LEAD CONTAMINATION IN SANTO AMARO DEFIES DECADES OF RESEARCH AND DELAYED REACTION ON THE PART OF THE PUBLIC AUTHORITIES

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Introduction

Heavy metal contamination, caused by the Brazilian Lead Company, Cobrac, a subsidiary of the multinational company Penarroya, in Santo Amaro, state of Bahia (BA), Brazil, has been the subject of research for the past 40 years. That is, since the first signs of heavy metal contamination were found in the waters of the Subaé River and in the blood of plant workers and fishermen. The plant was established in 1960, in Santo Amaro, in the state of Bahia, and after a few years, signs of contamination were observed after the death of animals in nearby farms (CEPED, 1977).

Studies on this subject were first carried out during the following decade. Lead concentrations were found in environmental compartments and in samples of the human biological matter of fishermen and Cobrac employees.

This article presents a chronological and critical analysis of the scientific production concerning this case between 1975 and 2010. It is subdivided into cycles, and argues that there has been little engagement on the part of the social sciences in the studies conducted. In addition, there is a latent demand to include the people affected in addressing this problem. This study is based on the perspective of extending the peer community as proposed by Funtowicz and Ravetz (1997).

The literature review which underpins this article is based on evidence of the community being overwhelmed by studies and also by noting that the results of most studies were never divulged to the local population (BRASIL, 2003; DI GIULIO, 2010; ANDRADE, 2012).

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Bibliographical references include: *Avaliação de risco à saúde humana por metais pesados em Santo Amaro da Purificação* [Assessment of risks to human health from contamination with heavy metals in Santo Amaro da Purificação] (BRASIL, 2003) and *Baía de Todos os Santos – aspectos oceanográficos* [Baía de Todos os Santos – oceanographic aspects] (HATJE; ANDRADE, 2009).

The selection criteria adopted prioritized references containing the words 'Santo Amaro', 'Rio Subaé' or 'lead contamination'. This generated a list of 110 items which were classified according to research categories (five theses, fifteen dissertations and six monographic studies), scientific articles (36), technical reports (40) and others (8). During a second stage, research was conducted to find out whether the 26 research studies and the 36 scientific articles were present in the libraries of Santo Amaro, in order to calculate the feedback of this scientific production to the community.

Cycles of the research on lead in Santo Amaro

The 1970s – the first signs of evidence

In order to measure the amount of lead and cadmium in the Subaé River, Reis (1975) analysed ten sites in the city for a year (December 1973 to December 1974). He found that sometimes levels exceeded the amounts of lead established by the World Health Organization (WHO) (0.1mg/l) by a factor of sixty.

Reis' data (1975) contributed to the environmental department's decision to withhold permission for expanding Cobrac's production. According to CEPED [Research and Development Centre for the State of Bahia], "cadmium levels found in molluscs were so high that the consumption of a single five-gram oyster could mean exceeding recommended weekly amounts of cadmium intake, as stipulated by FAO/WHO - 500 micrograms (maximum level)" (CEPED, 1977, p. 556).

Cobrac was the target for complaints from the very start of its operations, particularly by cattle farmers, due to animal deaths. Farmers paid for technical studies which blamed the company for soil, air and water contamination and for the death of cattle. As a result of these studies, there were demands for the closure of the factory, based on contravention of Decree n. 50.877 of 29th June 1961, which dealt with the pollution of water courses (CEPED, 1977) - but to no avail.

In 1975 *Variáveis epidemiológicas no controle do saturnismo* [Epidemiological variables in lead poisoning control] (SPÍNOLA, 1975) was published. The author, who also worked as a doctor for the company, studied a group of Cobrac employees and a group of workers from the Department of Public Cleaning, as well as members of a Brazilian reserve army base in Santo Amaro. When comparing clinical and laboratory test dosages of *delta amino levulinic acid* (ALA) (which indicates lead poisoning), higher levels were found among the group of Cobrac employees (CEPED, 1979).

In 1983, Loureiro *et al.* (1983) published findings on the relationship between lead poisoning and hookworm infection in the occurrence of anaemia among 216

Cobrac employees, in an article in the journal *Transactions of the Royal Society of Tropical Medicine and Hygiene*.

According to Loureiro *et al*. (1983), there were high levels of hookworm infection among Cobrac employees. This was a good opportunity for looking at the differences in the risk of contracting anaemia in a population exposed to lead contamination or hookworm infection or both. The article does not make reference to measures adopted by the company to reduce the risks of both health problems for employees as a result of the findings of this study, but it points to the need for occupational physicians to put in place preventive measures.

The works of Spínola (1975) and Almeida (1984) were the only studies carried out within Cobrac and represented research on the occupational aspects of exposure to lead during the period the company was in operation – 1960 to 1993. The vast majority of research relates to human exposure to lead and cadmium outside the metal plant.

As the first signs of contamination were divulged, CEPED - an organization which was, at the time, part of the State of Bahia's Planning, Science and Technology Department – started to study the issue. In 1976, an inventory of metal pollutants in the Baía de Todos os Santos bay area showed evidence of high concentrations of heavy metals in the fauna around Santo Amaro. Thus, it established the need for studies about the effects of cadmium and lead exposure on coastal communities (CEPED, 1979). These studies were carried out with reference to Carvalho's dissertation (1978).

Carvalho (1978) compared the results of interviews and hair and urine sample analyses of 201 fishermen from the Subaé River with those of 83 fishermen from Guaibim, which was considered to be a non-polluted area. He concluded that levels of intoxication in the former were higher than in the latter.

The 1980s – focusing on children

After studying the case of fishermen, Carvalho *et al.* (1983) concluded that, although high concentration levels of metals were found in these men, the situation was far more serious in relation to children between 1-5 years of age and women over fifty. These 'are respectively the groups more susceptible to the toxic effects of lead and cadmium from an environmental source" (CARVALHO *et al.*, 1983, p. 365). Thus, in 1980, Carvalho initiated an epidemiological study involving 640 children who lived in two areas, one considered close to Cobrac and the other distant. This study involved a team of researchers made up of chemical analysts, physicians and biologists from the Federal University of Bahia - UFBA (TAVARES; CARVALHO, 1992). They formed the Interdisciplinary Centre for the Environment, NIMA in Portuguese. According to Carvalho, all the material produced in this first research was handed over to Avicca – the Lead and Cadmium Victims' Association of the State of Bahia, with headquarters in Santo Amaro.

Whilst they were developing studies on the level of lead in the blood of children in Santo Amaro, Petersen (1982) studied the presence of lead and cadmium in vegetable

crops cultivated close to Cobrac and concluded that the highest concentrations of lead were found in mint and lettuce plants. An inverse relationship was found between concentrations of lead and distance from the factory. Furthermore, levels of lead found in Santo Amaro were higher than WHO guidelines on daily tolerance, per person: "Thus, with the exception of fruit, a diet based on vegetables produced in the nearby region was potentially hazardous" (PETERSEN, 1982, p. 71).

According to Tavares e Carvalho (1992), Petersen's work was the largest regular epidemiological study of populations environmentally exposed to heavy metals outside the workplace. This body of research also contributed to the establishment of pollution control measures, the result of laboratory tests which identified high levels of *zinc protoporphyrin* and lead in the blood of children.

The government of the State of Bahia decreed that Cobrac had to comply with a number of measures: remove the population living within a radius of 500m from the factory to other areas; take responsibility for the treatment of the children affected; build a 90m high chimney; install a filter system in all sources of particulate material; suspend the donation of slag and used chimney filters; and supply special clothing to plant employees, to be used exclusively at work (TAVARES, 1990).

A second study with children was carried out in 1985, in order to evaluate the effects of the mitigating measures imposed on the company. Results showed that there was a reduction in the level of poisoning children suffered from, but the amounts of lead and cadmium remained high and there was also the emergence of new cases (TAVARES, 1990).

In relation to technical and scientific research regarding the Santo Amaro case, there are also a number of technical reports, documents and recommendations which underpinned the decisions of environmental bodies and the courts in legal actions put forward by ex-employees and the Public Prosecution Service of the State of Bahia.

In 1990, Tavares' work consolidated the research that had been conducted for over ten years by members of the Interdisciplinary Centre on the Environment/ Federal University of Bahia (NIMA/UFBA). Tavares (1990) concluded that cadmium concentrations in children's blood, as a result of environmental exposure, were the highest in the world, and that damage to the kidneys, which is a long-term clinical effect, may emerge in children studied from the 1990s onwards. He also argued that the slag spread throughout the region was an additional factor in increasing cadmium - but not lead - levels in the children's blood. Finally, according to him, the compensatory/mitigating measures considerably reduced levels of cadmium, and to a lesser extent, levels of lead, both in the environment and in the children's blood However, new cases of risk of intoxication continued to appear, indicating that the measures implemented had not been sufficient (TAVARES, 1990).

Shortly before the end of the decade, results obtained from a study in 1998 indicated that lead blood levels in 88% of the children in Santo Amaro were above 10ìg/dL and in 32% of cases levels exceeded 20ìg/dL (CARVALHO *et al.*, 2003). The authors highlighted the fact that tested children (between 1 and 4 years of age) were born after the factory had closed. The study revealed that the metal plant's residual

"environmental liability" continued to be a significant source of exposure to lead poisoning, particularly among children with eating disorders (such as those who ate earth, mud, plaster or other materials).

In 2001, another dissertation produced by a member of the Interdisciplinary Centre on the Environment, NIMA, was published. It revealed that percentages of chromosomal abnormalities in both bovine cattle and adult women in Santo Amaro were significantly higher when compared with the control population (COSTA, 2001).

The most recent studies involving children were conducted at the beginning of 2000s. Some aspects of these studies are addressed below, under "New studies with children and pregnant women".

Slag disposal

During the 1990s, when Cobrac was no longer in operation after having been sold by the Penarroya multinational and during which stage its activities were conducted under the name of Plumbum, research focused on soil decontamination. Cobrac's legacy included 490,000 tons of heavy metal contaminated slag, mainly accumulated lead and cadmium at the site of the factory (ANJOS; SÁNCHEZ, 2001). There was also, however, an unknown quantity of material which was used in paving public and private areas.

During the 1990s, a study entitled *Estratégias para remediação de um sítio contaminado por metais pesados – o caso da Plumbum* [Strategies for recovering a heavy metal contaminated site - the case of Plumbum] (ANJOS, 1998) revealed that waste left by the company was classified as hazardous, according to results of chemical analyses and in accordance to ABNT [Brazilian Association of Technical Standards] regulation NBR 10.004. Years later, Anjos (2003) concluded that the floodplains created by Cobrac's operation, formed a geochemical, physical and biological barrier in the control of slag pollution.} The end of the 1990s saw the launch of the *Purifica*[1] Project or "Proposal for the Remediation of Areas Degraded by Lead Extraction activities in Santo Amaro da Purificação between 1999 and 2002" (UFBA, USP[ii], CEPED, FINEP[iii], CRA[iv], 2002).

The main conclusions of *Purifica* pointed to the economic feasibility of processing slag in order to reduce the concentration of metals such as lead (1 to 3%) and zinc (8 to 12%), through a solvent extraction process based on hydrochloric acid from the Camaçari Petrochemical Complex. The lead slag in Santo Amaro would then be known as a metal reservoir and the study even included income generation plans.

Purifica also predicted the removal of 3,000m^3 of slag from patios, yards, schools and wasteland sites and an extra 54,796m ^{3} from urban paving. The *Purifica* report caused controversy when the State of Bahia's Environmental Council (Cepram) assessed the licensing of the company interested in reprocessing lead slag, in Santo Amaro. Those opposed to the licensing questioned: "would it not be excessively risky to leave so much acid in a city that has already suffered so much from heavy metal contamination?" (UFBA, 2007, p. 8). The argument revealed a clash of rationalities

between the Health and Engineering fields. The environmental license for metal reprocessing in Santo Amaro was not authorized.

Beginning of the 21st century - delayed action by public authorities

An "*Avaliação de Risco à Saúde Humana por Metais Pesados em Santo Amaro da Purificação/Bahia*" [Assessment of Risks to Human Health caused by Heavy Metals in Santo Amaro da Purificação/Bahia], carried out in 2003 by a contracted company, marked the beginning of the Ministry of Health's involvement in this case, twenty years after the first studies revealed contamination in children in Santo Amaro. This assessment identified the need for a number of health protection measures. It employed the methodology used by the Agency for Toxic Substances and Diseases Registry - Atsdr (USA) and identified the primary focus of contamination as the area around Cobrac, and as a secondary focus, the estuary of the Subaé river. Both areas were classified as hazardous to public health.

The report also concluded that Subaé river sediments presented concentrations above reference values of lead, cadmium, copper, mercury, nickel and zinc. In addition, molluscs (*sururus - mytella charruana)* also contained lead, arsenic and cadmium in concentrations above reference values (BRASIL, 2003). The report also cautiously stated that the fact that someone may have, at some time, consumed these molluscs did not mean they would be poisoned or that they would eventually suffer from a related health problem. "However, the consumption of molluscs must be avoided, particularly by children, because they are contaminated with two toxic substances (lead and cadmium) which are potentially harmful to health" (BRASIL, 2003, p. 224). However, the dissemination of risk factors did not take place and the results of the assessment were not divulged in Santo Amaro (ANDRADE; MORAES, 2010).

It was only after the Ministry of Health's risk assessment that the Government of Bahia started to take action. It established the Purification Inter-sectorial Committee (BAHIA, 2005) and the Health Working Group, part of the Program for the Inter-sectorial Purification of Santo Amaro (BAHIA, 2007).

In 2010, the "Protocol for the Monitoring and Health Care Provision for People Exposed to Lead, Cadmium, Copper and Zinc in Santo Amaro, Bahia" was launched as part of a joint initiative between the Health Departments of the State of the Bahia, the Municipality of Santo Amaro and the Federal Ministry of Health. This document pointed to necessary actions for monitoring people who had been exposed in the past, who are presently exposed or who may be exposed in the future in the contaminated regions of Santo Amaro.

According to the Ministry of Health's Assessment (2003), all those living within a radius of 500 metres from the old Plumbum/Cobrac plant, mollusc consumers, in particular fishing families in the settlement of Caeira, and ex-plant employees and their families were considered to be exposed to risk.

New studies with children and pregnant women

The most recent articles on this issue are studies conducted with expectant mothers and new-born babies in Santo Amaro, between June and August 2002. Results pointed to an inverse relationship between lead concentration levels in the blood of pregnant women and the distance of their homes from the old lead plant (ZENTNER; RONDÓ; LATORRE, 2005).

Among the pregnant women who were admitted to the maternity hospital in Santo Amaro, during the same period, three had positive blood and umbilical cord lead concentrations of above 10ì/dL (ZENTNER; RONDÓ; LATORRE, 2005). The articles referred to do not mention the care these women received to treat the amount of lead present in umbilical cords.

In relation to children, the most recent study was carried out between 2001 and 2003, involving 384 children between 2 and 11 years of age, who lived within 5km of the Santo Amaro lead plant. The diet of these children was studied in relation to their consumption of foods rich in iron. Rondó *et al*. (2011) found that 18.2% of children had blood lead concentration levels above 10ìg/dL, that is, concentration levels equivalent to acute toxicity. The majority of children (44.3%) presented concentration levels between 5 and 9.9ìg/dL, equivalent to potential chronic exposure.

According to the authors, the presence of lead in the blood is a good indicator of acute poisoning, whereas chronic exposure is best assessed by establishing the amount of lead in the bones. This was studied by Guerra (2010) years later, when he analyzed the milk teeth of Santo Amaro children.

Rondó *et al*. (2011) reiterated evidence known since the first studies with children, in the 1980s, that is, that the distance to the metal plant was positively associated with levels of lead in the blood, and that this relationship continued to apply more than 10 years after the closure of Cobrac.

This research report is not available on the worldwide web, or in Santo Amaro libraries, another example of a study that did not feedback to the community. Concerns with children in face of the risk of lead contamination and the lack of feedback from the research that had been conducted with children is a recurrent topic in local reports, as was observed in a group interview conducted with a Santo Amaro community, in which three teachers, a community health worker and a fisherman participated (ANDRADE, 2012:69).

The 2000s – the most studied period

Almost half of the dissertations produced between 1975 and 2010 took place during the last two years of the 2000s. Pontes (2009) measured lead concentrations in samples of acerola, lettuce, manioc, banana, cabbage, mint, citrus fruit, papaya, chicken eggs (shell and yolk), peppers and okra in areas to the north, east, south, as well in front of the old Cobrac factory, and in a vegetable plot close to the ruins of the old plant. He also analyzed metal concentrations in sediment and water samples from the Subaé River.

Lead levels were found to be above the standards established by the Ministry of Health's Decree n.15 (published on 13/03/1990) in samples of lettuce, mint and mustard (PONTES, 2009). Oliveira (2010) analyzed the particulate material from air conditioning filters installed in 60 public and private buildings, and traced the distribution profile of the following elements deposited over the city: cadmium, lead, copper and zinc. He concluded that the environmental liability of the Cobrac plant is harmful to the inhabitants of Santo Amaro.

In "*Qualidade de vida em saúde de ex-trabalhadores do chumbo*" [Quality of life in the health of former lead workers] (TEIXEIRA, 2009) another aspect of occupational health was disclosed. This sort of study had not been conducted since Spínola (1983) and Almeida (1984), when Cobrac was still in operation. The most poignant results in Teixeira's study (2009) were the very low average values found in all aspects of the quality of life of the studied group (functional capacity, physical aspects, pain, general state of health, vitality, social aspects, emotional aspects and mental health).

Almeida (2010) produced the first quantitative study entitled *Significados da contaminação alimentar para os feirantes de Santo Amaro-BA* [The significance of food contamination for Santo Amaro market traders] (ALMEIDA, 2010). This dissertation was the first of a number of studies using this approach to analyze the contamination in Santo Amaro.

In the narratives analyzed by Almeida (2010), a nostalgic conception of prosperity associated with the period of Cobrac's activities was revealed. Thus, the meaning of food contamination among Santo Amaro market traders is founded more on cultural influences than technical and scientific knowledge.

In 2010, Di Giulio's thesis opened a new frontier in research on the case, introducing the perspective of risk communication. Analyzing the statements of researchers, residents, journalists and administrators, she concluded that in the cases studied "the addressing and managing of risk followed a technical-scientific approach, prioritizing technical knowledge and legitimizing the autonomy of scientists, while disregarding the interests of those affected" (DI GIULIO, 2010, p. 174). The author points to the need for intra-sectorial and inter-sectorial activities, using an interdisciplinary approach which includes participative methods of communicating risk, in addition to cooperation, integration and networking between the social groups involved.

Comparing lead concentrations in the different layers of enamel and dentine in pre and post-natal milk teeth collected in Santo Amaro/BA, Cubatão/SP, Ribeirão Preto/SP and Mato Leitão/RS, Guerra (2010) concluded that data collected in Santo Amaro revealed statistically higher values than in the other cities studied. The author observed that studies on the effects of contamination on the health of the Santo Amaro population conducted between 1978 and 2001 did not research the psychomotor development of the children involved and this may explain the lack of clinical findings regarding the Santo Amaro population studied:

> Lead has a half-life of 40 days in the blood. It is then mainly deposited in bones and teeth (95%) (Smith, 1996). Thus, data collected annually

> may not reflect the level of population exposure, since blood mainly reveals acute exposure (Guerra, 2010, p. 7).

Discussion

From the point of view of the different areas of knowledge, the multi and inter-disciplinary dimensions of research on lead contamination in Santo Amaro is clear. However, despite the diversity of scientific fields involved, health sciences (in particular, epidemiology) and natural sciences (analytical chemistry) predominate.

Among the population groups studied, children received the most attention if compared to employees or fishermen who were the first groups to be examined.

Another trend observed in recent years has been the emergence of qualitative research based on the human and social sciences. Up to then, this case had been almost exclusively analyzed through quantitative methods. Almost thirty years went by before the thoughts and feelings of the Santo Amaro population started to appear in scientific studies, through the publication of an article by Aragão and Alonzo (2005).

The absence of studies in the social sciences relating to the field of environmental threats had already been pointed to in the 1980s, when in the United States, Shorts Jr. (1984) stated that it was both surprising and lamentable that so few sociologists had studied risks in society within a risk analysis context.

The low participation of the social sciences in scientific research on health, and in particular within the context of the environment, had already been detected in a study by Freitas (2003) on environmental health in Brazil. According to him, among 305 theses and dissertations produced in Brazil between 1980 and 2000, only 5.6% were within the field of social sciences. Freitas (2003) highlights that the social sciences is one of the disciplines which most resists changes in its knowledge paradigms and the opening up of its chosen topics of research to environmental studies.

According to the diagram proposed by Funtowicz and Ravetz (1997), it can be observed that the Santo Amaro case underwent various stages: from pre-normal science - when the first signs of evidence of contamination involved amateurs in the debate (farmers who saw their animals die and blamed this fact on Cobrac) - through to normal science - with the arrival of experts and research, when laypeople were excluded from discussions – to the current, so called, post-normal phase in which laypeople are demanding to be included in debates in face of an uncertain scenario (*idem*) and the inability of experts to provide conclusive solutions - for example, in relation to the contradictions of the assessment of risk to human health by the Ministry of Health regarding the origin of contaminated molluscs in the Subaé river estuary. Affected by the negative impact of recommendations for the non-consumption of molluscs from the region, fishermen have been demanding more precision in relation to official data: "where and in which part of the river are there more heavy metals, where are the contaminated shellfish and what is the level of contamination?" (ANDRADE, 2012).

The incorporation of knowledge and the participation of those who experience and are exposed to risks in their daily lives present a challenge to the social sciences.

It must increase its presence within the field of environmental health (FREITAS; GOMEZ, 1997). Statements, such as the one by a Santo Amaro inhabitant, "all the knowledge was taken away", reveal the perception that the local population became alienated from this process. Despite the fact that this statement does not question the quality of the studies carried out, when looked at in conjunction with the lack of research reports available in the community, in places such as libraries and schools, it is symptomatic of the quality of the relationship between science on the one hand and sociological and ethical aspects on the other (FUNTOWICZ; RAVETZ, 1997).

The democratization of science proposed by Funtowicz and Ravetz (1997) necessarily means the inclusion of those affected as participants in the research process. They not only "enrich the traditional peer communities, forming what can be called the extended peer community, but they are necessary for transmitting knowledge and skills and for ensuring the quality of results" (FUNTOWICZ; RAVETZ, 1997, p. 228). Another approach within this perspective, popular epidemiology, which is also referred to as community-based participatory research – CBPR (LEUNG; YEN; MINKLER, 2004), has proved to be appropriate to contexts in which scientific knowledge is thought to be inaccessible.

According to Leung, Yen and Minkler (2004), epidemiological research findings may not be disseminated within the community studied due to fear that this knowledge may prove to be disturbing, confusing or both. "By not sharing this knowledge however, epidemiologists deny the community the opportunity of becoming more critical and aware of their situation and, finally, of facing the problems uncovered" (LEUNG; YEN; MINKLER, 2004, p. 501).The availability of research reports on lead contamination in Santo Amaro in public libraries and schools was one of the indicators of the feedback of research to the community involved in this study. Out of the 25 places visited (libraries and schools), only one held material about the case, and out of the 62 listed titles which included theses, dissertations, monographs and articles, only four were accessible. It was therefore possible to state that the rate of feedback of research to Santo Amaro in 2011 was only 6.45%. It is not the purpose of this analysis to explain the reasons as to the lack of feedback of research to the community, but to initiate a debate which will, no doubt, critically examine the science carried out on lead contamination in Santo Amaro. According to Santos (2008), this reflection, based on epistemological precepts, is consistent with one of the facets of the predominant paradigm crisis.

The search for possible answers must involve the social sciences, because, given that the dissatisfaction of the Santo Amaro population is a social phenomenon, subjectivity is a necessary factor in order to arrive at an understanding of this topic. The narratives of subjects were mainly disclosed through the press, this resulted in situations where different discourses (scientific, lay and political) competed for the attention of the public (DI GIULIO, 2010). According to this author, "there is a clear perception that research results do not reach those researched; and when they do, they are disseminated using academic language, making it difficult to understand the information therein" (DI GIULIO, 2010, p. 285). It is in the fields of human sciences

and ethno-botanics that the debate around the issue of feeding back research results, though still incipient, seems to be more open (DEBERT, 2003, p. 31 *apud* ANDRADE, 2012). For Debert, anthropology was the first field in the social sciences to draft a code of ethics and debate issues such as how and whether to provide the people researched first-hand access to studies produced: "for the human sciences it is imperative to politicize the debate in areas that affect our daily lives and the lives of groups researched". Diniz (2008) points to the controversy over legitimacy and the need to regulate ethics in research, as proposed by the biomedical sciences, using qualitative methods. "Ethics in human sciences research is a new development and a hot topic of debate in Brazil" (DINIZ, 2008, p. 418, *apud* ANDRADE, 2012). Research practices in environmental health have led to new commitments such as "ensuring that results return to research subjects" as highlighted by Rigotto (2010).

In reports of research conducted in Santo Amaro and referred to in this literature review, there is no mention of any initiative to feedback results to the population studied. Only in studies about children during the 1980s is there any mention of referring the most serious cases of poisoning for medical treatment. However, it was not clear from studies which analyzed chromosome changes in Santo Amaro women (COSTA, 2001) whether the referral of women in whom these changes were detected took place.

The results of the most recent studies with children, conducted in the 2000s, were not disseminated in the community. The inexistence of public health policies geared towards the provision of care in cases of contamination of children examined during the 1980s (and who are now adults) and at the beginning of the 2000s, as well as new-born babies from the same period, further reflects the lack of connection between knowledge and health governance.

Risk assessment recommendations and other recommendations made by researchers have not been adopted by the public authorities, despite the fact that there were demands on the part of activists associated to Avicca [Association of Victims contaminated by Lead and Cadmium in the State of Bahia], with headquarters in Santo Amaro.

Scientific knowledge was neither appropriated by the community, nor by public authorities, as Santo Amaro still lacks the necessary infrastructure to care for the health of people affected, or to clean up contaminated areas.

Another crucial aspect regarding public authorities relates to the fact that risk was not disseminated. Risk communication is seen as an important stage within the process of risk assessment. This meant that the Ministry of Health's initiative resulted in yet another technical report not reaching the local community (ANDRADE; MORAES, 2010). Government actions in relation to this case have so far not proved to be effective. There is a need for greater and better interaction between all levels of governance in health and the environment. Recently, the municipal government of Santo Amaro was right to make a public appeal to experts: "after a large number of studies, we lack solutions" (CETEM, 2012, p. 15).

Conclusion

The analysis proposed in this article, based on a survey of the bibliography on the case of lead contamination in Santo Amaro, was developed taking into account data from academic research and scientific articles produced over almost forty years. It used 1975 as a reference year when the dissertation *Determinação polarográfica de Pb2+ e Cd2+ em águas do rio Subaé – Sto. Amaro – Bahia* [Polarographic Determination of Pb2+ and Cd2+ in the waters of the Subaé River - Sto. Amaro – Bahia] (REIS, 1975) was published, considered to be the first piece of research carried out on this case. Structured chronologically, this analysis identifies the research cycles, from the first signs of evidence to present times – the latter period being classified as the period with the greatest amount of scientific production. This article discusses critical aspects of the relationship between science and society. The fact that the last decade represents the period with the largest number of studies conducted not only reveals a permanent scientific interest in the case of Santo Amaro, but also indicates the gravity of the situation, as it points to the existence of evidence of environmental contamination even twenty years after the closure of the metal plant responsible for this problem.

The fact that children are still born with lead concentrations in their blood is proof that the efforts undertaken by science in almost four decades have not been sufficient to ward off the risks of contamination. Thus, it is necessary to highlight the responsibility of Public Authorities in relation to this situation. The first government action – a risk assessment to human health - only occurred 20 years after the publication of the first scientific articles providing proof of environmental contamination in workers and children. A generation grew up and saw their descendants born with an unwanted inheritance. In face of the inability of science to mobilize public authorities to develop the necessary measures, we are left to consider both the viability and the need to extend the community of peers beyond the academic circle and bring the population into this debate and even into the research itself. In this way we believe that there will be sufficient pressure to force changes.

This is an opportunity for the social sciences to act as a catalyst to change the dominant paradigm based on the natural sciences. According to Santos (2008), there have never been so many scientist-philosophers as there are now. They have acquired the skills and philosophical interest to problematize their scientific practices. In an age where we still have to question the role of accumulated scientific knowledge in the practical enrichment or impoverishment of our lives (SANTOS, 2008), the possibility of participative research practices is an innovative tendency that will add to the efforts required to resolve a situation which has been dragging on for decades.

The insignificant feedback of research on lead in Santo Amaro to public spaces associated with knowledge is not just a stimulus for a new posture by the producers of scientific knowledge, but an analytical tool proposed by this study which could also be applied to similar cases. We believe that when the people suffering from the consequences of environmental contamination take possession of the knowledge about the risks to which they are exposed, they can stop being victims and start acting for change.

Notes

[i] *Purificação* – purification in Portuguese is also part of the name of the city "Santo Amaro da Purificação" – thus the 'pun' with the name of the Project.
[ii] USP – University of São Paulo
[iii] FINEP – Studies and Project Funding Agency
[iv] CRA – Regional Business Council

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LEAD CONTAMINATION IN SANTO AMARO DEFIES DECADES OF RESEARCH AND DELAYED REACTION ON THE PART OF THE PUBLIC AUTHORITIES

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Resumo: A contaminação por chumbo em Santo Amaro (BA) é estudada há quase 40 anos, desde as evidências encontradas no Rio Subaé e em amostras de sangue de trabalhadores da Companhia Brasileira de Chumbo (Cobrac), e de urina e cabelo de pescadores. A persistência da contaminação continua motivando novas pesquisas, mesmo após 20 anos do fechamento da Cobrac, o que evidencia a falta de políticas públicas para afastar o risco de contaminação da população exposta, principalmente crianças e mulheres adultas. Este artigo apresenta uma análise cronológica e crítica da produção científica sobre o caso, e discute a pouca participação das Ciências Sociais na discussão, assim como a necessidade de inclusão dos afetados, baseada na perspectiva da ampliação da comunidade de pares (FUNTOWICZ; RAVETZ, 1997). A partir da percepção de que as pesquisas não retornaram à comunidade (DI GIULIO, 2010), constatou-se em levantamento bibliográfico nas bibliotecas que apenas 6,45% da produção científica estavam disponíveis.

Palavras-chave: Contaminação. Chumbo. Santo Amaro. Retorno de pesquisas. Ciências sociais.

Abstract: Lead contamination in Santo Amaro (BA) has been studied for almost 40 years since the first signs of evidence were found in the blood samples of employees at the Brazilian Lead Company (COBRAC), and in the urine and hair of fishermen. Continued contamination carries on motivating further research, 20 years after the closure of Cobrac, highlighting the lack of public policies to prevent the risks to the population exposed to contamination, especially children and adult women. This article presents a chronological and critical analysis of scientific literature on the case and discusses the limited participation of the social sciences in the discussion, as well as the need to include the affected population, based on the prospect of an extended peer community (Funtowicz and Ravetz, 1997). From the perspective of feedback of the research to the original community (Di Giulio, 2010), it was found that only 6.45% of this scientific production is available in local libraries.

Keywords: Lead contamination. Santo Amaro. Return researches. Social sciences.

Resumen: La contaminación por plomo en Santo Amaro (BA) ha sido estudiada desde hace casi 40 años, ya que la evidencia encontrada en el Río Subaé y em las muestras de sangre de los trabajadores de la Empresa Brasileña de Plomo (Cobrac), y en la orina y el pelo de los pescadores. La persistencia de la contaminación motiva nuevas investigaciones, incluso después de 20 años de cierre la Cobrac, lo que pone de manifiesto la falta de políticas públicas para evitar el riesgo de la población expuesta, especialmente niños. En este artículo se presenta un análisis cronológico y crítico de la literatura sobre el caso y se analiza la participación limitada de las Ciencias Sociales en la discusión, y la necesidad de incluir las personas afectadas según la perspectiva de la ampliación de la comunidad de pares (Funtowicz, Ravetz, 1997). Desde la percepción de que las investigaciones no regresaron a la comunidad (Di Giulio 2010), se encontró en estúdio en las bibliotecas locales que sólo un 6,45% de la producción científica estaban disponibles.

Palabras clave: Contaminación. Chumbo, Santo Amaro. Regresso de investigaciones. Ciências sociais.