Environmental Justice and Ecological Debt in Belgium: The UMICORE case[1]

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Abstract

The harbour city of Antwerp (Belgium) has a long history of expanding industrialisation with impacts on the environment and inhabitants' health. Life expectancy in Antwerp is two years shorter than the average in Flanders, a highly industrialised region in itself[3]. In the suburb of Hoboken, where UPMR[4] runs the world's largest precious metals recycling unit, the link between pollution and health is intriguing. Although the plant has implemented substantial ecological modernisation since the 1970s, the legacy of 122 years of historic pollution is still present: lead, arsenic and cadmium levels in the soil increase with proximity to the factory, as does the level of lead in the blood of toddlers and infants. Cancers are significantly more frequent in Hoboken than in Flanders or Antwerp, particularly lung cancers, the type most likely to result from the plant's activities. Since the early 1920s local actors have been actively asking for cleaner air, decontamination and compensation. In 2004, the company paid 77 million € for a clean-up of the area in closest proximity to its plants in Hoboken and Olen. UPMR drastically reduced emissions and is now recognised as one of the most sustainable companies in Belgium. However, claims of UPMR management to have recognised the company's 'historic responsibility' have so far translated mostly into cleaning up surface contamination in the area. This paper sets the clean-up operation of the company within a framework of **ecological debt,** calculating the amount that UPMR owes to the environment and nearby residents, with a focus on health damages and loss of capabilities, the major collateral damages inflicted by UMPR's direct and recognised environmental impacts. The best available studies on damage to health and crops in Hoboken are combined with existing and relevant calculations on the **cost of illness,** the **value of human life** and **the economic value of gardening** for results that provide insights on how to apply the ecological debt concept to a single industrial plant, and inform recommendations for actions to be taken by the chemical industry and the government of Belgium. The concept of **post-normal science** also helps to explain why the difficult exercise of calculating the ecological debt for a single industrial plant, despite its drawbacks on accuracy, is relevant and urgently needed. The final results should not be interpreted as exact figures, but as indicative of the scale of indirect damages to the real economy, through the study of direct damages to the environment and to inhabitants.

Keywords

Ecological debt, lead pollution, de-silvering health risks, manufacturing of uncertainty, environmental justice, popular epidemiology, historic liability, environmental externalities, corporate accountability/liability, value of human life, ecological modernisation, discount rate,

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[2] VODO (Flemish Platform for Sustainable Development) with help from ULB (Université Libre de Bruxelles)

[3] http://www.hivnet.org/index2.php?option=com_content&do_pdf=1&id=7469

[4] In 1887 'Usine de désarg' started a lead de-silvering operation in Hoboken. From 1919 the name changed to 'Metallurgie Hoboken'. Union Minière (previously known as Union Minière du Haut Katanga) integrated several daughter companies in 1989, including Metallurgie Hoboken, before changing name to UMICORE in 2001. Since 2003, the UMICORE plant in Hoboken is referred to as Umicore Precious Metals Refining (UPMR). We argue in this paper that UMICORE inherited the socio-environmental liabilities of the previous companies.

greenwashing.

Environmental justice/ecological debt: Case UMICORE – Hoboken (VODO-ULB)

1. Introduction

1.1. Geographical context

Flanders is not only the most populous and industrialised region in Belgium, it also ranks at the top for Europe. Antwerp is the second largest port in Europe, the fourth largest in the world and the engine of Belgium's GDP. The city has gradually swallowed smaller villages surrounding the old city, Hoboken included. Industries have also surrounded neighbourhoods.

1.2. Historical context

Just outside of Antwerp, the small rural village of Hoboken became a major industrial hub. What began as a lead de-silvering operation in 1887 grew to a large industrial plant extracting heavy metals from waste. The factory became gradually surrounded by a working class neighbourhood, mainly built on the initiative of the factory owners. It did not take long before the people who lived nearby nick-named the de-silvering plant "the sweet death". In the early 1920s, workers started to ask for the recognition of lead poisoning as an occupational disease. By 1930, Hoboken had grown from a few thousand to 30 000 inhabitants. The whole area slowly merged with the city of Antwerp. Many local people thought their health problems were somehow related to pollution from the factory, but they could not prove it. While two World Wars were fought with a major economic depression in between, people were happy to just have a job and ask no questions, "seeing all but saying nothing''.

This humble attitude changed after World War II. The economy was booming, prosperity was growing fast and workers wanted better jobs. The solution from the factory owners was to look for other, less demanding workers. During the golden 1960s, the de-silvering plant attracted a large amount of Moroccan and Turkish workers to fill this gap. By the early 1970s some 700-800 immigrants worked there, mainly in the dirtiest jobs. By that time, the ecosystem surrounding the factory had already started to send emergency signals. Bees are to an ecological system what the canary birds were to the mineworkers: if they die, something is deeply wrong. In the sixties, several mass extinctions with great losses of the honey harvest occurred in municipalities downwind from the factory. According to Professor Debackere from the University of Ghent, the cause of death was an increased arsenic dose[5]. However, the polluter remained unknown.

By 1973, many people from Hoboken noticed that their laundry, drying in the garden, became eroded with holes when the wind blew from the factory. When dozens of cows and horses died after grazing near the plant, Professor Debackere measured the lead concentrations in the

[5] As mentionned in the Dutch language book on pollution in Hoboken from Gijsels (1979)

soil. They were sixty times above normal and more than twenty times above the legal limit. In places, the legal limit for arsenic was exceeded 225 times[6]. Was the factory the source of the arsenic clouds killing off the bees in a wide area around Hoboken? The factory actually admitted that they were the source of this pollution. Farmers later admitted that they were secretly paid compensation for every dead cow, on the condition they kept silent[7]. The research from Debackere forced the government to undertake a larger screening of pollution with heavy metals in the area around the factory.

In 1973, the Provincial Institute for Hygiene (PIH) from the Province of Antwerp did a detailed survey which showed that the levels of lead, copper and cadmium were all several times above the legal limits and increased with proximity to the factory[8]. At the end of 1973, concerned officials leaked protected information of complaints from local people and measurements of lead at a nearby playground to a group of local doctors. The maximum allowable level of lead at that time was 40 ppm, but on the playground it was 2000 ppm[9]. The Ministry of Health then wrote a letter to the municipality to discourage the growing of home grown fruits and vegetables in Hoboken, widely practiced in this community[10].

In 1974, the Doctors for the People (GVHV) published a report on lead poisoning in Hoboken. The Doctors provide free health care to anyone in need, seeing health care as a basic human right. However, the group has also been conceived as a radical Maoïst political organisation, seeing free health care as their way to 'reach out to the masses'. Their radical political views overshadowed their health research, harming their credibility in the eyes of media, government and universities. Their timing was bad as well, as the oil crisis of 1973 had shocked the economy so the time was not ripe for radical action against employers. Two Doctors nonetheless were elected to the local council of Hoboken in 1976. From the beginning of their mandate they asked to make all results from government research on air and water pollution by the plant public and insisted on further research. Their battle with the company, at that time called Métallurgie, intensified as they improved their research and mobilized people.

In 1977 the Doctors again made a stir by referring to an article published in the internationally renowned magazine *Archives of Environmental Health*, where the air pollution by lead for school-age children in Hoboken was described as dangerous[11]. Upon this, a Commission under the leadership of Professor Clara was formed, which published its findings at the end of 1977. The message was alarming: "The health situation of the children ages 11 to 12 (the sample group researched) living in the nearby environment of the 'Métallurgie' (now UPMR) is under threat, probably for other groups, but primarily for toddlers. There should be a general screening". Out of 1192 children examined, at least 26 had lead poisoning. At least

6 Gijsels (1979)
7 Merckx (2008)
8 PIH (1973)
9 Merckx (2008)
10 Letter from the Ministry of Health to the municipality of Hoboken, 18 June 1973
11 Roels et al. (1975)

65% suffered from what was then called a "lightly increased risk" that needed further medical attention. In total, 37 children were taken to hospital and 22 received intensive treatment for lead disease. Still, Métallurgie claimed that as far as they knew, lead poisoning had never been confirmed for children in Hoboken. The giant research project of Professor Clara, who went on to become the Rector of the University of Antwerp, was dismissed. This is just one example in a long list of many in which the company denied scientific evidence and manufactured **uncertainty**.

Finally, based on the results of this and other research and under increasing public pressure, the government held an environmental summit on the issue in 1978. The summit with experts, professors and the bosses from the factory came to the following conclusions:
"The dust in houses within a range of 500 meters from the factory contains three times more lead than in urban areas (where the level is already high). At a distance between 500 and 1500 meters from the factory, the dust contains two times as much lead. *There is no doubt that the source is the factory 'Métallurgie' Hoboken*. This causes increased lead levels in the blood of children. We discourage the growing of vegetables on the soil of the community of Hoboken. Children younger than six should not live in Moretusburg (the neighbourhood in Hoboken closest to the factory) and children younger than twelve should not live in the area surrounding the factory (the first line of houses next to the factory border). *The severity and possible consequences on the health of children who suffer from lead intoxication have been known for a few years*."[12]

Many important conclusions can be drawn from this. First, the cause-effect relationship between the factory and the levels of pollution from heavy metals was established and confirmed. Secondly, Métallurgie could no longer uphold the claim that it had not known what kind of damage it was inflicting on the environment from 1978 onwards, if not earlier. Although the total ecological debt runs since the start of production in 1887, Métallurgie has knowingly produced ecological damage since 1978. To the credit of the company, this date was also the beginning of Métallurgie´s emissions reduction policy. However, even with evidence of ecological damage and the resulting efforts, Métallurgie hid information about the true scale of the damage. The official company doctor, Dr. Verhoeven, illegally prescribed sick people with lead abortive pills (Sormental) in order to temporarily lower lead levels in blood, without revealing patients' true lead levels,[13] a practice which lasted until as late as 1981. Doctor Verhoeven, informally admitted in a conference of company doctors that if he had really respected the rules and regulations, two-thirds of these workers would have been eligible to apply for invalidity under the Fund for work-related diseases[14].

The implication of this confession cannot be underestimated. It means that the company had prior knowledge of the fact that its workers suffered from work-related health problems but decided to cover them up. It means that if the rules had been followed in the year of his claim

12 Gijsels (1979)
13 Merckx (2008)
14 Merckx (2008)

alone, the 2000 or so workers who represented two-thirds of the workforce at the time could have claimed around 7.7 million € in compensation[15]. In recent years, emissions have been decreased drastically, safety within the factory has improved and bio-monitoring shows that the vast majority of workers are healthy. However, incidents still happen and every year some workers die for unknown reasons. A large research project on the combined effects of low dose exposure to several heavy metals is currently taking place among the workers at UPMR. Results are expected by the end of 2010 or in 2011. When this data becomes available we could add a chapter on the extent of the health damages to workers, but for the moment we have decided to focus on the much stronger and existing evidence of the direct impact of UPMR on its environment.

2. The case for a causal relation between UMPR production and above-average cancer rates in Hoboken

The current case presents a clear example of **popular epidemiology**, a process in which, as defined by Phil Brown[16], "laypersons gather scientific data and other information, and also direct and marshal the knowledge and resources of experts" in order to investigate a case involving toxic contamination. "Many people who live at risk because of toxic hazards have access to data otherwise inaccessible to the scientist. Their experiential knowledge usually precedes official and scientific awareness, largely because it is tied to the labour and domestic care of everyday life. Whether or not the health hazards in communities and workplaces are due to toxic substances, discovery most often stems from lay observation". Members of the local community, workers and concerned doctors played key roles gathering evidence of the health hazards related to the company emissions. VODO has been able to tap into this existing layperson data and information to build upon it and use it to search for better and clearer data,, with sufficient success to come to this chapter.

Cadmium and arsenic are proven to cause cancer in humans according to the International Agency for Research on Cancer (IARC). This institute, which is part of the World Health Organisation, summarizes the worldwide scientific knowledge on cancer. In 1980 the IARC found that "there is sufficient evidence that inorganic arsenic compounds are skin and lung carcinogens in humans"[17]. In 1987 the IARC published an update on all carcinogenic risks for humans. Based on the best available scientific knowledge and many studies, arsenic was again confirmed as causing cancer among humans[18]. At that time there was only limited evidence for the carcinogenic risk of cadmium. However, in a new publication in 1993, the institute concluded that "there is sufficient evidence in humans for the carcinogenicity of cadmium and

15 Between 2000 and 2007, the average payment by the fund for professional diseases to patients from the sector of precious metals and non-ferrous metals was 3861 euro a year. There are no data before that for this sector, but if we use this average the total cost *in 1981 alone* would be (3861*2000) = **7.7 million €.**

16 Brown (1993)

17 IARC (1980)

18 IARC (1987)

cadmium compounds"[19]. For lead, the IARC conclude that "there is sufficient evidence in experimental animals for the carcinogenicity of inorganic lead compounds" and "inorganic lead compounds are probably carcinogenic to humans"[20].

Even if proving a direct correlation between a particular disease and the operation of an industrial plant is very difficult and complex, examples in the literature exist upon which we can base our reflections. A positive correlation between lung-cancer mortality rates and distance from a smelter emitting arsenic, copper, lead and zinc has been proven in Sweden[21]. A non-ferrous smelter in the US caused a 60% increased risk of lung-cancer, after standardising for smoking habits and profession[22]. Based on many other comparable cases elsewhere and on the subjective impression that Hoboken saw a high incidence of cancer cases, six doctors from Doctors for the People decided to do an extensive study on the incidence of cancer in relation to distance from the factory, based on all patients they had consulting with in 1997. At that time, no reliable cancer registry existed, so their effort was pioneering. We briefly present their results below, bearing in mind that this study remains explorative and cannot be used as the unique source to analyse cancers in Hoboken. We also acknowledge the fact that this study does not take into account other potential interfering factors such as medical history, exposure to toxic substances, family history, etc..

In this study, these doctors divided the area surrounding the factory into 6 Zones, depending on the distance from the plant and the dominant wind direction. The first zone consisted of people living 150 metres from the plant, zone 2 of up to 525 metres and so on, up to zone 6, which consisted of the rest of Hoboken. According to this research, in Zone 1 and 2 the chance of getting cancer was 3.5 times higher than for people living in Zone 6. For every Zone nearer to the factory, the number of cancers rose. Through extrapolation of their empirical results they concluded that 171 cancers in Hoboken alone could have been avoided. The six doctors reported 78 cases of persons who died of cancer in 1997 or had cancer between the 1st of January 1997 and 31st December 1997. Cancer cases before 1997 were not considered and skin cancers and minor tumours were excluded. Unfortunately, the team of volunteers did not have the time and resources to standardise their results for the many possible interfering factors such as age, smokers and other living habits.

Despite their shocking preliminary results, no government institute or university decided to do further research, probably as the Doctors were part of an extreme left political group. When the Doctors realised they would not find support from the academic community, nor from the government, they conducted a follow-up study in 1999 themselves. Without any subsidies or means to cover the expenses of their study, the six Doctors looked into their archives and made a geographical distribution of the 303 cancer cases reported in their practice from 1976 to 1998. Again the correlation with distance to the factory was very significant. In Zone 1

19 IARC (1993)
20 IARC (2006)
21 Pershagen (1985)
22 Blot (1986)

they discovered chances of developing cancer were 4 times greater, and for the whole of the neighbourhood of Moretusburg, the chances of getting cancer were 60 to 70% higher than the average for Flanders. Although their study was not standardized to account for example for smoking habits, the theoretical hypothesis that the already-proven pollution caused by Métallurgie also had also resulted in more cancers was in line with both empirically obtained data in the field and with the international literature on the link between these emissions and cancer. Once again, these results do not correspond to a serious epidemiological study but confirm the hypothesis that some cancers of the area could have been due to its industrial pollution.

In parallel, the list of measurements done in Hobokenshowing high pollution levels is extensive. Since the 1970s, the institutes that have published one or several reports on air, water and soil pollution from heavy metals in Hoboken include: VITO (Flemish Institute for Technological Research), IHE (Institute for Hygiene and Epidemiology), ISO (Institute for Chemical Research), VMM (Flemish Environment Agency) and OVAM (Flemish Waste Agency). Private environmental consultancies were performed by Ecolas, Tauw, Lisec and UMICORE themselves. The evidence has been so overwhelming that the company no longer denies the fact that they are responsible for the excessive amounts of cadmium, lead and arsenic in soil, water and air around the site. They refer to this damage in explaining their payment for the soil rehabilitation in the area surrounding the factory. However, the company still denies that this excessive ecological damage has caused illnesses among people.

There is further indication of a direct link between pollution from UPMR and cancer in the higher incidence of cancer in Hoboken compared to Antwerp or Flanders, as found in official figures of the official Belgian cancer registry. VODO obtained specific data for Hoboken, Kruibeke and Hemiksem (the latter two are neighbouring municipalities out of the main windpath of UMICORE), including standardised comparisons with Flanders and Antwerp. A smaller geographical scale for Moretusburg, the neighbourhood in Hoboken bordering UPMR, was not available. Between 1999 and 2005, the registry recorded 146 more cancers in Hoboken than what could be expected from the indirect standardised incidence ratios (SIR) based on a comparison with Flanders. The results are standardised for age. Compared with Antwerp, the most polluted city of Flanders, Hoboken still had 129 more cancers than expected. Tables 1 and 2[23] summarize the data given by the Belgian cancer registry and include a 95% confidence interval of the figures.

It is important to keep in mind that the higher than average number of cancer cases is an estimate with a probability range rather than an exact number. It means that we are 95% sure that the number in Hoboken is in the relative range between 101 and 116 while 100 is the average of cancer cases we can expect, after standardisation for age. It is relevant to point out here that all action on climate change is based on at least 90% certainty from science that humans are involved in climate change. No matter how cautiously one deals with the figures

[23] These data are from the Antwerp cancer registry that existed as a provincial initiative until 2005 ; as a result, they may provide incomplete datasets

in Table 1 and no matter with which level you compare Hoboken to (the world, Europe, Flanders or Antwerp), even after standardisation for age the figure of Hoboken always stands out as being significantly higher. In all cases, Hoboken is the only community where the range always stays above 100, which clearly means that we are 95% sure of a higher incidence of cancer in Hoboken than normal (100). The best estimate according to these figures is a total of 146 more cases of cancers when compared with Flanders[24]. Compared to the age-adjusted standardised incidence rate for the World, both males and females in Hoboken suffer from double the amount of cancers as can be expected, while Hemiksem and Kruibeke are below what could be expected. The difference between Hoboken and the other communities surrounding UPMR, Hemiksem and Kruibeke, is that Hoboken lies directly in the windpath of UMICORE.

Table 1: Invasive tumours (exclusive non-melanoma skin cancer), 1999-2005, compared with data for Flanders, Europe and the World

Men	Tot	FSR	ESR	WSR	SIR	95% CI
Hoboken	787	723.7	533.4	360.6	108.8	[101.15;116.35]
Hemiksem	171	208.6	388.6	258.4	82.0	[69.7;94.28]
Kruibeke	318	316.8	494.7	337.9	100.4	[89.34;111.4]
Women	Tot	FSR	ESR	WSR	SIR	95% CI
Hoboken	646	563.0	405.4	296.7	114.7	[105.89;123.59]
Hemiksem	166	157.2	379.7	283.1	105.6	[89.52;121.65]
Kruibeke	233	243.6	345.2	255.4	95.6	[83.36;107.93]

Tot: Total observed cases
FSR, ESR and WSR: Expected cases based on age-adjusted standardised incidence in Flanders, Europe and the World Standard populations (n/100.000 person years).
SIR: Standardised incidence ratio compared to Flanders= (tot/FSR) *100
95% CI: Range of expected cases based on a 95% confidence interval

Table 2: Invasive tumours (exclusive non-melanoma skin cancer), 1999-2005, compared with data for Antwerp, Europe and the World

Men	Tot	FSR	ESR	WSR	SIR	95% CI
Hoboken	787	730.8	533.4	360.6	107.7	[100.17;115.22]
Hemiksem	171	211.3	388.6	258.4	80.9	[68.8;93.06]
Kruibeke	318	320.0	494.7	337.9	99.4	[88.45;110.3]
Women	Tot	FSR	ESR	WSR	SIR	95% CI
Hoboken	646	573.2	405.4	296.7	112.7	[104.01;121.39]
Hemiksem	166	160.5	379.7	283.1	103.4	[87.71;119.18]
Kruibeke	233	248.6	345.2	255.4	93.7	[81.69;105.75]

Tot: Total observed cases
ASR, ESR and WSR: Expected cases based on age-adjusted standardised incidence in Antwerp, Europe and the World Standard populations (n/100.000 person years).
SIR: Standardised incidence ratio compared to Antwerp= (tot/ASR) *100
95% CI: Range of expected cases based on a 95% confidence interval

[24] 146=MEN (Observed (787) – Expected (723.7 rounded to 724))+WOMEN (Observed (646) – Expected (563))

VODO then asked the registry if this might show that there is a link between a suspiciously high incidence of cancers in Hoboken and environmental cancers caused by UPMR. The registry did not want to suggest that there is this link, but they gave more details on which cancers are most prevalent. They noticed a relatively high percentage of lung cancers, suggesting that these might be explained by multiple factors[25].

Table 3: Lung cancers, 1999-2005, compared with data for Flanders, Europe and the World

Lung Cancer	Tot	FSR	ESR	WSR	SIR	95%CI
Men	159	125.9	107.2	72.3	126.3	[106.66;145.92]
Women	55	27.5	33	23.2	200	[147.14;252.86]

Tot: Total observed cases
FSR, ESR and WSR: Expected cases based on age-adjusted standardised incidence in Flanders, Europe and the World
SIR: Standardised incidence ratio compared to Flanders = (tot/FSR) *100
95% CI: Range of expected cases based on a 95% confidence interval

The official number of females suffering from lung cancer in Hoboken is exactly double the figure expected when looking at the average for Flanders: 55 cases instead of 27.5. These are official figures from the Belgian cancer registry and the best data available. This is remarkable when compared with the findings of Professor Lison, who was called upon by UPMR to defend the company. Reacting to concerns about the high number of cancer cases in 2006 and 2007, not among inhabitants but among workers in the factory, the Professor claimed that the ten registered and different cancers among workers could not be linked with the exposure to pollutants within the factory[26]. In fact, he claimed that *"the type of activities and exposure (Ashes, SO_2, asbestos…) would rather lead to more lung cancers, which is not the case"* [27]. The information from Professor Lison was never published but was communicated to workers during the summer of 2009. VODO obtained a copy of this information, but when Professor Lison was asked for further clarification of his comments, he refused to go into detail. His findings in fact represented a rather curious response to the concerns of workers, as an earlier study based on lung cancer patients in Antwerp had shown that those with a professional background in the non-ferrous industry had a 1.6 higher chance of getting lung cancer[28]. Interestingly his own findings seemed to imply a direct link between UMICORE's production in Hoboken and abnormally high incidences of lung cancer.

25 Belgian cancer registry (2009)
26 UMICORE (2008b)
27 UMICORE (2008b)
28 Droste et al. (1999)

As we have pointed out already, examples from Sweden and the US show that similar emissions from non-ferrous smelters caused a much higher incidence of lung cancers[29]. Two other large research projects in the US found a positive dose-response relationship between blood lead concentrations and lung cancer[30]. One possible explanation of why the problem of lung cancer is higher in the surrounding area than among the workers suggests itself: Workers wore protective masks and were subject to following safety rules at all times, but lead was expelled from chimneys 60 meters above the work place, spreading toxic clouds into the wider environment of surrounding inhabitants who did not have masks. However, this does not imply that workers were safer from the risk of cancers than inhabitants, merely that they seemed to have been more protected against inhaling chemicals while working in the factory halls. In addition, exposure to a multitude of other toxic metals before the products entered the ovens, might have caused other cancers among the workers. The number of possible causes and how they relate to each other, such as the combined effect of exposure to several low doses of toxic metals, is not sufficiently known at present. As mentioned earlier, a large-scale study on this aspect using the workers of UPMR as the sample population is currently under way.

The significantly higher incidences of cancers in Hoboken, with lung cancers particularly higher than the expected figures, is a further empirical indication that supports the hypothesis derived from scientific studies that there might be a direct link between the historic UPMR emissions and local cancer cases[31]. Further proof of the link between historical pollution from non-ferrous smelters and higher incidences of cancer was given in *The Lancet* in 2006[32]. The study concluded that exposure to the levels of cadmium caused a higher incidence of lung cancer. Although the context of the Umicore site was comparable, the company did not take the study seriously because of other findings from other scientists. For the people of Hoboken who are suffering from lung cancer it actually does not really matter if the cause is arsenic, lead or whatever other chemicals UPMR is emitting. What matters to them is that they are sick at a rate exceeding world, regional or city averages and that empirical data suggests that UPMR is the cause of their illness. What matters is that no one has received any compensation for health or ecological damage. Lowering emissions and cleaning up the soil is a good start, but it is only a part of addressing a historic legacy of liability and it falls far short of taking up real **corporate accountability** or **internalising all external costs**.

3. The case for a causal relation between UPMR production and other health damages in Hoboken

The identification of other negative health effects directly linked to UPMR is methodologically difficult, and therefore means that any calculation of UMPR's total

29 Pershagen (1985) and Blot (1986) (BLOT REFERENCE?)
30 Lustberg & Silbergeld (2002)
31 Belgian cancer registry
32 Nawrot et al (2006)

ecological debt will be an underestimation. However, a substantial body of international literature has been written on other detrimental health effects of lead (Pb) and cadmium (Cd), the most ubiquitous developmental neurotoxins[33]. Typical effects of Pb-exposure and possibly also Cd-exposure are concentration deficits, diminished planning and organisation capabilities and altered behaviour[34]. A landmark article on the effects of increased lead in blood for children living near to a smelter was published as early as 1975 in the famous *New England medical journal*[35]. In 1979, the medical peer-reviewed magazine the *New England Journal of Medicine* shows that children with increased lead levels had lower IQs and fewer social skills. A high lead level decreases the formation of haemoglobin, necessary for oxygen transport. Acute lead poisoning causes intestine malfunctions, cramps, high blood pressure, kidney stones and eventually coma and death. Chronic lead poisoning leads to asthma, vomiting, nervous system failure with permanent brain damage, and kidney disease.

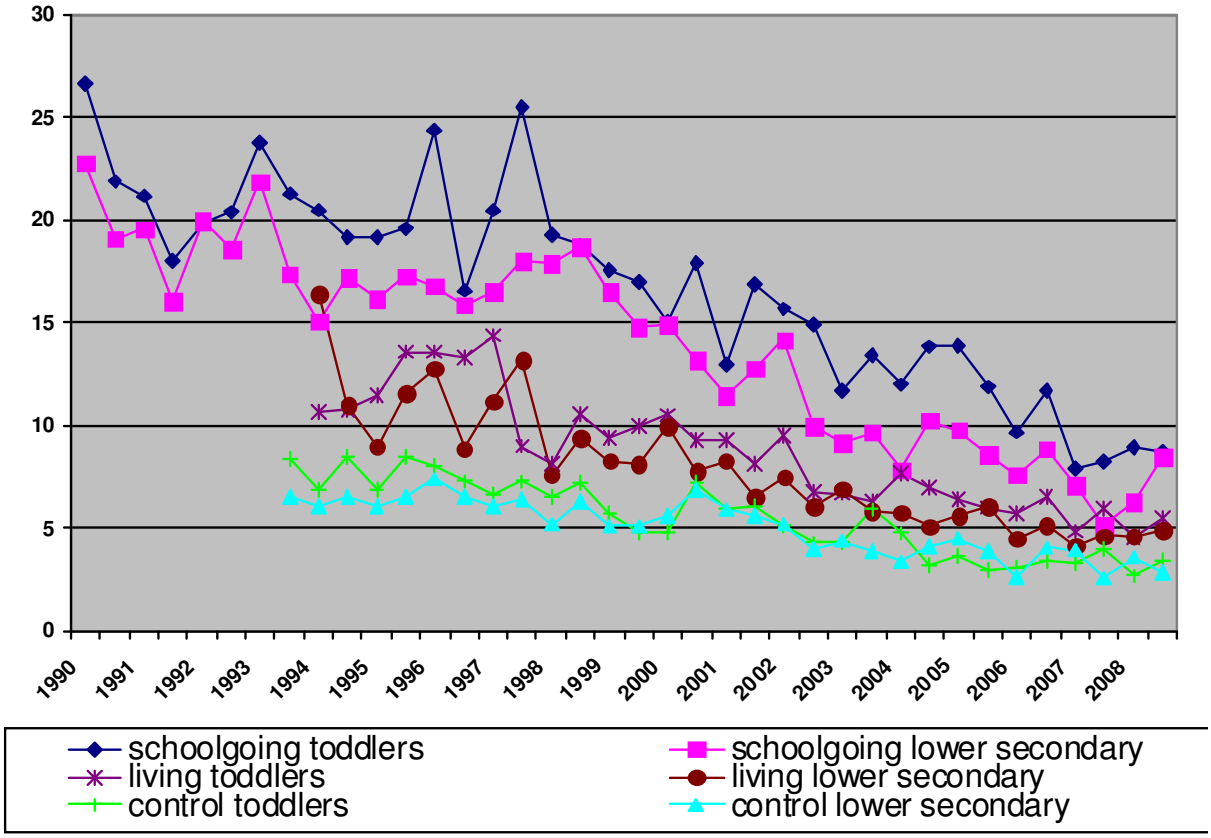
Apart from the lead problem, emissions such as copper, zinc, cadmium and arsenic cause bone diseases, infections of the mucous membrane, liver and kidney failures (among others) [36]. Children are more sensitive, especially toddlers. This has not only been proven in international literature, but has also been proven within Hoboken. Children who lived near the plant in Hoboken matured sexually at an older age than others, and testicular volume was significantly smaller for boys[37]. Other studies showed that even a low level of lead, under the current norm of 10 µg/dl, has significant effects on the hormonal balance, concentration, causes several social and emotional problems and delays development of walking and language skills for children from 0 to 3 years old[38]. In Hoboken, a systematic and large-scale study on this issue has never been undertaken. However, one systematic and large scale study done every 6 months since 1978 in Moretusburg-Hertogvelden is available: the lead-in-blood measurements from the government PIH agency.

The PIH studies were the direct result of a request from Professor Clara for a general screening of children in Moretusburg after his 1977 study showing increased lead in blood levels among children 11 to 12 years old. The PIH from the province of Antwerp started with biannual measurements in 1978 and continues them until today[39]. Since 1993 there has also been a biannual screening in a control group and in children living in the region but not going to school there. According to the head of research Vera Nelen, every study since 1978 by the PIH or by the University of Antwerp has shown that the most important factor for explaining the higher lead level is the combination of time and distance from the UPMR-factory. The more time a child spends close to the UPMR factory, the higher the lead in blood level. Figure 1 clearly illustrates this fact. The upper two lines show the evolution of the lead level of two different age groups who both live and take classes in Moretusburg, expressed in µg lead / dl

33 Pokock et al. (1994) Guo et al.(2004) Chiodo et al. (2004)
34 Viaene et al. (2000) Vermeir et al. (2005)
35 Landrigan Ph. J., (1975)
36 Staessens (1996, 1999)
37 Staessen et al. (2001)
38 Viaene M.K., Vermeir G., (2009)
39 Neelen V. (2008)

blood. The middle two lines are children who live in Moretusburg but go to school outside the neighbourhood. The lower two lines are children from the control group. Since 1992 the health norm has been 10 µg/dl.

Figure 1: Evolution of lead in blood for children in Moretusburg – Hoboken (µg/dl)



4. The response from UPMR

By the time people had united against the pollution inflicted upon them by the factory in the 1970s, it was no longer an issues of interest to a few Maoïst doctors and a handful of enlightened professors. Several big demonstrations from mothers of sick children, youth clubs, some lawyers and even the local socialist government took place in 1978, asking for decontamination. People filled sacks with sand and the lead inside it and "brought back the lead to the factory". There were threats to close down the factory from the mayor of Hoboken. A committee of concerned parents finally convinced a judge that a decontamination team should be formed, that the legal limits should be lowered by a factor of ten (Métallurgie had somehow managed to receive exemptions from the legal limits for the area around the factory) and that environmental commissioners should monitor remediation works. There was one important catch though: the Judge also ordered that the parents who had filed the case would have to pay the costs of the experts who would check the claim, in advance. That was

the end of the case for the parents, who of course could not pay for that[40].

However, after an environmental summit in 1978, the official position of Métallurgie changed radically from one of denial to recognition, and some promises were made by the factory. The promises included lower emission norms, the identification of pollution sources, the covering of resource deposits, decontamination works in Moretusburg, vacuum cleaning of roofs, attics and streets, the creation of a buffer zone and soil replacement. Other measures were also pledged: the temporary closure of schools and nurseries, the building of new schools and nurseries and the organisation of sea and forest excursions as a health cure for the children. An information campaign by the Ministry of Health, *Medical Research on Adults of Hoboken* followed up measurements of lead in soil, air and water. These well intended actions, while they demonstrated that Umicore had recognized its negative impacts on the population, were not sufficient to compensate for the total ecological debt of the company.

In the mid-1990s the company further researched data on the presence and extent of historical soil and groundwater contamination. A study conducted by VITO in 1996 concluded that the consumption of home-grown vegetables and groundwater posed a health risk to most children and to a lesser degree, adults[41]. One year later UMICORE signed a framework with the Flemish government, guaranteeing at least ten more years of research and decontamination works from 1997. In 1999 the company began publishing annual environmental reports and working hard to create a **green image**. By the time the company name changed from Union Minière to UMICORE in 2001, the company had developed a progressive environmental policy and started to recognise (part of) its historic responsibility. The 2000 environmental report[42] states: "The processing of non-ferrous metals at most UMICORE plants in Belgium, France and the Netherlands started over 100 years ago. Many production techniques used then were very environmentally unfriendly compared to present standards, resulting in soil and groundwater contamination and sometimes inappropriate storage of wastes". This first *mea culpa* seemed to acknowledge the possibility of having incurred an ecological debt. But not a comment was made on the ecological debt they incurred in places like Katanga, Congo, where they have a very long history of mining. The global legacy of UMICORE however is beyond the scope of this present study.

Further research done by UMICORE and the Public Waste Agency of Flanders (OVAM) resulted in a second much bigger agreement in 2004 which obliged UMICORE to pay 77 million € for sanitation works around the Flemish sites. In full page newspaper advertisements published after the agreement was signed, UMICORE claimed that they had initiated this deal and turned the page of history, but that is only a part of the story. VODO obtained letters from OVAM to UMICORE from 2001 showing that the company had not complied with the necessary soil research. OVAM research from 2001 for example, indicated heavy pollution of soil and water in several zones around the site, with measurements in neighbouring

40 Merckx (2008)
41 Cornelis (1996)
42 UMICORE (2001)

Moretusburg showing levels of cadmium exceeding the norm up to 59 times[43]. UMICORE had disputed the results of the OVAM studies and gone to court. An agreement was finally signed in 2004 between UMICORE and the first Green Environment Minister for Flanders, Johan Tavernier. Since then, Thomas Leysen who became the CEO of UMICORE in 2000, has taken environmental issues seriously. Leysen is working to create a brand new image for UMICORE as the most sustainable industry of Belgium. By signing the 2004 agreement, UMICORE became one of the first entities to acknowledge a part of its ecological debt on such a scale.

In Hoboken and the direct surroundings of UMICORE sites, UMICORE is today paying for ongoing decontamination works. In the wider area around the sites both UMICORE and the Flemish Government are each paying 15 million €. In their environmental reports, UMICORE often talks about 'voluntary commitments' with **Corporate Social Responsibility** (CSR) at the heart of its long term strategy, but how far does CSR go? Realizing that the corporate self-regulatory approach has its limits, the corporate accountability movement came into existence in the 1990s[44]. The movement has proposed the development and implementation of regulatory instruments and penalties for non-compliance rather than voluntary self-regulation.[45]. The ongoing debate over whether current voluntary corporate efforts to achieve sustainability are amounting to anything other than **greenwash** is highly relevant in light of the outstanding ecological debt of UMICORE in Hoboken.

Pictures 1 and 2: UPMR buildings old style and new style

The goal of this study is to contribute to the search for a methodological framework in which ecological debt can be used as a tool for people searching for **environmental justice.** The final results which follow should not be interpreted as exact figures, but should mainly be seen as a contribution to the development of a methodology, for which UPMR was the most convenient example at hand. If the people of Hoboken want to use it, is up to them.

43 Touchant (2001)
44 Broad and Cavanagh (1999)
45 Utting and Clapp (2008)

5. Ecological debt

5.1. Definition and methodology

The idea of ecological debt was first conceived by South American civil society organisations (CSOs) in the early 1990s as a way of re-conceptualising the financial debt owed by the South to the North. It has since been picked up by CSOs all over the world, and followed by scientists who investigated and devised solutions to associated methodological problems.[46]. Martinez-Alier introduced the distinction between **private ecological debt** by corporations and **public ecological debt** such as the **carbon debt** or climate debt[47]. Simms, Rijnhout and Martinez-Alier state that "ecological debts may be very broadly defined. They include pollution, 'theft' of resources and disproportionate use of the environment"[48]. The pollution aspect is often also referred to as ecological damage. Ecological economists have often embraced this translation of the ecological debt because it is the most readily calculable. Ecological debt can also be referred to as environmental liability. This paper now asks the question: "What is the minimum ecological debt the UMICORE plant in Hoboken owes to people living in Hoboken?"

To explain why asking this question is relevant and how the question itself should be interpreted, it is imperative to introduce **the post-normal science** framework. Post-normal science was developed to deal with circumstances where normal science alone can not handle the complexity of a situation, this is when facts are uncertain, values are in dispute, stakes are high and urgent decisions have to be taken. Originally described by Silvio Funtowicz and Jerome Ravetz , the concept has been used to improve our understanding and ability to deal with surprises such as "mad cow disease" or climate change. In these situations accredited experts were not capable of foreseeing the implications of certain technologies and decisions, so their knowledge was not sufficient to handle the complexity of the problems. Post normal science involves the formation of an "extended peer community" in which stakeholders affected by a problem or decision take part in the assessment process, as they also hold valuable insights (everyday experience, in-depth knowledge of their surroundings). In this participative arena, science is one of many sources of evidence that contributes to feeding policy decisions. For instance, in the climate change debate, even if there still are uncertainties, the stakes, values and the urgency are so high that action is required and public involvement is needed to ensure the quality of the process.

In our case study, even if at first there were uncertainties about the relationship between industrial pollutants and health, the last 100 years of scientific research have radically diminished these. Communities have also mobilized to gather information and to build local health statistics to prove this link locally and to call for action (popular epidemiology). But, the company has worked in the other direction, to increase perceptions of uncertainty,

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46 Martinez-Alier (2002)

47 JADES email list, 22 December 2003

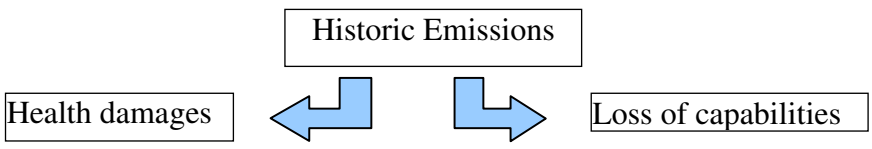
48 Martinez-Alier, Simms, Rijnhout (2003)

effectively weakening the communities´ demands. Our case is an example of post-normal context, not because there are very high uncertainties (as the company stresses), but because there are very high stakes and urgent decisions to be made. We see overwhelming indications that show a cause-effect relationship between emissions from UPMR and health damages and loss of capabilities among the inhabitants of Hoboken.

To answer the central question of how big the minimum ecological debt actually is, we calculated the associated costs of as much ecological damage as we could find, without pretending to give a full picture of all damages. Some costs, like that of having a lower IQ due to increased lead levels in the blood of toddlers living near the factory, can clearly be linked to the plant, but cannot be calculated. Others, such as the damage done by the high volume of heavy traffic are hard to link to the factory because there are other nearby industries contributing to traffic. There might also be a link with the mass extinction of bees in the 1960s but these incidents are too far away in the past and there is not enough data in existence to allow the investigation of the real cause. In this study, we therefore focused our calculations on the damage caused by lead, arsenic and cadmium emissions from UMICORE in Hoboken for which there is substantial evidence. The goal is to get an idea of the minimum ecological damage done since the moment the company knew they were causing the damage.

Calculations of the ecological debt of a single industrial plant are not new and have had varied impacts, with a few calculations resulting in successful court cases against large polluters. Well-known cases are Bhopal in India or the case against PG&E in the US. The latter was forced to pay 333 million US$ in compensation to victims, the largest settlement ever paid in a class-action lawsuit in US history at the time. Unlike in the US, Belgian law does not permit class-action cases, but even with this legal barrier, some options do exist. Normally, plaintiffs have to pay the costs of experts, which would likely run in the region of a few thousand € per patient. However, a new ruling made in 2007 may offer scope to exempt plaintiffs from these costs if they can prove that their income is insufficient, something that should not be difficult in the case of the average worker or sick person living off of health care allowances. An upfront fee to specialist environmental lawyers remains, but this would be dwarfed by the compensation should a case be won, and could be avoided entirely with the use of pro-deo lawyers. Of course, it is up to victims themselves to decide if and how they want to pursue environmental justice through the courts. The calculation that we make only gives them and the company an idea of what the stakes are. Figure 2 gives an overview of the ecological debt framework used in this study. Only the elements in bold have been calculated, representing a partial sum of the total ecological debt.

Figure 2: Ecological debt framework (Parts in bold are calculated and only represent a part of the total ecological debt).



Lead poisoning	**Gardening**
Cancer →	Ability to work
Lower IQ →	Ability to learn
Lower social skills	Groundwater use

5.2. Cancer treatments

The typical treatment cost of cancer patients has been calculated in great detail by Baker et al[49] and is cited in *The Cost of Illness Handbook*[50]. The handbook from the US Environmental Protection Agency is a widely used reference. Baker made an estimation based on the average cost calculated from the only long-term study of cancer costs available. According to these calculations, the total lifetime, incremental, undiscounted direct medical cost for a typical cancer in 1996 dollars comes to US$ 82 581.16.[51] This figure is the starting point of several adjustments for reaching the best estimate of the cost for our own case.

1. Baker uses a mortality rate of 50%. The mortality rate for cancer in Belgium in 2005 was 43.5%[52]. However, in 1999 the rate was 52.5%. The average mortality rate therefore becomes 48%. Taking into account the uncertainties and our wish to not overestimate our accuracy, we also use a 50% mortality rate, as in the US.
2. Medical costs are subject to inflation. Using the medical care service component of the consumer price index in the US from 1996 to 2009, the costs increased 1.59 fold[53]. We use the value of 2009 for extrapolation up to 1980 because although in 1980 the cost of medical care was less, UMICORE has been able to use that money until now in other capital investments. Since the income from capital has increased more than the cost of medical care in the same period, this is still a calculation to the advantage of UMICORE.
3. Using the average exchange rate from 1999 (introduction of the euro) up to 2008 (the last available yearly average) we multiply the dollar figure by 0.89066 to calculate the

[49] Baker, Mary S. et al. (1989) *Site specific treatment costs for cancer: an analysis of the medicare continuous history sample file.* In: Cancer Care and Cost. DRGs and Beyond.

[50] This handbook from the US Environmental Protection Agency was developed by the Office of Pollution Prevention and Toxics (EETD, EPAB) under the direction of Nicolas Bouwes (EPA WAM) by Abt Associates, Cambridge, Massachusetts (K. Cunningham, Project Manager).

[51] For a wider discussion on the sources, modifications to the data and methodology used by Baker we refer to the update version of the cost of illness handbook, available on http://www.epa.gov/oppt/coi/

[52] Cancer incidence in Belgium (2008) contains the most recent data from the Belgian Cancer registry. The report mentions a mortality rate of 45% for males and 42 % for females in 2005 but a rate of 55% for males and 50% for females in 1999 (p34)

[53] Data from the US Bureau of Labor Statistics on http://data.bls.gov/PDQ/servlet/SurveyOutputServlet

value in Euro.[54]

This brings us to the total lifetime, incremental, undiscounted direct medical cost for a typical cancer in 2009 euro equivalent of **116 412** €[55]. If an expert confirms that the cancer is caused by pollution from UMICORE, this is the minimum compensation a patient should get. The official cancer registry noted a higher than expected incidence of cancers of 129 in Hoboken, when compared with the already high levels of the city of Antwerp. Using this most cautious comparison, the total debt from 1999 to 2005 would therefore come to **at least 15 million €.**

The official cancer registry has no reliable data from before 1999, when pollution was proven to be even higher. The most reliable data available come from the 1998 study from the 6 Doctors who, based on their own patient population in 1997, calculated that in West-Hoboken alone, there were probably 171 more cancers than expected. When we use the same amount of 116 412 € this debt would come to **20 million €**. In fact, this figure is rather low if one considers that the time span covers 18 years: from 1980 (when UMICORE was aware that arsenic causes cancer) up to 1997, due to lack of other data. The figure of 129 from the cancer registry is only based on a 7 year span, in a period when pollution levels were much lower than they had been from 1980-1997. At present, the best available data suggest that the number of 300 more than usual cancer cases from 1980-2005 is an underestimation of the real number.

In total, since 1980, 300 incidences of cancer more than the norm have been registered in Hoboken, so if the link with UMICORE could be proven, this would amount a total debt of at least **35 million €.**

5.3. The value of human life

Unfortunately, half of cancer patients still die, even after treatment. The average amount received by relatives from the life-insurance payment of someone who dies in Belgium is around 300 000 €. In the previous section we calculated that around 300 more than usual cancers were recorded in Hoboken. If half of them survive, a rather optimistic estimate, 150 more than usual cancer related deaths occurred since 1980. Multiplied by the average payment of life insurance, the amount comes to **45 million €.** This is what UPMR would owe the families of those cancer patients who actually died from the disease, if the link were proven. However, in this calculation, we have not taken into account the suffering of relatives, data which escapes economic valuation. The payment of life-insurance does not necessarily correspond to the value of human life. To the contrary, it is easy to argue that the economic value of human life is infinite, impossible or immoral to calculate due to ethical reasons. That is certainly true and putting a price on the 'value of human life' should never be seen as something companies can internalize in their accounts when considering future plans. The

[54] Based on the exchange rate on 21 April 2009 on www.xe.com

[55] Calculation: (81 926 $) * (1.59538) * (0.89066) and dollar/euro rate average based on http://www.oanda.com/convert/fxaverage_result

obligation is instead to do everything possible regardless of cost to prevent illness and of course death.

One could also argue however, that *not* putting a price on those that have already died and are sick is also unethical toward families left behind with no compensation. While it is impossible to compensate for grief, it is important to make it more difficult for other companies to continue to externalize costs that expose their workers to fatal illnesses. In fact, when one compares the figure of 300 000€ per person with what other companies have been obliged to pay in similar cases, it becomes apparent that this amount is relatively low. In the Chevron case in Ecuador, plaintiffs filed a claim asking 9.5 billion US$ compensation for 1400 deaths from cancer, or 6.78 million US$ per person[56]. Economists Orley Ashenfeiter of Princeton University and Michale Greenstone of the University of Chicago, have proposed that in the US $1.54 million is a more accurate "value of human life"[57]. Greenstone even mentions that this figure is useful when setting out norms for pollution by arsenic. This seems highly relevant to our case, so when we use his calculation on the "value of human life", the debt from the around 150 cancer deaths would come to 231 million US$ or using the average exchange rate of 0.89066 (in the first ten years of the euro since 1999), the debt would come to **206 million €.**

5.4. Diagnosing children with increased health risks due to increased lead in blood values and prevention of further lead intoxication

The *cost of illness* handbook contains very specific figures on the cost of reducing high lead levels in the blood of children[58]. The PIH has measured the lead in blood levels of children in Moretusburg since 1978[59]. Their biannual results are classified in the CDC tables for interpretation of the risk level of lead in blood. Using the medical care service component of the consumer price index in the US from 1996 to 2009 and converting the costs in euros, these are the costs for diagnosing, helping (through prevention) and sometimes treating children with increased health risks due to increased lead in blood for each risk class:

Table 4

CDC risk level	cost in 1996 US $	cost in 2009 US $	cost in 2009 €
I	122.7	209.4	149.8
II	241.0	411.3	294.4
III	2632.0	4492.2	3215.1
IV	5200.0	8875.3	6351.9

The results are based on the biannual research in schools in Moretusburg and do not cover all

[56] http://www.economist.com/world/americas/displaystory.cfm?story_id=13707679
[57] http://www.dailyprincetonian.com/2002/10/09/5646/
[58] US EPA (2007)
[59] PIH (1978-2008)

children living in the area, only the ones who go to school in Moretusburg. Further evidence of the under-representation of cases comes from the fact that some of the studies from the PIH do not mention the total student population. In most cases, where the sample size and the total student population size are known, we used extrapolation to find the total cost for the whole student population. Based on the costs related to the different risk classes, the total cost for dealing with lead in blood in Moretusburg since 1978 comes to **11 753 334 €** [60]**.**

5.5. Loss of capabilities from gardening

Another historical liability of UPMR is based on the fact that from the early 1970s, the local government of Hoboken began advising people not to grow vegetables and fruits themselves, because of the pollution coming from UPMR. The first such notice was given in April 1973[61] and people had to switch to buying these items instead (although not everyone followed this advice). The ecological debt calculated here is an estimate of the total loss of capabilities for the people of Hoboken who were advised not to grow edible products in their gardens as a direct consequence of pollution from UPMR. Even if home-grown vegetables did not go to market before consumption, they have an economic value. It should be noted that not all people have followed the health advice and some still grow vegetables. However, the ecological damage through emissions from UPMR is there and remains in all but the decontaminated soils just around the factory.

According to figures from the city of Antwerp, Hoboken has 14 626 households with 33 468 inhabitants[62]. The number of households and inhabitants has not changed significantly over the last four decades. According to official figures for Hoboken from 2001, 63.9% of all 13 653 residences have a garden[63]. In 1991, only 57% of 17 081 Hoboken residences had a garden. We do not know the exact number of gardens and residences for other years, so we take the cautious average of 60% and 15 000 residences or 9000 gardens. This is slightly higher than the figures of 7832 gardens in 1991 and 8352 in 2001, as mentioned in the same study from the city of Antwerp. However, they explain that these figures are certainly an underestimation because they are based on respondents only and they acknowledge that a certain number did not respond.

A large-scale study done by several institutes on green waste production in 2007 showed that 26% of people with gardens in Flanders also kept vegetable gardens[64]. This reduces the estimate of the number of private vegetable gardens in Hoboken to around 2340. This estimate of vegetable gardens does not include commonly managed vegetable gardens, which make up a separate land use category outside of private vegetable gardens. A study ordered by the Flemish department of agriculture and fisheries, executed by the University of Ghent, has

60 For a detail of the calculation we refer to annex 1
61 Letter from the Ministry of Health to the community of Hoboken, 18 June 1973
62 City of Antwerp (www.antwerpen.be)
63 Based on Stad Antwerpen (2009)
64 M.A.S. et al (2007)

shown that they are very popular in the area[65]. Half of all commonly managed vegetable gardens in the whole of Flanders and Brussels together are in the province of Antwerp, a province which covers only 21% of the surface area of Flanders. In fact, the study states that most of these commonly managed vegetable gardens in the province of Antwerp are within the city of Antwerp itself. Hoboken is a district of the city of Antwerp, the one with the most green space. The study calculated in detail that in Hoboken there are 24 500 m² of commonly managed vegetable gardens and goes on to mention that there is a demand for increasing this size to 46 100 m². This gives us very good reason to believe that the 24 500 m² existing commonly managed vegetable gardens are used intensively.

According to Jan Vannoppen, the director of the Society for Ecological Living and Gardening (VELT), an average small vegetable garden of 40 m² produces vegetables worth 920 € per year in Belgium. The large-scale research on green waste production showed that 187.4 m² was the average size of a vegetable garden[66]. Because Hoboken is an urbanised area with below-average garden size it might be more realistic to extrapolate from the average small vegetable garden of 40 m² suggested by VELT than the average size as calculated for the whole of Flanders. The study from the city of Antwerp showed that in 2001, 56.2% of gardens in Hoboken were bigger than 50m² but that is the total garden size. However, the high demand for more commonly managed vegetable gardens suggests that when people don't find the common space for cultivation they will use their own garden at maximum capacity. Again, in the case of lack of exact data, we use the more cautious estimate of 40 m² average vegetable garden size. VELT also calculated that the cost of maintaining the same 40m² garden is around 182 € per year for tools and seeds. The net profit would therefore be 738 € in the first year and higher in later years, because new tools are not needed every year. But again, we stay with the cautious figure of 738 € profit per year.

To check the figure given by VELT it is useful to look into some other figures. According to the National Institute for Statistics (NIS), average spending on fresh fruit and fresh vegetables is around 500 € per year (not including spices). The difference with the figure of 920 € comes from the fact that the value of home grown vegetables is usually higher because most of them are organically grown and also because people with vegetable gardens usually sell or give some of their crops to friends and family without gardens. Therefore, the figures from the NIS rather confirm that the net profit of 738 € per year for a small 40m² garden is anything but exaggerated. Using these figures, in a single year, the 2340 private vegetables gardens of Hoboken alone could produce 1 726 920€ net profit from vegetables and fruits. The total value of the commonly managed vegetable gardens (at the same rate of 738 € for every 40 m²) comes to 452 025€. The total for one year is 2 178 945€. The local government of Hoboken advised people not to grow vegetables or any food from the end of April 1973 up until 1999. For those 26 years, the total loss of capabilities in Hoboken comes to 56.6 million €[67].

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65 Allaert et al. (2007)

66 M.A.S. et al (2007)

67 (2.178.945)*26 = 56 652 570

From 1999 the municipality made a distinction between Moretusburg and the rest of Hoboken. For those soils in Moretusburg which have not yet been replaced it is still advised not to grow anything to be eaten. From 1999 to 2009 the population of Moretusburg was around 3000 ,or a tenth of the population of Hoboken. When we add this up to the debt for the whole of Hoboken up to 1999 we reach 58.8 million €[68]**.** For the other part of Hoboken, certain vegetables are allowed and others not. It is not pertinent here to try to calculate the debt of not being able to grow only a few vegetables but it is important to mention that the real figure is most likely higher than the one we calculate. In fact, the debt should be much higher when considering what UMICORE has been able to do with money it should have paid in compensation in the same period. From 1978 to 2005, spending on fresh vegetables for households increased by 91%, but in the same period the income from capital increased by 237%[69].

More evidence of the underestimation of our calculation comes from the fact that even in neighbouring communes like Kruibeke and Hemiksem, UMICORE's own research from 1996 showed that cultivating vegetables in these communities was dangerous for the health of children due to increased levels of cadmium[70]. The internal research was labelled confidential, but VODO was able to obtain copies. The report goes on to claim that "the concentrations of cadmium in the soil cause intolerable concentrations in beef. The lead concentration in the soil locally is too high to use groundwater untreated". In fact, the whole of Hoboken had been advised not to use groundwater since 1973. The authorities' ban on vegetable cultivation implies more than economic losses in view of the stress placed on families as they debated threats to their health and the prohibition of an activity they enjoyed. These examples all serve to illustrate that the real, total ecological debt is actually much greater when we look beyond the few aspects that we have calculated in detail. Based on the best available data and using the most cautious options and extrapolations, the total cost from loss of gardening capabilities from 1973 until today comes to **a minimum of 58.8 million €**.

6. Conclusion

In this paper we have tried to calculate the ecological debt for a single production unit. We have selected a large company where a large body of data on their pollution and externalities already existed. We identified a number of environmental damages that together form part of the ecological debt. Our list is neither exhaustive nor perfect, but the calculations of the external economic costs associated with UPMR production are based on the best available scientific references. We can make a distinction between the part of the ecological debt that has already been compensated by UMICORE, the part which needs compensation at present and the part that needs future research to determine the exact need for compensations. For this last part we have only made an estimation, based on the best available data at the moment,

[68] 2 178 945 + 56 652 570 = 58 831 515

[69] Statistics Belgium – Federal department of Economy (www.statbel.fgov.be)

[70] Cornelis (1996)

what the scale of the debt would be like if these official data for Hoboken are confirmed as linked to UMICORE.

The first part mainly consists of the 77 million euro UMICORE is spending on replacing the top soil and cleaning the streets and houses just around its production units in both Hoboken and Olen. This is the ecological debt for Hoboken and Olen which has already been paid back. One could add the payments they make to people who find holes in their PVC windows or cars and even the secret payments to farmers who find their cattle dead.

The second part consists of the costs associated with the diagnosis and treatments for children in Moretusburg (the Hoboken neighbourhood closest to the factory), which comes to almost 12 million **€** and the loss of capabilities due to the official health advice not to grow anything edible in the gardens of Hoboken, clearly related to pollution from UPMR, which comes at around 59 million **€**. Although the former figure is rather detailed and based on actual costs, the latter is based on an estimation of the cost of lost opportunities and needs to be seen within a certain range.

The third part of the ecological debt calculation that we made is the possible ecological debt, which still needs further scientific research. Based on actual costs per cancer patient and on the best estimate of the number of more than normal cancer patients we arrived at a figure of roughly 35 million **€.** If the link with cancer ever becomes confirmed by further research, we have also made a hypothetical debt calculation for the costs associated with the number of cancer patients who died. Using existing examples in a comparable context on the value of human life, we arrive at a rough estimate of 206 million **€.**

In order to put these latest potential ecological debt figures into their proper perspective, we have referred to the example of climate change, where similar indications have provoked further research and where actions are being taken before the 100% scientific guarantee has been given. We have also clearly pointed out that this result only gives us an idea of the scale of the problem, without pretending to be precise, nor complete. What matters more is the methodology we developed to reach this figure and its implications for action.

As we have shown in this paper, science confirmed decades ago that the effects of human exposure to a certain level of cadmium, arsenic, dioxin and lead are causing cancers and other health damages. A wide range of institutions and professional consultants have calculated in great detail how much the people around the factory in Hoboken have been exposed to levels of these toxic metals through thousands of measurements in air, water and soil. The results have consistently shown levels of toxic chemicals often dozens of times above the normal health standards. After decades of studies that prove that the factory is the source of this pollution, the company no longer denies this link. However, they do deny that there's a link between their pollution and the high incidence of cancer in the area. We do know from a detailed, but unpublished and unconfirmed, study based on patients' records that there is a

clear positive correlation between cancers and proximity to the factory[71]. Unfortunately the government or academic community was not ready to build upon their research to do the necessary standardisations. However, we see the same correlation between distance to the factory and lead blood levels from an official 32 year ongoing half-yearly analysis of lead in blood of toddlers who go to school in Moretusburg.

The clearest indication comes from the official cancer registry for Belgium: it clearly shows a remarkably higher incidence of cancers in Hoboken compared with neighbouring municipalities, Flanders or the heavily polluted city of Antwerp. There are even strong indications that the especially higher incidence of lung cancer is caused by UMICORE as their own documents state that the exposure to certain chemical would rather lead to lung cancer then other cancers. All this empirical data only confirm that what international literature has already agreed upon, also could count for Hoboken. It seems that the only thing we do not know at present is the exact number of cancers the pollution from the factory has caused, but we can make a good estimate, based on the best available data. However, cancer is only part of the story. Many other diseases and loss of capabilities have a proven direct link with pollution from the factory. We have only dwelled upon a few of them, where no further scientific research is necessary because the link is already clear. The recognition of the important scale of the problem should lead to the implementation of a large-scale study to the exact extent of the health damage and to identify the victims.

As with the problem of climate change, we should not wait until the precise extent of the damage or the exact percentage of human involvement becomes clear before we take some urgently needed action. Large polluting industries carry a large environmental liability. The people of Hoboken are now paying the external costs of production in the UMICORE factory. It is encouraging that the company has made great efforts to eliminate excessive emissions, lowering the source of the problem substantially. It is also encouraging that the company has already started to pay back a part of its ecological debt. However, victims of UMPR's past excesses have a right to claim compensation for the often drastic damages and losses of capabilities they suffered. UMICORE does not stand alone in this kind of production and implicit consequences for the local environment. We have to recognise that this way of production in general is not sustainable and a drastic change is needed. Business and industry should stop manufacturing uncertainty on the external costs they create. Companies have to do everything they can to stop provoking further external costs and at the same time, they should internalise the external costs they have already accrued.

Finally, this study should not be seen as a critique of UMPR's efforts so far to address its environmental legacy. It should be viewed instead as a source of opportunity for UMPR to become one of the first companies in the world to fully acknowledge its past, present and future responsibilities for environmental and social matters. UMPR now has the chance to take a true leadership role by accepting the notion of ecological debt and mainstreaming both ecological modernisation and corporate accountability within the chemical industry.

[71] Baekelandt (1998)

Recommendations

*to UMICORE and the Chemical Industry in general

- Recognize that a history of production can leave an ecological debt behind.

- Initiate the creation of a Fund that can compensate victims of Lead, Arsenic and Cadmium related diseases by mobilizing the chemical industries in Flanders that cause these emissions. A template might be the fund of the Asbestos industry that already compensates asbestos victims.

- Continue with efforts to reduce the emissions of toxic metals until the levels are not only below agreed world norms (political negotiations) but as low as real health norms require. Continued research and innovation is necessary, but if studies already show for example that children's sexual development is hampered even at much lower levels than current norms, such external damages cannot be tolerated.

- Continue working for a level playing field at the international level, lobbying for this in international institutions. Leysen's presence in The World Business Council on Sustainable Development provides a good opportunity to not only to press for better environmental laws globally, but also to lead by example.

*to the Government of Flanders

- Initiate a large, multidisciplinary, specialised epidemiological study of the health effects of UPMR on *all* inhabitants of Hoboken, and other sites where the chemical industry is active.

- Work on stronger legislation to keep norms for emissions in line with the latest scientific knowledge on the health impacts of these emissions, without prioritising economic arguments. Protection of the life and health of citizens is non-negotiable.

- Ensure corporate accountability instead of counting on corporate responsibility. Regulatory instruments should ensure obligation rather than only voluntary responsibility, including penalties for non-compliance

- Participate in the active diffusion of the concept of ecological debt.

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ANNEX 1

This is one of the four tables used to calculate the costs for treating children with increased health risks due to increased lead in blood. The other three tables are nursery school (fall), lower secondary (spring) and lower secondary (fall). All are based on the half-yearly measurements from the official PIH. The calculations are explained below.

	CDC risk level											
nursery school (spring)	I	II	III	IV	total sample size	average leadlevel (µg/dl)	total cost (see table 3) in euro	average cost per patient in euro	average cost per patient/average leadlevel	total/sample size	Multiplication factor	extrapolation to total cost
1978					83	33,5	166830	2010	60		1,00	166830
1979					43	36,3	93654	2178	60		1,00	93654
1980					44	34	89760	2040	60		1,00	89760
1981					28	25,4	42672	1524	60		1,00	42672
1982					31	33,7	62682	2022	60		1,00	62682
1983					38	34	77520	2040	60		1,00	77520
1984					41	27,3	67158	1638	60	93	2,27	152334
1985					48	29,8	85824	1788	60		1,00	85824
1986					35	26,4	55440	1584	60		1,00	55440
1987					33	23,5	46530	1410	60		1,00	46530
1988					28	23,5	39480	1410	60	92	3,29	129720
1989					33*	25,1*	49698	1506	60		1,00	49698
1990					38	26,7	60876	1602	60	77	2,03	123354
1991					51	21,2	64872	1272	60	82	1,61	104304
1992	2	19	25	0	46	19,9	86269	1875	94	75	1,63	140657
1993	0	16	40	0	56	23,8	133313	2381	100	73	1,30	173782
1994	2	15	18	0	35	20,5	62587	1788	87	73	2,09	130538
1995	3	20	14	0	37	19,2	51348	1388	72	62	1,68	86043
1996	0	11	21	0	32	24,4	70754	2211	91	64	2,00	141509
1997	0	9	12	0	21	20,5	41230	1963	96	34	1,62	66754
1998	1	13	8	0	22	19,3	29697	1350	70	37	1,68	49946
1999	2	17	9	0	28	17,6	34240	1223	69	41	1,46	50137
2000	1	16	4	0	21	15,1	17720	844	56	36	1,71	30378
2001	6	21	2	0	29	13	13511	466	36	50	1,72	23295
2002	1	24	3	0	28	15,7	16860	602	38	50	1,79	30108
2003	11	26	3	0	40	11,7	18947	474	40	65	1,63	30790
2004	6	27	1	0	34	12	12063	355	30	59	1,74	20932
2005	8	20	7	0	35	13,9	29592	845	61	59	1,69	49883
2006	22	20	1	0	43	9,7	12399	288	30	57	1,33	16436
2007	16	5	0	0	21	7,9	3869	184	23	47	2,24	8660
2008	15	8	0	0	23	9	4603	200	22	47	2,04	9405
	96	**287**	**168**	**0**			**1641999**		**60**			**2339573**

*: average compared to previous and next year

The first step was to make an overview of all the cases classified in CDC risk level classes by the PIH since 1978. However, from 1978 to 1991 the PIH research used an older CDC classification in use in those days. Conversion was not possible, but a solution to this problem was found.

Let us start with the easier part from 1992 to 2008. Based on the number of cases in each CDC class it was possible, by using table 1 adapted from the cost of illness handbook, to calculate the total costs of treating these patients. In the spring of 2006 for example, the total cost for the nursery students comes to 12399 euro, based on 43 cases with an average lead in blood value of 9,7 µg/dl. The total student population that spring was 57. By multiplying the 57/43 rate with the total cost, we get a reasonable estimate of the total cost for all nursery students in the spring of 2006: 16436 euro.

The next step was to find a solution for the period before 1992. The 6-monthly reports from the PIH did mention the average lead level in blood from 1978 up to 2008. By dividing the total cost with the sample size we could calculate the average cost per patient. We then divided this result by the average lead level for that year. The idea is that the higher the average lead level, the higher the total cost so there must be some rate. This rate should therefore give us an idea of the cost in the years before 1992, from which we have the average lead level. It turned out that when calculating this rate for the years 1992 to 2008, the rate was 60 on average both for all the spring results from 1992 to 2008 as for the fall results from the same period. We then used this rate to calculate the cost for the years before 1992. A careful observer will notice that this is in fact most likely an underestimation because the table clearly shows that rate actually increased with higher average blood levels, never being under 60 in the years 1992 to 1999. Therefore, applying this rate of 60 for the previous years, where lead levels were even higher, is almost certainly an underestimation of the real costs.

In addition to these calculated costs, it turned out that doing the 6 monthly research itself has cost 387 500 euro (12 500 euro for every year). These costs, together with the 50 000 euro from a one-time-only bigger research on the issue in 1984 have already been included in the total figure.