33

	Regulatory aspects aimed at limiting pollution	Law	1.66
		Measure	1.66
Assessment of students on knowledge of toxic substances	Pupils' knowledge of toxic products	Toxic products: your opinion	90
		Effect of toxic products	74
		Organs affected by these products	77
Assessment of students on knowledge of hormones and their action	Student knowledge of hormones	hormones	86
		A few hormones:	
		Testosterone	19
		Insulin	11
		Estrogen	19
		Thyroxine	12
		Glucagon	11
		Triiodothyronine	7
		Progesterone	18
		Inhibin	3
		Their action	0
Student Assessment of Gland Knowledge	Student Knowledge of Glands	Some endocrine glands	
		Pancreas	20
		pituitary	18
		Testicles	23
		Ovaries	19
		Thyroids	20
	Opinions on reproductive glands	None	20
		Medium	47
		Good	25
		Very good	8
	Diseases of reproductive gland dysfunction	Cryptorchidism	16
		Prostate cancer	19
		Cervical cancer	24
		Hypospadias	5
		Sterility	36
Assessment of students on knowledge of endocrine disruptors	Endocrine disruptors	Endocrine disruptors: your opinion	4
		Natural endocrine disruptors	0
		Chemical endocrine disruptors	8
		Effect of endocrine disruptors on the endocrine glands	8
		Origins of endocrine disruptors	8
		Routes of entry of endocrine disruptors into the body	
		Ingestion	21
		Trans -placental transfer	10
		Absorption	36
		Inhalation	33
		Exposure to endocrine disruptors	18
Bisphenol A and its health effects	Bisphenol A		47
		Bisphenol and the manufacture of teats	28
	Organs affected by Bisphenol	Testicles	31
		Heart	31
		Thyroids	23
		Lungs	23
		The nervous system	46
		Immune system	46
	Diseases caused by bisphenol A	Breast cancer	16
		Early puberty	21
		Prostate cancer	37
		Decline in immunity	26

4. Conclusion

Our work has made it possible to identify the regulatory texts aimed at limiting the risks of exposure to toxic substances in Gabon. The study on toxic substances shows that knowledge of regulatory aspects is completely ignored by students and most staff using these substances.

The recrudescence of certain diseases, cancers, asthma, allergies, neurological affections, which weaken the immune system lead to suspect toxic substances more and more present in the environment. The public authorities and companies must assume their responsibilities between the need to better supervise industrial development that generates jobs and profits with the imperative obligation to maintain a certain quality of life. A real application of these regulatory provisions must therefore be considered. In the school environment, education in Sustainable Development is a deterrent weapon against ignorance and better involvement of the various actors in their social and environmental responsibility.

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7. Conflicts of interest
The authors have no conflicts of interest to declare

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