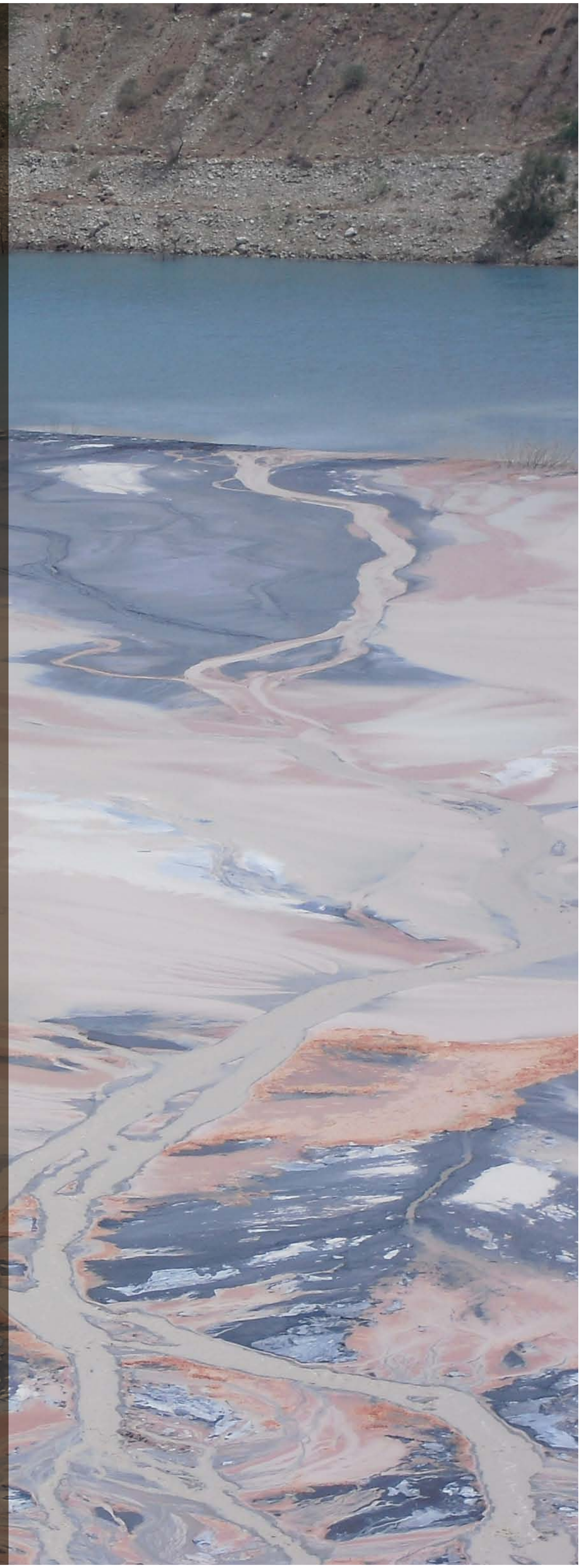
BLACKSMITH INSTITUTE

The World's Worst Pollution Problems:

Assessing Health Risks at Hazardous Waste Sites



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This report is available online at
www.worstpolluted.org

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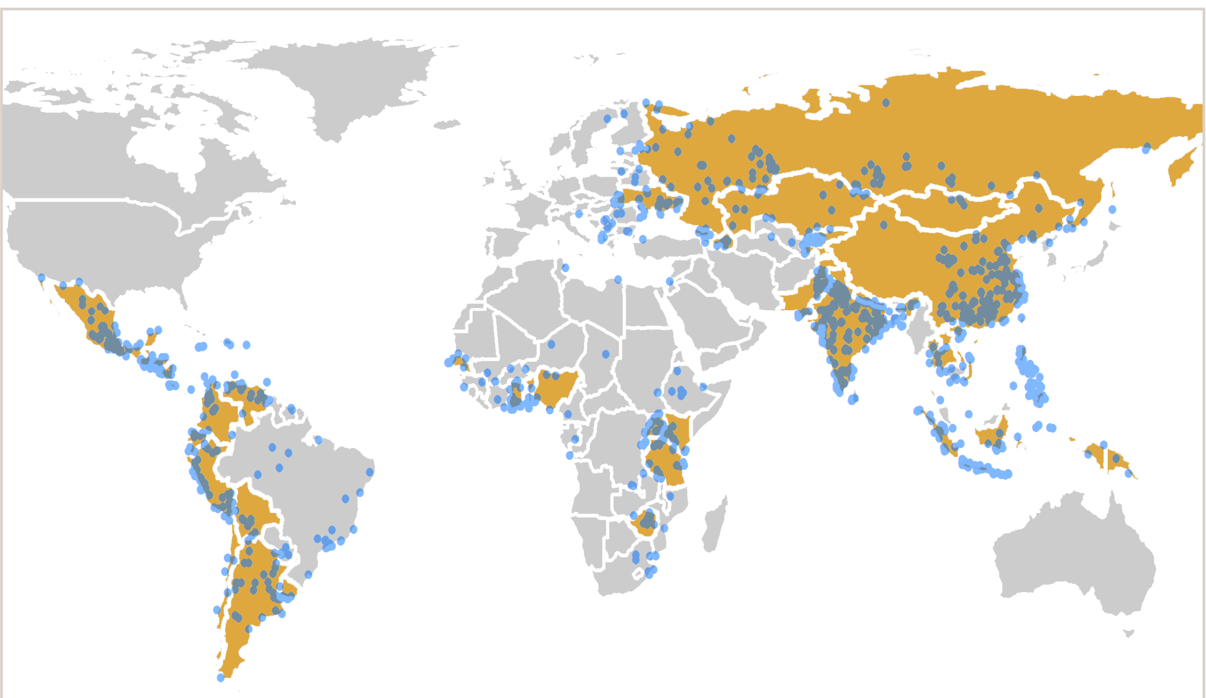
EXECUTIVE SUMMARY

The World's Worst Pollution Problems: Assessing Health Risks at Hazardous Waste Sites report reveals that close to 125 million people are at risk from toxic pollution across 49 low to middle-income countries. Also, the report, for the first time estimates the total global burden of disease attributed to toxic pollution from industrial sites in these countries. It establishes the global burden of disease from toxic pollution as on par with better-known public health problems such as malaria and tuberculosis.

Previous World's Worst Pollution reports have ranked pollution sources by the potential number of people at risk (2010) and created disease burden estimates for location-specific case studies (2011). This year's report is the first attempt at creating a widespread estimate of disease burden attributable to toxic pollution from industrial sources. Previous estimates from these reports indicated that the at-risk population was in the range of 100 million people. Over the past year Blacksmith Institute's extended efforts in new countries identified hundreds of more toxic pollution sites. Based on this work, we are certain that the types of issues we look at affect millions more than we could previously confirm. It is important to note that this number is necessarily an underestimate of some magnitude and we anticipate these numbers growing significantly as more sites are identified.



Based on Blacksmith Institute's investigations and observations, as well as the research of others, it is clear that the impact on health in low and middle income countries from these sites is very significant and likely higher than in the developed world.

There are several general underlying reasons for this:

- Poor regulation and oversight of those industries using hazardous substances and generating hazardous wastes
- Poor practices for control of hazardous wastes and emissions, coupled often with poor or no technology for management and treatment of wastes and emissions
- The presence of hazardous industries close to or within densely populated areas
- The local communities and industry operators limited understanding of the potential health impacts from exposure to hazardous wastes and emissions.
- The large role of small-scale enterprises in emitting toxic substances. These operations are often in the informal economy and have limited financial resources to implement best practices.

This year's report extrapolates from Blacksmith Institute's existing database of contaminated sites and creates a Top Ten List of Industrial Sources ranking industries based on the contribution of toxic pollutants to the global burden of disease. The sources of industrial pollutants presented in the 2012 report are placed in broad categories used by the Blacksmith Institute's database and may differ slightly in name only from past reports. All source types are comparable to past reports.

TOP TEN LIST BY DALY (DISABILITY-ADJUSTED LIFE YEAR)

RANK	INDUSTRY	DALYS
1.	Lead-Acid Battery Recycling	4,800,000
2.	Lead Smelting	2,600,000
3.	Mining and Ore Processing	2,521,600
4.	Tannery Operations	1,930,000
5.	Industrial/Municipal Dump Sites	1,234,000
6.	Industrial Estates	1,060,000
7.	Artisanal Gold Mining	1,021,000
8.	Product Manufacturing	786,000
9.	Chemical Manufacturing	765,000
10.	Dye Industry	430,000

Blacksmith Institute found that the public health impact of industrial pollutants, measured in DALYs, is the same or higher than some of the most dangerous diseases worldwide. Below is a comparison of the DALYs for HIV/AIDS, tuberculosis and malaria to the DALYs from industrial pollutants.

DALYS COMPARISSON

Industrial Pollutants	17,147,600
Tuberculosis	25,041,000
HIV/AIDS	28,933,000
Malaria	14,252,000

These numbers are by no means conclusive but can be taken as indicative of the potential scale of the problem. Appropriately, large amounts of time and resources are devoted to addressing the burden of HIV/AIDS, tuberculosis and malaria. The striking fact is that international and local government action on these disease burdens greatly outpaces the attention given to toxic sites; which, as demonstrated in this report, contribute greatly to the global burden of disease.

INTRODUCTION

ABOUT THE REPORT

The 2012 World's Worst Pollution Problems Report sets out to quantify the human health impacts from major sources of hazardous pollution in low to middle-income countries. In particular the focus is on sites in the developing world where toxic pollution has occurred because of industrial activity.[1] This evaluation of industries and pollutants is based on data collected by the Blacksmith Institute and Green Cross Switzerland through investigations of pollution hotspots around the world, principally abandoned ("legacy" or "orphan") sites and informal artisanal activities. This report is compiled using analysis of the Blacksmith Institute's site database and a review of industry research, statistics and peer-reviewed studies.

In 2011, the Blacksmith Institute and Green Cross Switzerland published a report that began to quantify the burden of disease from industries using a single site, beginning the process of measuring health impacts. This report revisits that process but goes a step further. Using additional data the 2012 report estimates the total health impact from toxic industrial pollutants in 49 countries in the developing world, extrapolating health impacts to provide a better understanding of the true scope of the issue. Within the last year the Blacksmith Institute has investigated and analyzed hundreds of additional sites around the world and initiated in depth research on the process of estimating the global burden of disease from hazardous waste sites.[2] That information and research has produced increasingly more accurate estimates that get closer to reflecting the impact of toxic substances on people in the developing world.

The goal of this report is to identify and quantify the contribution to the global burden of disease of the most significant pollutants and industry sectors in low and middle-income countries.

SCOPE OF THE PROBLEM

Blacksmith Institute currently estimates that the health of some 125 million people is at risk from toxic pollution globally. Previous estimates had indicated that this number was in the range of 100 million, but the investigation of hundreds of additional sites over the past year has expanded the estimation of the impact.

Hazardous waste sites in the U.S. and around the developed world have been extensively documented and are now closely monitored by national agencies such as the U.S. Environmental Protection Agency (EPA). Similarly, mining and industrial processes and their related wastes and emissions are typically tightly

1 Neither this report nor Blacksmith Institute evaluates all forms of hazardous pollution. Many serious forms of hazardous pollution, such as indoor air pollution and carbon pollution are not addressed in the report and are outside the scope of Blacksmith's work.

2 Ericson et al 2012. "Approaches to systematic assessment of environmental exposures posed at hazardous waste sites in the developing world: the toxic sites identification program." Environ. Monit. Assessment, May 17. (Epub ahead of print). Environmental Monitoring and Assessment.

regulated. However, in the developing world, the prevalence of hazardous pollutants and their resulting health impacts have generally not been investigated in depth. There are many toxic contamination sites from previous industrial or mining activities as well as many active industrial and mining sites that continue to pollute the surrounding environment.

Based on Blacksmith Institute's investigations and observations, as well as the research of others, it is clear that the impact on health in low and middle-income countries from these sites is very significant. For example, 98% of adults and 99% of children affected by exposure to lead live in low- and middle-income countries.[3] To exacerbate the problem, the expanding production of high-volume chemicals is increasingly being transferred to developing countries. The Organization for Economic Cooperation and Development (OECD) has estimated that the global output of chemicals in 2020 will be 85% higher than in 1995, and nearly one-third of the production will take place in developing countries, compared to about one-fifth in 1995.[4]

Populations of developing countries are particularly vulnerable to toxic pollution resulting from industrial processes. At the local level, participants in small-scale industries often do not have knowledge of best practices or may not be aware of the toxicity of the chemicals and processes they use. Poor communities, in which small-scale industries are often located, have little ability, either financially or culturally, to take measures to reduce their risk of exposure. Additionally, these communities have limited or no health care infrastructure that can address the health effects of toxic pollution. To further exacerbate the health risk, poor communities often have low overall standards of health, due to poor nutrition and other causes, which increase health risks and impacts from toxic substance exposure, particularly for children.

At the governmental level, the reasons are more complex. The World Health Organization (WHO) and UN Environment Programme (UNEP) Health and Environment Linkages Initiative project found that barriers to addressing environmental pollution are economic, institutional, political and social in nature and include trade globalization, market liberalization, debt burdens and structural adjustment policies.[5] Governments may view environmental regulation as a barrier to development and environmental systems supporting livelihoods are not considered in economic equations. As more research is published and links between health impacts and environmental pollution are better understood, the connection between poorly managed economic growth and human health needs to be appropriately accounted for. Making the connection between economics and human health is easy – the cost of illness and the loss of productivity due to disease and death is a huge and preventable economic burden.

In order to make this connection, it is essential to begin the process of quantifying the public health burden. This report examines the health burden that toxic pollutants put on human populations, specifically covering those pollutants associated with the contaminated sites that are the focus of Blacksmith Institute and Green Cross. Broad air and water pollution from sources such as urban emissions and poor sanitation

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3 "Global health risks: mortality and burden of disease attributable to selected major risks." World Health Organization. 2009.

4 Health & Environment: Tools for effective decision-making." The WHO-UNEP Health and Environmental Linkages Initiative. World Health Organization and United Nations Environment Programme. 2004. Available at: http://www.who.int/heli/publications/brochure/en/index.html

5 Ibid.

are not considered. Additionally, occupational exposures and risks are not addressed, since these are the mandate of local regulatory agencies. While these other sources contribute greatly to human health risks, they are well recognized and being addressed by other agencies and groups. The work summarized here on pollution and health is not being undertaken by other agencies and is intended to fill a very important knowledge and research gap.

Other considerations have also narrowed the scope of the report. The investigated sites making up the Blacksmith Institute's database are located only in countries where political and logistical considerations allow for routine and safe access for investigators. The discussion of impacted geographic regions in the report is by no means complete and only represents the current sites investigated by Blacksmith Institute. Financial limitations constrain our ability to investigate sites in all countries as well; so the countries that are chosen are considered to be representative of similar low to middle-income countries. In addition, the current lack of reliable human-based studies on the health impacts of pollutants has limited our ability to quantify the health effects of certain toxic pollutants. Despite the intent to achieve wide coverage for low and middle-income countries, these constraints have led to some important omissions. These geographic, financial, political and information limitations mean that the global burden of disease represented in this report is almost certainly underestimated.

TOXIC POLLUTION AND HUMAN HEALTH

The WHO has estimated that environmental exposures contribute to 19% of cancer incidence worldwide.[6] Additionally, a WHO Global Health Risks report looked at five environmental exposures, (unsafe water, sanitation and hygiene, urban outdoor air pollution, indoor smoke from solid fuels, lead exposure and climate change), and estimated they account for nearly 10% of deaths and disease burden globally and around one quarter of deaths and disease burden in children under the age of five.[7]

The connection between pollution, notably toxic substance pollution, and human health has long been made in the developed world. Incidents such as Love Canal, a hazardous waste site in New York causing illness in the 1970s, brought industry pollutants and their effect on human health to prominence in public health studies. However, these connections between toxic pollution and human health have largely not been made as clearly in the developing world.

The lack of investigation and quantification of the human health impacts of contaminated sites have left an often-marginalized population with few resources to address this growing problem. Sadly, health impacts from environmental pollution often affect the most vulnerable, especially children, within these already neglected populations. The objective of the work of the Blacksmith Institute and Green Cross Switzerland and one goal of this report is to give a voice to this marginalized population that is in danger from toxic pollutants.

6 Vineis, P. and W. Xun. "The emerging epidemic of environmental cancers in developing countries." Annals of Oncology 20: 205–212, 2009.

7 Global health risks: mortality and burden of disease attributable to selected major risks." World Health Organization. 2009.

WHAT CAN BE DONE?

Mining and industrial production are critical drivers of global GDP. According to 2012 data from the CIA World Fact Book, these industries currently contribute over 30% to world GDP. Industries also contribute greatly to the improvement of the human condition and advance society as a whole. However, should be recognized that the amount of pollution produced in these processes is unsustainable unless great efforts are taken to minimize and control pollution and waste; particularly in developing countries where advanced control technologies and "green" manufacturing practices are less prevalent. Major toxic environmental pollution problems are generally preventable and markedly easier and more economical to prevent than to clean up. This report is intended not only to identify the problems, but also to explore some of the solutions that currently exist, as they are many and varied.

While many countries and many industries have made great strides to reduce and prevent hazardous pollution, there remains a vast, dispersed and tragic legacy of toxic waste and a continuing problem of hazardous substance pollution. More can and should be done. Governments in developing countries are often constrained by political and economic forces, reducing their ability to address environmental pollutants. The Blacksmith Institute and Green Cross Switzerland endeavor to partner with local entities and industry leaders to implement cost effective solutions that rely upon proven technologies, both to prevent and to remediate pollution problems. For each industry sector discussed in the report, a typical example of remediation solutions and a discussion of preventative actions are presented. These solution examples show that these quantified risks can be reduced; and our intent is to move people, governments and industries to action.

GLOBAL BURDEN OF DISEASE AND DALYS

It is clear that human exposure to hazardous pollutants is a very large public health problem. However, the ability of public health professionals to quantify this problem has been constrained by several factors.

In order to quantify health impacts related to pollutants there are numerous information inputs needed, including: amount and length of exposure, size of population, type of pollutant, and the type and severity of health impacts per unit of pollutant exposure, (known as the dose-response relationship). For many of the pollution problems presented in this report, verifiable data on each of these inputs is not fully available, and in fact may be very limited. For example, dose-response data from human studies is sometimes limited because of the ethical inappropriateness of doing studies on humans, so data must be inferred from animal studies. In addition, observation studies of exposed populations are not often done because of the difficulty in isolating one cause for a disease in a population and the difficulty of obtaining community-level data on the extent of pollution and the local population that may be exposed.

The WHO is carrying out ongoing work to calculate the global burden of disease from all causes, by specific cause. Other researchers have sought to specifically calculate the burden of disease from defined chemical exposures.[8] This is done using a WHO-developed indicator that estimates the burden of disease on the basis of a Disability-Adjusted Life Year or DALY. The burden of disease – measured in DALYs – quantifies the gap between a population's current health and an ideal situation where everyone lives out their full life expectancy in good health.[9] This tool was developed as a way to quantify the effects of disease and compare the level of impact for various diseases and adverse health causes. The results give signals about the causes, effects and level of impacts of certain diseases to health and environmental policy makers.

In the last year the Blacksmith Institute and Green Cross Switzerland have been using field studies and expertise in pollution analysis to prepare estimates on the contribution of industrial toxic pollutants to the burden of disease. The estimates in this report are based on information collected through the Blacksmith Institutes Toxic Sites Identification Program (TSIP). This program is an ongoing process to identify and screen contaminated sites in low and middle-income countries. The goal of TSIP is to identify point-source pollution coming from contaminated sites that present a risk to public health. The TSIP database includes information on the concentration of key chemicals, the primary environmental media causing the exposure pathway and the size of population at risk. Building on this primary source data, it has been possible to use information and relationships with the WHO, the IRIS database of the US EPA, Health Canada, the US Agency for Toxic Substances and Disease Registry, the US Center for Disease Control, and various epidemiological studies to estimate disease incidence and severity associated with exposure to toxic pollutants.

CALCULATING THE GLOBAL BURDEN OF DISEASE IN — *DISABILITY ADJUSTED LIFE YEARS (DALYS)*

Using all of the above sources and extrapolating from current data coverage to a larger scale, a global DALY for the selected 49 low and middle-income countries was estimated for each of the top polluting industry sources and contaminants presented in this report. These DALY estimations are clearly limited in their accuracy by the data available. However, these ranges are becoming more accurate as better information is obtained from pollution sites all over the world. The calculations revealed in this report were produced and reviewed by members of the Blacksmith Institute's Technical Advisory Board, a group of technical experts with many years of experience in the field of pollution and public health. Blacksmith will continue to expand upon these calculations in upcoming research and published reports.

In this year's report we attempt to estimate the disease burden from contaminated sites in 49 countries in the developing world. We express these estimates in a commonly utilized measurement called Disability Adjusted Life Years (DALYs). We then provide context for these DALY estimates by comparing them with DALY estimates for other well-known public health threats, such as malaria and tuberculosis.

DALYs represent the sum of two other calculations, Years of Life Lost (YLL) and Years Lost to Disability

8 Prüss-Ustün et al. "Knowns and unknowns on burden of disease due to chemicals: a systematic review." Environmental Health 10:9. 2011. Available at: http://www.ehjournal.net/content/10/1/9

9 Global health risks: mortality and burden of disease attributable to selected major risks." World Health Organization. 2009.

(YLD). The first of these, YLL, attempts to capture the number of years lost to early death that results from a given disease. As an example, if an individual with a life expectancy of 85 years contracts liver cancer at 50 and dies at 55, he would have lost 30 years to the disease. His resulting YLL would therefore be 30.

YLDs by contrast attempt to capture the affect of a disability on an individual while he is alive. The World Health Organization (WHO) assigns a certain "Disability Weight" (DW) to each disability. The DW is an approximation of the relative impact of a given disease on a given year of life, and ranges from 0 to 1. More mild disabilities are given low DWs (for example moderate hearing loss has a DW of .04), while more severe disabilities are assigned higher DWs (blindness resulting from onchocerciasis, a parasitic disease, has a DW of .594). DWs are then multiplied by each year lived with the disease to determine YLD. In the example above, the individual that contracts liver cancer at 50 and dies at 55, would have lived 5 years with the disease. Because liver cancer has a DW of 0.20,[10] the person would have a resulting YLD of 1 (5 x .20). As we have already seen, the YLL was 30. Therefore the resulting DALY for this individual would be 31 (30+1).

APPLYING DALYS GLOBALLY

In our analysis we attempt to apply this methodology to populations living near contaminated sites in 49 different countries, where primary data is available. These populations range widely in size and demographic composition. Moreover, health data at nearly all sites is very limited. We therefore rely on a number of key assumptions to estimate the likely disease burden at these sites.

The first such assumption relates to global scale of the problem. Since 2009, Blacksmith Institute has been working with partners in 49 countries to identify and assess contaminated sites. Through this work, we

10 This DW reflects the diagnosis/ therapy DW only. Metastasis and terminal stages each have separate DWs. For purposes of clarity only the .20 DW is used here.

have compiled one of the world's most comprehensive databases of polluted sites. This effort has not been equal in all countries. Some countries have relatively high quality national databases that have resulted from the process, while others are only beginning to get started. In those cases where more comprehensive databases exist, estimating the potential number of additional sites was somewhat straightforward. A small multiplier was used to try to capture sites not yet identified or assessed. In the countries where very few sites have been identified it was more difficult to determine the potential number of total sites. Various factors such as GDP, types of industry, and level of industry were all taken into account in developing these estimates. To compensate for a considerable number of unaccounted variables, estimates are kept very conservative. By way of example, the total number of potential sites in 49 countries provided in this report is about 10,000, or about 1/30 of the total number of sites requiring remediation in the US.[11]

A second major assumption relates to disease rates and demographics at given sites. There have been relatively few epidemiological studies carried out at hazardous waste sites, complicating predictions of disease incidence. Additionally, only basic demographic assessments are carried out as part of the site screening process. For the purposes of estimating disease incidence and death rates, this report relies on models currently being developed by Blacksmith Institute and due for publication in 2013. For the purpose of determining demographic information, national population pyramids were applied to individual sites.

The population and DALY estimates in this report are intended to be indicative rather than conclusive.

THE POLLUTANTS

The generation of the list of industry sources was based on an analysis of toxic pollutants found at the source sites and a projection of their related human health impacts. The list sets out the most significant industry sectors based on these toxic pollutants, ranked by estimated health impacts. A short discussion of some of the major pollutants found at the sites is presented below, included is a description of the toxic pollutant and a discussion of its uses and health impacts.

Pollutant types examined in the 2012 report only include those with measurable health outcomes whose contribution to DALYs can be calculated. Lead, chromium, mercury, and asbestos are the toxic pollutants highlighted below. These pollutants have quantifiable health outcomes that are given disability weights by the WHO. Toxic pollutants without established health outcomes recognized by the WHO cannot be quantified by a DALY measurement and were not included in the burden of disease calculations. Those identified in past years but not specifically measured in this report include cadmium, pesticides, radionuclides and arsenic. Pesticides and radionuclides are briefly discussed in the Remaining Five Sources section. Arsenic contaminated groundwater is one of the world's larger environmental health risks. Hundreds of millions of people in South and Southeast Asia use water containing very high levels of arsenic

11 USEPA has estimated that some 294,000 contaminated sites require cleanup in the US. Compare this with the estimate of ~10,000 for the 49 countries listed in this report. See for example: United States Environmental Protection Agency (EPA). 2004. New Report Projects Number, Cost and Nature of Contaminated Site Cleanups in the U.S. Over Next 30 Years. Available: http://www.epa.gov/superfund/accomp/news/30years.htm [accessed 31 May 2012].

for their daily needs. The source of the arsenic is naturally occurring high background levels. This can be somewhat aggravated by the use of shallow hand dug wells or by over utilization, but is fundamentally a naturally occurring phenomenon. Blacksmith Institute is focused on mitigating toxic exposures resulting from industrial processes. Therefore, after careful consideration, Blacksmith Institute decided in 2012 that arsenic contaminated groundwater would no longer be covered, and data relating to this issue would no longer appear in the annual report.

POLLUTANT: LEAD

Lead is a metal that is found in various ores and is used in many different products. The toxic properties of lead are well documented yet it is still used in varied and important ways within the world economy because of its dense, corrosion-resistant, and malleable characteristics.[12]

SCOPE AND NATURE OF PROBLEM

Lead is the most pervasive pollutant found in the Blacksmith Institute's database and is a well-documented health hazard. The Blacksmith Institute has identified over 500 sites polluted by lead, putting an estimated 16 million people at risk. Based on the Blacksmith Institute's investigations, the top sources contributing to lead pollution, by population, are lead smelting, mining and ore processing, industrial estates and lead-acid battery recycling and manufacturing. Lead pollution is also found in polluted sites around product manufacturing sites, e-waste recycling and chemical manufacturing sites. In the U.S., lead is most predominantly used for manufacturing lead-acid batteries.[13] But around the world lead is used in many different industrial-manufacturing processes for plumbing materials, alloys, paints, ammunition, and in a limited amount of countries, as a lubricating agent in gas.[14] This extensive list illustrates the widespread problem of lead pollution.

The majority of lead contaminated sites in the Blacksmith Institute's database are found in Africa, South America, South and Southeast Asia, but the problem of lead pollution plagues most developing countries worldwide. Its uses are varied; in Latin America it has often been utilized for ceramic glazing and in other countries leaded gasoline is still used. In the U.S. lead paint is the cause of a majority of lead exposures and such exposures can be expected in most countries since paint pigments using lead were commonly used worldwide up until a few decades ago.[15] Global production of lead was expected to increase 9% in 2011 to 4.52 million tons, due to increases in China, India and Mexico, with China accounting for one-half of

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12 USGS Minerals Information: Lead. "Lead Statistics and Information." U.S. Department of the Interior, U.S. Geological Survey, 16 Aug. 2012. Web. 20 Sept. 2012. http://minerals.usgs.gov/minerals/pubs/commodity/lead/

13 Ibid.

14 "Exposure to Lead: A Major Public Health Concern". World Health Organization. 2010. Available at http://www.who.int/entity/ipcs/features/lead..pdf

15 Fewtrell, LJ et al. "Lead: assessing the environmental burden of disease at national and local level." World Health Organization. *WHO Environmental Burden of Disease Series, No. 2.* 2003.

all lead mining production.[16] Increasing quantities of lead are being recycled. But often recycling occurs at uncontrolled or poorly controlled facilities in the informal economic sector, making lead reprocessing itself a significant problem in many countries.

Lead enters the environment through the air (as dust) and through water; the specific form of introduction varies depending on the industry or product.

HEALTH IMPACTS

When humans inhale or ingest lead it is distributed to the brain, liver, kidney and bones and can be stored in the blood, teeth or bones.[17] Because lead is an element, it cannot be broken down or destroyed; it accumulates in the body as long as a person continues to be exposed to it. Lead accumulation leads to neurological, gastrointestinal, and cardiovascular problems. Lead exposure during pregnancy can lead to miscarriage, stillbirth, low birth weights, premature births and birth defects.[18] The International Agency for Research on Cancer declares it to be a possible human carcinogen.[19]

Children are exceptionally vulnerable because their bodies absorb 4-5 times as much lead as adults; even at the lowest levels of exposure lead is toxic to children.[20] The brain damage resulting from lead exposure in children is untreatable and includes mild mental retardation, decreased IQ, shortened attention spans, loss of executive function, increased risk of dyslexia, and diminished productivity.

It is estimated that the effects of mild mental retardation and cardiovascular problems alone, caused by lead exposure, amount to almost 1% of the total global burden of disease, with developing countries carrying the largest burden.[21]

16 USGS Minerals Information: Lead. "Lead Statistics and Information." U.S. Department of the Interior, U.S. Geological Survey, 16 Aug. 2012. Web. 20 Sept. 2012. http://minerals.usgs.gov/minerals/pubs/commodity/lead/

17 Exposure to Lead: A Major Public Health Concern". World Health Organization. 2010. Available at http://www.who.int/entity/ipcs/features/lead.pdf

18 Ibid.

19 World Health Organization, 2006. International Agency for Research on Cancer (IARC). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans - Inorganic and Organic Lead Compounds. Available from: http://monographs.iarc.fr/ENG/Monographs/vol87/mono87-6.pdf

20 Exposure to Lead: A Major Public Health Concern". World Health Organization. 2010. Available at http://www.who.int/entity/ipcs/features/lead.pdf

21 Fewtrell LJ, et. al. "Estimating the global burden of disease of mild mental retardation and cardiovascular diseases from environmental lead exposure." Environ Res 94(2):120-33. 2004.

POLLUTANT: CHROMIUM

Chromium is a metallic element that occurs naturally in the environment in the form of trivalent and hexavalent chromium. Trivalent chromium, or chromium-3 can be found in fruits, vegetables, grains and meat and is considered a key part of the human diet.[22] Hexavalent chromium, or chromium-6 is naturally occurring through erosion of ore deposits, or is leaked into the environment by industrial processes. Chromium-6 is used in the manufacturing and processing of steel, alloys, plating, dyes, and leather and can be a very serious health risk. In certain environmental circumstances trivalent chromium can turn into hexavalent chromium, and vice versa, after being released into the environment.[23]

SCOPE AND NATURE OF PROBLEM

The Blacksmith Institute has identified over 150 sites polluted by chromium, putting more than 5.5 million people at risk of exposure from the sites identified. The top sources of chromium pollution, by at risk population, in the Blacksmith Institute's database are industrial estates, product manufacturing, mining and ore processing, tanneries, industrial dumpsites, chemical manufacturing and the dye industry. It also is found at e-waste recycling sites, petrochemical plants, and heavy industry sites.

The majority of the chromium-polluted sites in the Blacksmith Institute's database are in South Asia, mostly within Pakistan and India. However, given the prevalence of tanneries and mining in various African, South American and North Asian countries, Blacksmith expects chromium pollution to be found throughout the developing world. Chromium enters the environment as dust in the air or is leached into groundwater from unmanaged waste from ore processing sites. Chromium exposure occurs mainly through dermal contact with contaminated soil or water, inhalation of dust or soil, ingestion of food exposed to chromium through contaminated water or soil and direct ingestion of contaminated water.

HEALTH IMPACTS

The two types of chromium differ drastically in their level of toxicity. Chromium-3 in appropriate amounts is an essential nutrient, but can be harmful in large quantities. Chromium-6 is a known carcinogen and when inhaled has been proven to cause lung cancer in humans. There is less understanding of the human health impacts of ingesting chromium-6 in drinking water. Some recent studies have linked ingestion to an increased risk for stomach and lung cancer, but authorities have not officially recognized the health impacts from ingestion.[24] However, as recognition of the known toxicity of the element the U.S. EPA has issued standards limiting the level of chromium in drinking water.

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22 "Basic Information about Chromium in Drinking Water." U.S. Environmental Protection Agency. April 18,2012. Available at: http://water.epa.gov/drink/contaminants/basicinformation/chromium.cfm

23 "Toxicological Review of Hexavalent Chromium." U.S. Environmental Protection Agency. Washington DC. 1998 Available at: www.epa.gov/iris/toxreviews/0144tr.pdf

24 Smith, A, and C. Steinmaus. "Health Effects of Arsenic and Chromium in Drinking Water: Recent Human Findings." *Annual Rev Public Health.* 2009 April 29; 30: 107–122

POLLUTANT: MERCURY

Mercury is a naturally occurring metal that can exist in the elemental form (a liquid at room temperature) or as organic or inorganic mercury. It occurs in different mineral forms, including in association with coal. Emissions from the burning of coal are the largest source of mercury pollution in the air in the U.S.[25] Mercury in the atmosphere is a pollutant that travels globally and is of major concern, but this is outside the scope of Blacksmith Institute's investigations and is not addressed in this report. The use of mercury in mining and industrial operations, however, is a major problem addressed by Blacksmith Institute.

SCOPE AND NATURE OF PROBLEM

The Blacksmith Institute's database contains almost 350 sites contaminated with mercury, putting close to 10 million people at risk from the identified sites. It is the second most prevalent pollutant in the database. The top sources of mercury pollution are artisanal gold processing, mining and ore processing, coal mining, processing and localized air pollution related to coal combustion at poorly controlled sites, and chemical manufacturing, notably for older chlor-alkali plants making chlorine.

Artisanal mining of gold ores and processing using mercury is common worldwide. Mercury is used to recover gold from ores and is released into the environment through mine tailings after processing or as a result of evaporating mercury from gold-mercury amalgams to recover the metallic gold. Mercury is a bio accumulative toxin and will persist in the food chain. Under certain environmental conditions inorganic mercury can be transformed into the most toxic form of mercury, methyl mercury.[26] Human populations at polluted sites can be exposed through dermal contact with contaminated soil and water, ingestion of contaminated water, inhalation of dust and vapor and ingestion of contaminated food.

HEALTH IMPACTS

Mercury health effects depend on the type of mercury to which a person is exposed. In general, health impacts include renal toxicity, damage to the immune system, alteration of genetic and enzyme systems and neurological damage, especially in babies exposed in utero. Methyl mercury is the most toxic form of mercury because it is absorbed quickly in the body and expelled much more slowly.[27] Currently there is not enough human exposure data to make links between mercury and cancer.[28] Mercury health effects are difficult to quantify using WHO's approach because disability weights have not yet been assigned to the types of health impacts mercury causes. However, because of the prevalence and toxicity of mercury we have included it in the report.

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25 Mercury: Basic Information. U.S. Environmental Protection Agency. Washington DC. 2012. Available at: http://www.epa.gov/hg/about.htm

26 "Mercury in the Environment." U.S Department of the Interior U.S. Geological Survey. 2009 http://www.usgs.gov/themes/factsheet/146-00/.

27 Ibid.

28 "Mercury: Basic Information." U.S. Environmental Protection Agency. Washington DC. 2012. Available at: http://www.epa.gov/hg/about.htm

POLLUTANT: ASBESTOS

Asbestos refers to a group of silicate fibers that are naturally occurring in the earth. These fibers are used for their strength and flexibility, they can be bonded together to create products like insulation, roofing, shingles, tiles, paper products packaging, and car parts.[29] Asbestos is used heavily in building products because of its natural fire retardant features.

SCOPE AND NATURE OF PROBLEM

Asbestos is recorded in a small number of sites in the Blacksmith Institute's database, but potentially puts over 350,000 people at risk. Asbestos enters the environment through either mining of the mineral or through the use of products containing asbestos. Occupational exposure to asbestos is a major issue for people that work in industries that mine asbestos or make products out of asbestos. Exposure pathways are mostly from inhalation of airborne asbestos fibers.

Because of the large amount of information about the toxic nature of asbestos, it is tightly regulated in most developed countries. All new uses of asbestos were banned in 1989 in the United States and the use of asbestos in manufacturing, processing and distribution is closely monitored. However, despite bans in 52 countries, asbestos continues to be used in low and middle-income countries. White asbestos is used in cheap building materials in China, India, Russia and Brazil, while blue and brown asbestos are no longer used anywhere.[30] White asbestos is mined and processed in both the developed and developing world, with Russia leading asbestos production in 2008.[31] The World Federation of Public Health Organizations (WFPHA), the International Commission on Occupational Health (ICOH), and the International Trade Union Confederation (ITUC) have called for a global asbestos ban, especially since asbestos mining and processing plants in developing countries are often under regulated and lack necessary pollution controls. [32]

HEALTH IMPACTS

Asbestos affects the whole respiratory system. There are three serious health impacts, asbestosis, lung cancer and mesothelioma. Asbestosis is a serious, non-cancer form of lung disease. There is no treatment or cure for it and it causes shortness of breath.[33] Lung cancer is the leading cause of death from asbestos exposure. Mesothelioma, another type of cancer, affects the lining of the lungs, abdomen and heart; largely all cases of mesothelioma can be directly linked back to asbestos exposure.[34]

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29 "Asbestos." Toxic Substances Portal. Agency for Toxic Substances & Disease Registry.
Available at: http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=4

30 "Morris, J. and S. Bradshaw. Inside the global asbestos trade." BBC News World. July 2010. Available at: http://www.bbc.co.uk/news/world-10623725

31 Ibid.

32 Ibid.

33 "Asbestos: Basic Information". U.S. Environmental Protection Agency. Washington DC, 2012. Available at: http://www.epa.gov/asbestos/pubs/help.html

34 Ibid.

THE TOP TEN LIST

The Top Ten List presents the most significant industries, ranked by estimated global health impacts in low and middle-income countries.

The construction of the list is based on calculations of the health impact from pollutants found at sites investigated by the Blacksmith Institute and Green Cross Switzerland. These calculations were done using the Disability-Adjusted Life Years calculation as described in the Global Health Burden section. The ranking system for the 2012 report draws heavily on data from Blacksmith Institute's ongoing efforts to identify and evaluate pollution hotspots, which allows for more thorough analysis of pollutants, pathways, and affected populations. Whereas previous reports relied on a ranking process carried out by experts including Blacksmith Institute's advisory board, there is now primary data from extensive site assessments that can be used for estimating broad impacts. These estimates are extrapolations based on estimated at risk populations, limited health information and assumptions previously mentioned.

The industries and toxic pollutants included reflect the toxic pollution problems on which Blacksmith has been focused and those for which health information is available to date. The data on pollution problems in certain regions of the world is more complete than in other parts of the world. As such, the coverage in this report is not complete; it is only considered to be representative of the major problems. As Blacksmith continues to collect data on pollution sites throughout the world, the scope of this analysis will be broadened, and we will be able to more thoroughly quantify disease burden associated with toxic pollution.

SOURCE #1: BATTERY RECYCLING

Lead-acid batteries are rechargeable batteries that are most commonly used as car batteries. They consist of a plastic case surrounding lead plates emerged in sulfuric acid. Lead-acid batteries are rechargeable, but eventually the lead plate breaks down and the battery is spent. Spent lead-acid batteries are hazardous waste and their disposal is regulated in most industrialized countries. When lead-acid batteries are recycled the battery the plastic and metal are separated. The plastics are recycled and usually used to create more battery cases. The spent lead plates are smelted to remove impurities and poured into molds to create recycled lead bar.[35] Lead bars are used in the manufacturing of new lead-acid batteries, making the system a closed loop.

In low and middle-income countries recycling of these batteries is a large industry as the lead in the batteries can be reused in various product-manufacturing processes. Countries with few lead ore sources are eager to collect and recycle lead-acid batteries to build up their lead resources. The rising demand for automobiles in low and middle-income countries is driving the upsurge in demand for lead.[36]

Battery recycling contributes to almost 100 sites in the Blacksmith Institute's database, potentially putting almost one million people at risk. Geographically the largest numbers of polluted sites are in Southeast Asia, with Africa, Central and South America also contributing a substantial amount. In addition, it is known that battery recycling is also a significant industry in South Asia and China as well.

EXPOSURE PATHWAYS

According to the Battery Council International, 97 percent of lead-acid batteries are recycled. The risk of pollution in modern recycling plants is low because of strict environmental, health and safety standards, emission monitoring, stack scrubbers, dust control, and waste treatment. However, in the developing world informal recycling factories abound, set up by marginalized populations looking to capitalize on the growing market for recycled lead. In these informal recycling processes, lead-acid batteries are broken up using hand axes, metal smelting occurs out in the open or inside homes, and waste products are disposed of into the surrounding environment untreated.[37] In addition, lead-acid batteries are repaired and refurbished by cutting them open, cleaning the plates, removing the interior sludge and resealing the cases. This type of recycling also leads to the dispersion of lead into the environment.

Emissions released from the smelting and pouring of battery metals, fugitive dusts from battery breaking and unsafe disposal of waste are the main exposure pathways in informal battery recycling. When lead is smelted the fumes released condense into particulates, which can settle into the immediate surroundings

35 "Battery Recycling." Battery Council International.
Available at: http://www.batterycouncil.org/LeadAcidBatteries/BatteryRecycling/tabid/71/Default.aspx

36 "The Basel Ban And Batteries, A Teaching Case: The Basel Ban And Batteries."
Available at: http://www.commercialdiplomacy.org/case_study/case_batteries.htm

37 "Recycling in the Informal Sector." International Lead Association. London, UK.
Available at: http://www.ila-lead.org/UserFiles/File/Recycling%20in%20the%20Informal%20Sector.pdf

and fall into soil and waterways. Fugitive dust emissions also are deposited in the local area. Waste from these processes is often dumped into uncovered piles or directly into nearby waterways. Contaminants then leach into ground water and waterways used by local communities. The largest sources of exposure in the Blacksmith Institute's database are ingestion of contaminated soil, particularly children who often play in the dirt, ingestion of lead dust that has settled on food or inhalation of dust, soil or emissions.

TOP POLLUTANT(S)

The amount of lead and the highly toxic nature of the element make it the top pollutant at polluted battery recycling sites. Other pollutants include arsenic and cadmium. Lead causes a host of health problems and disproportionately affects children, causing developmental and neurological problems. Reference the health impacts of lead earlier in the report for more information.

GLOBAL BURDEN OF DISEASE

Blacksmith Institute found that lead exposure was the single largest pollutant contributing to DALYs in the 49 countries assessed. Even with the severe underestimate of the scale of the issue, Blacksmith estimates DALYs from the lead-acid battery recycling industry were nearly 5 million in the 49 countries investigated. As a comparison, STDs (with the exclusion of HIV/ AIDs) in the countries reviewed accounts for 6.7 million DALYs.

WHAT IS BEING DONE?

It is recognized worldwide that informal recycling of lead-acid batteries is hazardous and shipping batteries from developed countries to least developed countries for processing needs to be tightly regulated or prohibited. In 1989 The Basel Convention on the Control of Trans boundary Movement of Hazardous Wastes and their Disposal was negotiated through the UN. This convention regulates the shipment of hazardous materials from developed countries looking for cheap disposal options. The Basel Convention entered into force as an international agreement in 1992, but the United States has never ratified the treaty. [38]

Remediation and education efforts can be very effective in addressing already polluted sites and preventing future pollution. In Senegal in the community of Thiorye Sur Mer, Dakar, the main economic activity was informal used lead-acid battery recycling. The practice was unregulated and often done in open-air settings, exposing some 40,000 people to lead dust. In March 2008, Blacksmith Institute was contacted about the death of 18 children under age five in the neighborhood of Thiaroye-Sur-Mer in Dakar. These children all died from acute lead poisoning due to constant exposure to lead dust in the air, soil and water. Blacksmith tested 41 children's blood lead levels - 100% of the children tested presented levels over 10 µg/dl, the highest being over 150 µg/dl. Blacksmith Institute, the Senegalese government, the University of Dakar's Toxicology department, as well as the Senegalese Ministry of Health were engaged to address the problem. An educational program was undertaken in conjunction with local religious and village authorities to convey

38 "Basel Convention: Overview." UNEP and The Secretariat to the Basel Convention.
Available at: http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx

the dangers of exposure to lead dust. The local government initiated remediation efforts to treat the soil and surrounding environments and treat those people already exposed to lead. Policy changes are also in effect, targeted toward regulating collection, transportation, storage, and recycling practices. Following the joint intervention by Blacksmith Institute and its local partners, the contaminated area has now been cleaned up. Soil levels are now below 400 ppm (versus levels in excess of 400,000 ppm in some places. While children between ages of 1 and 5 years old were presenting blood lead levels in excess of 150 µg /dl in early 2008, the average blood lead level in that age group is now down to 53.457 µg /dl.

SOURCE #2: LEAD SMELTING

According to the Blacksmith TSIP database, there are an estimated 2.5 million people at risk at almost 70 polluted lead smelting sites investigated worldwide. Lead smelting is an industrial process that refines lead ores to remove impurity, using furnaces and through the addition of fluxes and other chemical agents. Primary lead smelting uses mined ores while secondary lead smelting reprocesses lead scrap and waste collected though various recycling streams. The primary source of lead ore is from the mineral galena, lead sulfide. In primary lead processing the lead ore is fed into furnaces along with other materials where the sulfur is burned off. The material is then heated in order to melt and separate the lead metal from slag and other byproducts. The lead metal is collected for refining and further processing depending on its final use. The slag is a waste material that contains zinc, iron, silica, lime, as well as some lead. In well-regulated processes, the slag will be recycled to prevent pollutants from escaping.

In secondary smelting, the lead-containing components must first be separated from the used product and then a similar smelting process is used. One of the largest sources of recycled lead materials are lead-acid batteries, but it can also be obtained from cable coverings, pipes, sheets or other metals containing lead. Secondary lead smelting can be done in a similar manner to primary but high lead content waste can be processed at relatively low temperatures and is sometimes carried out in informal, crude and highly polluting facilities.

EXPOSURE PATHWAYS

Lead released from the process can enter the environment through several different pathways. Air emissions can contain lead fumes, sulfur dioxide (a gas) and other various particulates. Fine dust particles can contain arsenic, antimony, cadmium, copper, and mercury as well as lead.[39] Pollutants also are found in water near smelting factories, where wastewater from smelting processes has been improperly disposed. Dust and slag can accumulate in soil and seep into ground water or food if agricultural fields are located near smelters. In smelting processes with few or no pollution controls, air emissions could contain up to 30 kg of lead per metric ton of lead produced.[40]

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39 "Lead and Zinc Smelting". *Pollution Prevention and Abatement Handbook.* World Bank Group. Washington, DC, 1998.

40 Ibid.

Currently, the Blacksmith Institute's database shows the bulk of smelting related lead pollution problems in sites in China, Eastern Europe, South America and Southeast Asia. Global lead consumption was expected to increase by about 6% in 2011 to 10.1 million tons, partly from a 7% increase in Chinese consumption.[41]

TOP POLLUTANT(S)

Lead is the largest contributing contaminant from lead smelting pollution and puts surrounding communities at risk for numerous health problems. As discussed above, there are multiple pathways for contaminants to enter the environment, since lead itself is the input and output of lead smelting. Other pollutants could also include mercury and cadmium.

GLOBAL BURDEN OF DISEASE

Blacksmith Institute estimates that the health of 4.5 million people in the countries included in the TSIP database are potentially at risk from lead smelting. These exposures were determined to result in 2.6 million DALYs in the 49 countries reviewed. In all 49 countries reviewed, lead was the single largest contributor to the disease burden, resulting in more than 13 million DALYs. As a comparison, tuberculosis accounts for about 25 million DALYs.

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41 USGS Minerals Information: Lead. "Lead Statistics and Information." U.S. Department of the Interior, U.S. Geological Survey, 16 Aug. 2012. Web. 20 Sept. 2012. http://minerals.usgs.gov/minerals/pubs/commodity/lead/

WHAT IS BEING DONE?

Modern pollution controls, environmental health and safety standards and precautions can be taken to greatly reduce the incidence of pollutants entering the environment from lead smelting. Newer processes use energy and sulfur more efficiently and the use of scrubbers and other types of stack pollutant controls can reduce pollutants in emissions.[42] These types of controls are widespread in developed countries; however, these controls can be expensive to implement and are not often found at facilities developing countries. Smelters are concerned about the cost of production and so avoid putting on expensive emission controls, even though there is often a payback for such controls over the long term due to the ability to capture and recover lead dust. Another common problem relates to maintenance and proper operation of emission controls. Finally, in lower income countries the industry is often under regulated and these types of controls are not required for operation. The informal so-called "backyard smelters" are a particular problem for regulators. These are often crude operations are difficult to locate and are often packed up and moved to avoid regulation. In some cases these can be upgraded but in other cases they need to be closed down and the operations transferred to a better facility.

Remediation efforts at lead smelters have been successful and there are well-tested standards for the collection and removal of lead contaminated soils. In Russia, the Rudnaya River valley and the neighboring town of Dalnegorsk, the second largest city in the region, were heavily polluted by lead. The population was exposed to high levels of lead contamination caused by lead transport and a local lead smelter. Although the lead smelter was closed soon after Blacksmith first started working there in 2007, over 50% of children tested in the region presented abnormally high blood lead levels. Blacksmith implemented an outreach program that included educational efforts, lead remediation, and medical aid. The project removed the most heavily leaded soil, which was put into environmentally sound landfills. A group of families with children who had the most severely elevated blood lead levels were given treatment to accelerate the expulsion of heavy metals from their systems. Additionally, over 5,000 families were educated on how to reduce exposure and impacts of lead. By identifying and cleaning up the areas most heavily frequented by children, blood lead levels have decreased significantly. By 2009, only two years after the start of the project, the number of children in Dalnegorsk with very high blood-lead levels dropped to 9%.

42 "Lead and Zinc Smelting". *Pollution Prevention and Abatement Handbook*. World Bank Group. Washington, DC, 1998.

SOURCE #3: MINING AND ORE PROCESSING

Mining and ore processing is an essential industry that supplies the minerals, metals and gems needed to produce a wide variety of products and materials. Metals are mined for use in a vast array of products with many essential uses. For example, lead is used for batteries and electrical, communication and transportation products. While copper is used for electronics and construction and iron is used as a base for steel and automotive products. Gold and silver are used for jewelry.[43] Mining is the process of removing ore, minerals, metals and gems from the earth. Mining is done through surface or open-pit mining, underground mining or through fluid mining. Open surface mining entails digging out or blasting rocks and creating open-pits in the earth, exposing mineral veins. This is the most common method for iron, aluminum, copper, gold and silver mining. As upper-level ore deposits are taken away, blasting is done deeper and deeper into the earth to reach lower deposits.

Underground mining entails cutting shafts into the earth and putting workers underground to excavate ore. Lead, antimony, chromium and zinc are obtained this way and often, coal, gold, silver and other metals.[44] The invention of new technologies, equipment and cheap energy has made surface mining the prevalent mining method for most substances now, except where ore veins are located far below the surface.[45]

Mined ore is removed from the earth and typically trucked to ore concentrating facilities, where it is crushed, washed and separated to obtain the minerals in the ore. For ores with a low concentration of the desired mineral, initial ore concentration is often done at or near the mine due to the volume of ore to be processed and the resulting cost of transport. After concentrating the ore, the metal or mineral is sent for more processing, smelting, refining or some other type of finishing. These processes require a diverse and varied amount of chemicals. The waste from concentrators is called tailings, and typically wet, contaminated with chemicals and/or metals and large in volume.

The mining and minerals processing industry have taken considerable steps to monitor, control and safely manage the use of chemicals necessary to the production processes and manage tailings in environmentally safe ways. However, in less technologically advanced or older plants, some of the minerals mined, tailings and the toxic chemicals used are released into the environment. Due to their hazardous constituents, they negatively impact human health. In addition, the problem of abandoned mines and legacy pollution is widespread.

In the Blacksmith Institute's database there are more than 350 sites polluted from mining and ore processing, potentially putting more than 6.7 million people at risk. Geographically the sites are located in most continents and in almost 50 countries. Africa, Eastern Europe and Southeast Asia are the regions most represented in the database, but certainly toxic pollution from mining and ore processing affects all regions of the world.

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43 "Profile of the Metal Mining Industry." U.S. Environmental Protection Agency. Washington, DC. 1995. http://www.epa.gov/oecaerth/resources/publications/assistance/sectors/notebooks/metminsn.pdf

44 Ibid.

45 Ibid.

EXPOSURE PATHWAYS

Waste products are the main source of pollution from both currently operating mines and legacy pollution sites. Mines can produce a range of waste quantities. Waste can account for almost 10 percent of the total material mined to well over 99.99 percent, depending on the processes and substance being mined.[46] Waste products include wastewater, waste rock (containing metals and ore), tailings, process solutions and processed ore. The waste contains many of the chemicals used in the process, including chlorides, sulfur compounds, hydrochloric or sulfuric acids and lime, soda ash, and cyanide compounds. At abandoned or poorly closed mining sites, mine tailings and improperly stored waste can pollute groundwater, surface water, and agricultural activities. In operating mining and ore processing plants that are poorly managed, untreated waste water, slag and solid waste are often directly dumped into surface waters or piled up, uncovered, near the mine. Metals from the ore may be washed away along with soil, causing heavy erosion problems and contaminated runoff. The population surrounding the site then comes into contact with these pollutants through inhalation of contaminated dust and soil, ingestion of contaminated water and food and dermal contact with contaminated water.

TOP POLLUTANT(S)

The most hazardous pollutants at mining and ore processing sites investigated by Blacksmith are lead, chromium, asbestos, arsenic, cadmium and mercury. This reflects the emphasis in the database on abandoned sites and small-scale mining activities. However, pollutants found at mining sites are many and varied and could include radionuclides, cyanide, and other heavy metals. Lead and chromium are the top pollutants by DALYs and mercury is the top pollutant by number of population put at risk. Asbestos is particularly toxic and has a high DALY impact, but there is only a small number of asbestos mining sites in the Blacksmith database.

46 "Profile of the Metal Mining Industry." U.S. Environmental Protection Agency. Washington, DC. 1995. http://www.epa.gov/oecaerth/resources/publications/assistance/sectors/notebooks/metminsn.pdf

GLOBAL BURDEN OF DISEASE

Blacksmith Institute estimates that the health of nearly 14 million people is at risk from mining and ore processing locations in the countries in which Blacksmith has done investigations. These exposures result in approximately 2.5 million DALYs. It should be noted that the contribution of mercury and cadmium to this DALY calculation was miniscule. Limitations with the existing methodology inhibited the inclusion of the key health outcomes associated with these contaminants. Thus the resulting analysis relies almost entirely on health outcomes associated with lead and chromium. The actual DALY impact of this industry is likely much larger.

WHAT IS BEING DONE?

Well planned and managed mining operations, including rehabilitation following closely behind ore removal, can minimize problems at large-scale mines. The Strategic Approach to International Chemicals Management (SAICM) is a policy framework that was adopted in 2006 at the International Conference on Chemicals Management to ensure that by 2020 all chemicals are "produced and used in ways that minimize significant adverse impacts on the environment and human health."[47] The mining industry has engaged with SAICM and is tracking progress and achievements through the Minerals and Metals Management 2020 action plan. In September 2012 the International Council on Mining and Metals (ICMM), a trade group bringing together 22 mining and metals companies and 34 mining associations, published a report detailing the progress of the industry around the SAICM objectives of risk reduction, governance, capacity building and technical assistance and knowledge and information. In addition, the ICMM has implemented the Sustainable Development Framework, which all members are required to implement in their operations; the ICMM monitors progress annually and members publicly report on it.[48]

Blacksmith has worked on remediating contaminated surface waters used for drinking that was polluted by mining activities. When remediating pollutants in surface water, water treatment at the point of consumption can sometimes be a viable approach. The town of Mailuu-Suu, Kyrgyzstan, was the site of intensive Soviet uranium mining and processing between 1946 and 1968. What remains today are two million cubic meters of radioactive mining waste piled in open valleys along the Mailuu-Suu River. The town draws its drinking water from the river, and levels of heavy metals and radionuclides in the water present a health risk to the community. In 2008, Blacksmith Institute, with the support of Green Cross Switzerland, initiated a project to install water filters in local schools and hospitals. In 2012, Blacksmith and Green Cross reinvested in the community by replacing filter cartridges, installing additional filters in kindergartens, conducting a health monitoring program, and implementing a community education program to raise awareness and teach methods to mitigate risks.

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47 http://www.saicm.org/

48 "Sustainable Development Framework." International Council on Mining & Metals. Available at: http://www.icmm.com/our-work/sustainable-development-framework

SOURCE #4: TANNERIES

Tanning is a set of processes that turns animal hides into leather appropriate for making a range of consumer products. Tannery processes treat raw animal hides to remove hair and leftover animal parts, stabilize the hides so they do not decompose and then dye or treat them to create a finished product. Products include belts, shoes, clothing, pocketbooks and additional consumer items. These processes are done in many steps using many different types of chemical and mechanical means.[49] Sulfides are used to break down the hair and chlorides are used in the pickling or preservation process. Of particular concern is the use of chromate salts in the stabilization process, because, unless well-controlled, hazardous chromium wastes and chromium-contaminated wastewater can be released. In addition to these chemicals, massive amounts of water are used in the process.[50] Up to 30 or 40 cubic meters of wastewater is created per ton of raw material processed.[51]

Most tanning operations are regulated and have pollution controls in place but there are still many small tanneries operating under primitive conditions with little controls.

There are over 100 sites polluted by tannery operations in the Blacksmith Institute's database, potentially putting more than 1.8 million people at risk. These sites mostly consist of contaminated legacy tannery sites or smaller, poorly run facilities. These smaller scale tanneries will continue to operate as the consumer demand for leather goods grows, as leather tanning provides a good employment opportunity in low and middle-income countries. For example, in India in 2011, 75 percent of leather tanneries were small-scale operations.[52] These smaller industry sites are often under regulated, not well managed, and cannot afford the substantial pollutant control mechanisms that are needed to deal with the large amounts of waste.

EXPOSURE PATHWAYS

The tanning processes use various chemical solutions and create large volumes of wastewater, together with solid waste and sludge. Untreated wastewater can contain acidic and alkaline water, pesticides and insecticides, animal pathogens and most notably, may have chromium levels up to 100–400 milligrams per liter.[53] Solid waste can include skins, hides or hair and chromium-contaminated sludge waste, or mixed waste with a combination of all of these. Waste is often released through direct dumping or by improper disposal in unprotected dumpsites. Pollutants leach into the groundwater and are absorbed by the soil. The main pathways for human exposure to pollutants from tanneries in the database are ingestion of contaminated food and water.

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49 "Tanning and Leather Finishing." Pollution Prevent and Abatement Handbook. World Bank Group. 1998

50 Bosnic, M. et al. "Pollutants in Tannery Effluents." United Nations Industrial Development Organization. Regional Programme for Pollution Control in the Tanning Industry in Southeast Asia. 2000.

51 Ingle, K.N et al. "Policy framework for formulating environmental management strategy for sustainable development of tanneries in India." Environ Health Prev Med (2011) 16:123–128

52 Ingle, K.N et al. "Policy framework for formulating environmental management strategy for sustainable development of tanneries in India." Environ Health Prev Med (2011) 16:123–128

53 Tanning and Leather Finishing". Pollution Prevent and Abatement Handbook. World Bank Group. 1998

TOP POLLUTANT(S)

Chromium is the most pervasive and hazardous pollutant found in tannery processes. Trivalent chromium is used as part of the re-tanning process and is washed off from leathers during the dyeing processes and is present in the wastewater of tanneries in significant amounts.[54] Trivalent chromium is not highly toxic but can, under anthropogenic activity, using a strong oxidant factor, be converted into hexavalent chromium. Hexavalent chromium is found at a number of polluted tannery sites in the Blacksmith Institute's database and is a carcinogen that causes lung cancer and potentially increases the risk of stomach cancer when ingested.

GLOBAL BURDEN OF DISEASE

Blacksmith Institute estimates that exposure to hexavalent chromium from tanneries results in some 1.8 million DALYs, the fourth largest single pollutant contribution to DALYs in this report. Exposure to lead at tanneries also contributed 200,000 DALYs, for a total of almost 2 million DALYs from tanneries.

WHAT IS BEING DONE?

54 Bosnic, M. et al. "Pollutants in Tannery Effluents." United Nations Industrial Development Organization. Regional Programme for Pollution Control in the Tanning Industry in Southeast Asia. 2000.

Improving the standards and training for small-scale tanneries in low and middle-income countries could help prevent further contamination at these sites. If waste is treated, stored and disposed of properly the risk of pollution is much lower. For sites that are already polluted, remediation technologies are available to treat chromium pollution in soil and water.

Blacksmith Institute has successfully implemented programs to clean up and alleviate the impacts of chromium on human health and has found several cost-effective and efficient ways to address the problem. Kanpur is the ninth-largest city in India; its eastern districts feature about 350 industrial tanneries, many discharge untreated, chromium-filled waste into local groundwater sources and the Ganges River. Initial studies of the groundwater quality in Kanpur revealed chromium-6 levels of 6.2 mg/L; the Indian government places the limit at .05 mg/L. Blacksmith remediated the area using chemicals that neutralize the chromium, while implementing an education campaign warning locals of the hazards. For the awareness-raising campaign, Blacksmith supported Ecofriends, a local environmental NGO in Kanpur. For chemical remediation of the chromium, Blacksmith worked with Ecocycle/GZA (engineering consultants who supplied needed materials) and the Central Pollution Control Board in order to undertake the first such project in India's history. Blacksmith also dug four new wells to monitor water and provide new water sources to the community. Two new submersible water pumps were installed to provide safe, potable drinking water. The chemical remediation project decreased levels of chromium-6 at all test sites, in some cases to undetectable levels.

SOURCE #5: INDUSTRIAL/MUNICIPAL DUMPSITES

Waste at industrial or municipal dumpsites can include waste from batteries, scrap metal, agricultural, and hospitals, households and chemical waste from industrial processes. In the developing world, all waste often goes into the same place, there is often no difference between municipal and industrial dumpsites, Polluted dumpsites generally consist of two different types of waste disposal, open dumpsites and municipal landfills. Open dumpsites are unregulated informal sites where individuals or industries dump a variety of solid or liquid waste with no formal treatment or pollution controls. They may be unsanctioned or informally accepted by the government but likely there are no standards for treatment or control of waste, and little control over what types of wastes are dumped. Municipal landfills may be operated by the government or a private entity but are often poorly constructed and employ only limited measures for protection against pollution. In addition, abandoned municipal sites are often not properly capped or covered to prevent pollution.

There are almost 150 industrial or municipal dumpsites in the Blacksmith Institute's database that are polluting local communities, potentially putting almost 3.5 million people at risk. The largest shares of these dumpsites are in Africa and in Eastern European and Northern Asian countries. Combined, these regions make up more than half of the total at risk population in the Blacksmith investigations of dumpsites. However, industrial and municipal dumpsites are prevalent throughout the developing world including in South and Central America and South and Southeast Asia.

At properly run municipal solid waste landfills, hazardous materials considered carcinogenic, corrosive, toxic, or flammable are not accepted and are directed to special treatment or disposal sites.[55] At informal or improperly run sites, all these items are disposed together, creating a toxic stew of waste exposed to heat, rain and air, causing the materials to break down and easily enter the environment. Industrial waste is one of the most toxic wastes at dumpsites and makes up a large portion of the pollution problem at the dumpsites investigated by Blacksmith.

EXPOSURE PATHWAYS

The main sources of pollutants from dumpsites are either leachate (contaminated liquids leaching into the groundwater), dust from poorly covered or controlled landfills and landfill gas that is not captured.[56] Leachate can contain heavy metals, VOCs or hazardous organic compounds. These pollutants are carried into aquifers or surface waters. Dust from dumpsites may contain metals and human pathogens that come into contact with this pollution through contaminated groundwater and soil, or direct contact with the waste site.[57] Children often are seen playing in and around dumpsites, introducing direct exposure with hazardous waste through dermal contact, inhalation of dust or accidental ingestion. Informal neighborhoods are often built on top of previous dumpsites where the soil, groundwater and nearby surface waters are contaminated, indirectly exposing the local population to leached pollutants. A notable issue with dumpsites in the developing world is the presence of scavengers - workers and their families at dumpsites who make their living by recovering economically valuable materials in the waste. In such situations, people come into direct contact with the contaminants at the waste site.

TOP POLLUTANT(S)

In the Blacksmith Institute's database of industrial or municipal dumpsites the most pervasive and harmful pollutants are lead and chromium. Combined they are the key pollutants in a third of the sites, potentially affecting almost 1.2 million people. The health impacts of these pollutants have been covered in this report and include lung cancer, neurological problems and cardiovascular disease. Other pollutants in the database of dumpsites include cadmium, multiple types of pesticides, and arsenic and VOCs.

GLOBAL BURDEN OF DISEASE

Blacksmith Institute estimates that exposure to lead from industrial and municipal dumpsites results in 1.2 million DALYs. Chromium only contributes a fraction of this total; in the sites investigated by Blacksmith Institute lead was the predominant pollutant.

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55 Allen, A.R., Taylor, R. 'Waste disposal and landfill: Control and protection." Protecting Groundwater for Health: Managing the Quality of Drinking-water Sources, WHO Drinking Water Quality Series Monograph,IWA Publishing. 2006.

56 Johannessen, L.M. et al. "Observations of Solid Waste Landfills in Developing Countries: Africa, Asia and Latin America." The World Bank Group, Urban Development Division. 1999.

57 Ibid.

WHAT IS BEING DONE?

Ongoing international support to encourage governments to upgrade sanitary landfill sites could be expanded to address polluted dumpsites and prevent future unsafe dumping. Organizational and financial issues are a fundamental challenge in improving waste management performance in many countries. The technology for secure industrial landfills is well established in many developing countries but weak regulation often means that many industries take the cheaper option of dumping.

Many low-cost methods exist for reducing the impacts of pollution from industrial dumping. At a site in India over 60,000 tons of industrial waste had been dumped over the last decade. Several toxic components had leaked into the groundwater, turning local streams red and spreading contaminated materials through monsoon rains. Working closely with local industrialists, through the Gujarat Industrial Development Corporation (GIDC), a staged cleanup was implemented. The main core of hazardous wastes were removed and taken to a proper disposal facility. Blacksmith then funded the implementation of a low-tech bioremediation approach that included treating the remaining contaminated site with vermiculture – worms – that concentrate heavy metals in their bodies and reduce the contamination in the soil around them. Over several seasons of treatment with this innovative approach, the site continues to show a reduction of heavy metals, which are now at acceptable levels. This low-cost pilot bio-remediation method has proved highly effective.

SOURCE #6: INDUSTRIAL ESTATES

Industrial estates, also known as industrial parks, are areas where infrastructure and buildings, usually built by governments, attract and support industrial activity to the zone. Typically there are roads, power, utility services, waste treatment and other services built specifically to support the industrial processes happening there, and they are often located outside of major population zones. In some circumstances, the estates may be little more then areas zoned for industrial development, with limited infrastructure. The industrial processes within these estates vary widely and the pollutants resulting from them also vary.

Industrial estates are associated with over 100 of the sites in the Blacksmith Institute's database and pollutants from them potentially affect an estimated 4 million people near these sites. Industrial estates are located all over the world and the sites are highly variable across many different countries. Currently, the Blacksmith Institute database shows that a majority of sites polluted by industrial estates are located in South Asia, mainly in India and Pakistan, although such estates are known to exist in many developing countries seeking to increase their manufacturing sector.

EXPOSURE PATHWAYS

Pollution at industrial estates is generally caused by a lack of appropriate waste processing infrastructure or pollution controls. Air pollution emissions, contamination of surface waters or aquifers that communities rely on for water, and improper disposal of hazardous wastes are prevalent at poorly managed and controlled estates. In addition, these polluted industrial estates are sometimes located close to population centers. Alternatively, population centers (often including squatter settlements) grow near the estates due to availability of jobs. The World Bank Group recommends that industrial estates include systems for vapor recovery, sulfur recovery, recovery of waste, recycling of wastewaters, spill prevention and hazardous chemical and waste storage. These controls would reduce VOC emissions, sulfur emissions, and the release of many toxic pollutants.[58]

58 "Industrial Estates." *Pollution Prevention and Abatement Handbook*. World Bank Group. Washington, DC, 1998.

Because of the high variability of activity at industrial estates, there are many ways in which pollutants can enter the environment. Industrial estates contain the types of industries that are covered elsewhere in this report, including lead smelting and processing, battery manufacturing and recycling, and chemical and product manufacturing. However, there are many additional types of industry processing that happens at industrial estates, complicating the identification, assessment, and clean up greatly. At polluted sites, general pathways for pollutants include wastewater, direct exposure to improperly disposed waste or sludge, and dust or emissions. Pathways for human exposure include inhalation of dust, dermal contact, food ingestion, and water ingestion.

TOP POLLUTANT (S)

Blacksmith has identified lead and chromium as the top pollutants in the surveyed sites included in the Blacksmith Institute's database. An estimated 1.3 million people are potentially at risk from lead exposure related to industrial estates and almost 1 million people are estimated to be at risk from exposure to chromium. The combined health effects from these pollutants include mild mental retardation, loss of IQ, cardiovascular problems, and lung cancer. To read more about the health effects of lead and chromium go to the health effects sections for those pollutants.

GLOBAL BURDEN OF DISEASE

Blacksmith Institute estimates that industrial estates contribute a little over 1 million DALYs to the total disease burden in the 49 countries assessed. The largest contributor in this industry was lead, contributing to nearly all health risks. It should be noted that industrial estates release multiple and varied pollutants and this calculation of the burden of disease only examined known pollutants based on the Blacksmith Institute's database information. There could potentially be a much higher impact from the cumulative impact of combined pollutants, including possible pollutants not yet defined in our site investigations. As a result, this DALY calculation is very likely an underestimate.

WHAT IS BEING DONE?

Stricter regulation by government and more technologically advanced waste treatment systems built into the estates could greatly reduce the risk of pollution from industrial estates. For example the Blacksmith Institute has worked at a site in the Kafue River Basin in the Chingola District in Zambia, which has experienced heavy pollution over the past several decades. Several industrial units, including Konkola Copper Mines, pulp and paper mills, fertilizer factories, granulation plants, and textile manufacturers, regularly disposed of industrial waste products and various bio-chemical substances, used in their mining and ore processing operations, directly into the nearby water reservoirs. In 2005, Blacksmith surveyed the polluted sites to identify and prioritize cleanup efforts. As a result, Kafue Nitrogen Chemicals, Lee Yeast, and Bata Tannery established cleaner production and waste treatment methods. The government now continuously monitors pollution streams from industrial plants.

SOURCE #7: ARTISANAL GOLD MINING

Artisanal gold mining refers to small-scale informal mining activities that mine ores containing gold and process them to recover the gold. While the sites are often individually small-scale, 20 percent of the world's gold is produced in artisanal gold mines and it releases more mercury than any other sector worldwide.[59] The technologies and methods are exceedingly low-tech and the ore is usually processed in rudimentary structures with no pollution controls. The ore is crushed and washed to recover the gold, with mercury being added during the process. The mercury binds to the gold to form a dense lump of amalgam that is easy to recover from the crushed material. The amalgam is later heated, often with blowtorches or over open flames, so that the mercury evaporates and gold sponge is left. Gold sponge is then processed in gold shops, where more mercury is evaporated from the gold sponge and pure gold is left. The process is done by hand with very little or no mechanized tools. Artisanal mercury based gold processing is very inefficient; mercury use ranges from 4-20 parts of mercury per part of gold recovered and the process captures only about 30% of the available gold.[60] Despite the inefficiency, mercury is used because it is cheap and readily available. Because of the informal nature of the industry, there is little knowledge about best practice, putting the community at risk during and after the processing is complete. Non-industrial or individual purchase and use of mercury is illegal in most countries, however imports are routinely averted and sold on informal markets.[61] Once the gold ore has been worked out, the mining sites are usually abandoned, with no formal clean up or containment of waste. Worldwide there are thousands of abandoned small-scale mining sites, many with a legacy of mercury pollution and widespread health impacts.[62]

Artisanal gold mining is a small-scale industry but contributes a large number of polluted sites to the Blacksmith Institute's database. There are over 200 sites that potentially expose more than 4.2 million people to the risk of toxic pollutants. The majority of artisanal gold mining sites in the database are in Africa and Southeast Asia, however there is a high concentration of artisanal miners in Latin America as well. It is estimated that artisanal gold mining is done in as many as 55 countries employing between 10 and 15 million miners.[63] Artisanal gold mining is a subsistence industry engaged in at the individual level, and is likely to be located in countries or regions with limited government oversight or regulation of small-scale industrial activities. Small gold mining operations can be started with very little investment or infrastructure and producers can often make 70 percent or more of the price of international gold, a rare economic advantage in small-scale or informal industries.[64] Gold is an easily traded commodity and prices are continually stable or growing, making it a very attractive subsistence industry for marginalized members of society.

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59 "Reducing Mercury Pollution from Artisanal and Small-Scale Gold Mining." U.S Environmental Protection Agency. Washington DC. 2012 Available at: http://www.epa.gov/oia/toxics/mercury/asgm.html

60 Ibid.

61 Veiga, M.M. et al. "Abandoned artisanal gold mines in the Brazilian Amazon: A legacy of mercury pollution." Natural Resources Forum 26 (2002) 15–26

62 Ibid.

63 Veiga, M.M., Baker, R. "Protocols for Environmental and Health Assessment of Mercury Released by Artisanal and Small Scale Miners". Report to the Global Mercury Project: Removal of Barriers to Introduction of Cleaner Artisanal Gold Mining and Extraction Technologies. 2004.

64 "A Practical Guide: Reducing Mercury Use in Artisanal and Small-Scale Gold Mining." United Nations Environment Programme. 2012. Available at: http://www.unep.org/hazardoussubstances/Portals/9/Mercury/Documents/ASGM/Techdoc/UNEP%20Tech%20Doc%20APRIL%202012_120608b_web.pdf

EXPOSURE PATHWAYS

The US EPA estimates that approximately 400 metric tons of mercury is released into the air each year from the processing of gold in artisanal gold mining.[65] Mercury is released during the heating of amalgam, when mercury is evaporated. The mercury vapor is inhaled directly by workers and is absorbed into surrounding surfaces, where it is re-emitted into the air over time. The mercury vapor is also released into the environment and settles on plants, soil and waterways nearby. Gold processing is often undertaken in residential areas and done in the open around children and other family members, directly exposing the community to the mercury vapor. Those not directly exposed to the fumes are at risk of ingesting mercury that has been absorbed by waterways, soil or fish. The largest majority of exposures in the Blacksmith Institute's database are through inhalation of contaminated dust or vapors and ingestion of contaminated water.

TOP POLLUTANT(S)

Mercury is the top pollutant in artisanal gold mining operations. In the Blacksmith Institute's database it puts close to 3.4 million people at risk for exposure. Mercury is a bio-accumulative toxin that is absorbed by fish, birds and other wildlife, contaminating local food chains. It is known to cause neurological damage, especially in fetuses and children. As prevalent and hazardous as mercury is in small-scale mining, other pollutants are also released. Within the database lead has been found at over 20 sites, putting close to 250,000 people at risk. Lead is often released when the lead-containing ore is roughly crushed. Lead also causes neurological and developmental damage in children.

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65 Ibid.

GLOBAL BURDEN OF DISEASE

Blacksmith Institute estimates that lead from artisanal gold mine sites contributes roughly 1 million DALYs to the total burden of disease in the 49 countries assessed. However, the DALY number presented for this industry is by far the largest under-calculation presented in the report. There is very limited data available to calculate DALYs from mercury exposure, the key pollutant in artisanal gold mining. While the DALYs here are significant, in reality they are almost certainly an order of magnitude larger than the number that can currently be calculated.

WHAT IS BEING DONE?

In the last decade, the harmful effects of mercury poisoning from artisanal gold mining have been recognized and many international organizations are working to provide training, technology and safety standards for the industry. The EPA and the Argonne National Laboratory (ANL) have partnered to design a technology called the Gold Shop Mercury Capture System (MCS), a simple technology that captures and treats mercury emissions and can reduce emissions by 80 percent.[66] There are examples like this being

66 A Practical Guide: Reducing Mercury Use in Artisanal and Small-Scale Gold Mining." United Nations Environment Programme. 2012. Available at: http://www.unep.org/hazardoussubstances/Portals/9/Mercury/Documents/ASGM/Techdoc/UNEP%20Tech%20Doc%20APRIL%202012_120608b_web.pdf

implemented all over the world. Education can change behavior and is the best approach to altering dangerous practices, as there are many alternative approaches to gold processing that are less harmful to human health. Ideally all small-scale miners would be converted to mercury-free mining methods, but this is a major ongoing challenge.

Even though mercury use is pervasive among gold miners and processors, awareness of potential hazards to community health and the environment is very low. The US EPA, UNEP, and Global Mercury Partnership supported Blacksmith, in collaboration with the Ministry of Environment and Yayasan Tambuhak Sinta in Indonesia, in the implementation of interventions that reduce mercury emissions and improve mining practices. The project provided retorts to miners that are easy to use and inexpensive, in order to re-capture mercury that is emitted during the burning process. The mercury can then be reused multiple times, greatly reducing environmental damage. Additionally, Blacksmith installed dozens of water-box condensers in gold shops that capture additional mercury during the refining process. This has led to a dramatic reduction in the level of mercury emissions at these sites.

SOURCE #8: PRODUCT MANUFACTURING

Product manufacturing is a general term for industries that produce consumer products. It spans a wide range of manufacturing processes and material types. Product manufacturing is a major contributor to individual country GDP and the global economy. The World Economic Forum reports that 70% of country GDP variations can be explained by differences in the amount of manufactured products exported.[67] It is clearly essential to a country's prosperity and important to individual consumers. As lower and middle-income countries develop, the demand for consumer products grows, spurring rapid expansion of product manufacturing. Reduction of trade barriers, improved geopolitical relationships, and the improvement of infrastructure and technologies have all enabled this expansion and the global spread of product manufacturing.[68] Because of this globalization and efforts to incentivize manufacturing, many developing countries have been quick to reduce regulations and or release companies from complying with environmental standards in order to gain a competitive advantage. The result has been an extensive and widespread pollution problem caused by product manufacturing.

Product manufacturing pollution is an issue at over 100 sites in the Blacksmith Institute's database and potentially exposes almost 3.5 million people to toxic pollutants. More than half of the sites are located in South Asia and Southeast Asia where regulations on product manufacturing are frequently lax. Other regions disproportionally represented include several African countries and China. China is second in the world in manufacturing and produces 15 percent of the worlds manufactured products.[69]

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67 "The Future of Manufacturing: Opportunities to drive economic growth." World Economic Forum. 2012.
Available at: www.weforum.org/reports/future-manufacturing

68 Ibid.

69 "Facts About Manufacturing." National Association of Manufacturers.
Available at: http://www.nam.org/Statistics-And-Data/Facts-About-Manufacturing/Landing.aspx

Product sectors from the Blacksmith Institute's database of polluted manufacturing sites include textiles, electronics, food, fuel, plastics and metals. However, there are many more types of manufacturing that fall under this umbrella term, including raw materials, agricultural products, building products, pulp and paper mills and much more. According to the National Association of Manufacturers the top four largest manufacturing industries were food, chemicals, computers and electronics and metal products. Because of this variation, it is often difficult to characterize the type and nature of pollution problems in product manufacturing.

EXPOSURE PATHWAYS

Pathways for pollutants vary widely across types of product manufacturing; in general they include emissions from energy sources used to power production, emissions from incineration of waste products or heating during processes, and improper disposal of solid waste and wastewater. Some product industries use massive amounts of water, while other types of plants emit large amounts of emissions into the air. Once in the environment pollution from product manufacturing sites effects local populations. The majority of pollutant exposures in the Blacksmith Institute's database derive from inhalation of contaminated dust, soil or gases and ingestion of contaminated water.

Lead pollution from product manufacturing sites in the database enters the environment mainly through wastewater that is improperly stored, not treated and indiscriminately dumped into local waterways. Other pathways include burning of solid waste. The chromium pollution at these sites is through both groundwater and air emissions.

TOP POLLUTANT(S)

Again, because of the varied nature of product manufacturing, there are a wide variety of pollutant types that are released. As identified by Blacksmith, the key pollutants include lead, chromium, cadmium, arsenic, cyanide, dioxins, mercury, sulfur dioxide, volatile organic compounds and other particulates. The top pollutants by DALY are lead and chromium.

Combined health effects from these pollutants include neurological, gastrointestinal, cardiovascular and renal system problems and lung cancer. Refer to the health impacts section of these two pollutants for more information.

GLOBAL BURDEN OF DISEASE

Blacksmith Institute estimates that product manufacturing contributes about 800,000 DALYs. The contribution to these DALYs is nearly evenly split between lead and chromium exposure. It should be noted that only chromium in the hexavalent form was used in the analysis. It should also be noted that like industrial estates, product-manufacturing sites release a diverse mix of pollutants. Lead and chromium are

the top pollutants identified in the Blacksmith Institute's database information. There could potentially be a much higher impact from the cumulative impact of combined pollutants, including possible pollutants not yet defined in our site investigations. As a result, this DALY calculation is very likely an underestimate.

WHAT IS BEING DONE?

Product manufacturing is driven by the demand for consumer goods. Consumers have the power to demand cleaner and safer products. As such, green-purchasing practices implemented at the large-scale corporate level and the individual level can have a huge impact on the practices of product manufacturers. Large corporations like Wal-Mart have been pressuring their supply chain to meet sustainable standards for operations, transforming the way some companies manufacture and deliver products.

Pressure from government, NGO's and communities can cause the prohibition or phase-out of certain hazardous products. Many examples exist where products like the pesticide DDT, or leaded gasoline were phased out because of societal pressure. In 2005, the African Refining Company reported a voluntary phase-out of leaded-gasoline; however, it was essential to coordinate efforts among various stakeholders to implement a comprehensive phase-out program because one last refinery continued to produce leaded gasoline. The project primarily focused on the control of lead contents of gasoline all over Senegal. Using sampling results to show which areas were implementing the ban of leaded-gas, Blacksmith monitored the distribution of gasoline. Blacksmith also monitored ambient air quality to show the progress of the phase-out program.

SOURCE #9: CHEMICAL MANUFACTURING

The U.S. Bureau of Labor Statistics categorizes the following as chemical manufacturing: basic chemicals including pigments, dyes, gases and petrochemicals; synthetic materials like plastics; paint products, cleaning products; and other chemicals including film, ink and explosives. Pharmaceutical manufacturing is also considered under the umbrella of chemical manufacturing. These products and their related chemicals are essential to society and are needed to facilitate our daily life. They treat medical problems, improve standards of living and are relied upon for a vast range of activities. However, during the production of these chemicals and products, dangerous by-products and waste are often generated. A common feature in almost all of the organic chemical industry is the use of VOCs as solvents and raw materials. The manufacture of solvents is also a major part of the chemical industry. The dye industry and pesticide industry are part of the chemical industry and are major contributors to the pollution problems of chemical manufacturing but they are addressed separately in this report.

Chemical manufacturing is a large source of pollution worldwide and can be directly tied to close to 200 of the polluted sites in the Blacksmith Institute's database. Potentially putting approximately 5.3 million people at risk of exposure. The majority of sites are in China, Eastern Europe and South Asia. Eastern Europe carries a disproportionate number of the at risk population with over 3 million people at risk of exposure to pollutants from chemical manufacturing. The chemical manufacturing industry is truly a global industry with 16 different countries contributing to the trading and selling of chemicals, and likely there are contaminated chemical manufacturing sites all over the world.[70]

70 Buccini, J. "The Global Pursuit of the Sound Management of Chemicals." The World Bank Group. Washington, DC. 2004. Available at: http://siteresources.worldbank.org/INTPOPS/Publications/20486416/GlobalPursuitOfSoundManagementOfChemicals2004Pages1To67.pdf

Part of the reason for the expansive reach of chemical manufacturing is the diverse and varied types of sectors and activities that are included in it. The EPA defines chemical manufacturing as "creating products by transforming organic and inorganic raw materials with chemical processes."[71] These are further broken up into commodity and specialty chemicals. Commodity chemicals are basic singular chemicals in ongoing production at industrial plants. Specialty chemicals are batches of combination chemicals made at the request of certain industries and produced on an as needed basis.[72] New chemicals are introduced and old chemicals are withdrawn constantly, changing the chemical manufacturing market frequently, making it difficult to monitor and evaluate. The sheer size of the industry makes it difficult to monitor as well; it accounts for approximately 7 percent of global income and 9 percent of international trade,[73]

EXPOSURE PATHWAYS

Chemicals can be released through the same pathways as other pollutants, including emissions from heating and processing, accidental release of dust or other particulates, accidental spills and improper disposal of solid waste and wastewater. Once in the environment exposure media includes air, water, soil and food. In the Blacksmith Institute's database, which focuses on chemical dumps and abandoned sites, the exposure pathways are evenly split between inhalation of contaminated dust and soil, ingestion of contaminated water and food and inhalation of contaminated gases or vapor.

The chemical manufacturing industry is the largest single consumer of water by sector in all OECD countries.[74] The large amount of process water required provides many opportunities for pollutants to be released through wastewater.

TOP POLLUTANT(S)

The pollutants found in the largest quantities at chemical manufacturing sites investigated by Blacksmith include pesticides and volatile organic compounds. However, other pollutants found include arsenic, cadmium, cyanide, mercury, chromium and lead. The top pollutants by DALY calculation are chromium and lead, as DALYs could not be calculated for the other more pervasive pollutants. Reference the pollutant sections for more information on health effects of chromium and lead.

It is important to note that although DALY calculations could not be made for volatile organic compounds, exposure to VOCs released from chemical manufacturing sites potentially puts more than 1.5 million people at risk at the sites investigated by Blacksmith. VOCs are low molecular weight chemicals made from carbon

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71 "Sector Programs: Chemical Manufacturing". U.S. Environmental Protection Agency. 2011.
Available at: http://www.epa.gov/sectors/sectorinfo/sectorprofiles/chemical.html

72 "Sector Programs: Chemical Manufacturing". U.S. Environmental Protection Agency. 2011.
Available at: http://www.epa.gov/sectors/sectorinfo/sectorprofiles/chemical.html

73 Buccini, J. "The Global Pursuit of the Sound Management of Chemicals." The World Bank Group. Washington, DC. 2004. Available at:
http://siteresources.worldbank.org/INTPOPS/Publications/20486416/GlobalPursuitOfSoundManagementOfChemicals2004Pages1To67.pdf

74 Ibid.

and hydrogen, and often including oxygen, nitrogen, chlorine and other elements. Because of their low molecular weight, VOCs convert to vapor easily, and VOC vapors are emitted from certain products and processes. There are thousands of VOCs, many of which are familiar compounds in everyday life, such as ethyl alcohol, propane, mineral spirits, and the chemicals in gasoline, kerosene and oil. While many VOCs are relatively non-hazardous (aside from their flammability), there are thousands of VOCs that are toxic, and some can cause eye, nose and throat irritation and headaches, while others are known carcinogens. Some examples of toxic VOCs include benzene, formaldehyde, toluene, vinyl chloride and chloroform. VOCs come from a wide variety of products, most of which are used daily by society. The list includes most fuels, paints, stains and lacquers, cleaning supplies, pesticides, plastics, glues, adhesives and refrigerants. VOCs, including many more uncommon and toxic types, are very commonly used in manufacturing processes as solvents or raw materials in the production of plastics, chemicals, pharmaceuticals, and electronic products.

GLOBAL BURDEN OF DISEASE

Blacksmith Institute estimates that chemical manufacturing contributes an estimated 750,000 DALYs. A key limitation of our approach was our inability to calculate DALYs from VOCs and pesticides. Insufficient dose-response and disability weight information resulted in the complete exclusion of VOCs and pesticides. The estimate is therefore a considerable under-calculation as it only takes into account the health impacts of lead and chromium.

WHAT IS BEING DONE?

Creating standards for the strategic and sound management of chemicals is essential to reducing the risk of exposure. Nationally and internationally both private and public organizations including the United Nations are working to create globally applied standards for the management of chemicals so that the need for chemicals and the hazardous effects of pollution can be balanced.[75]

For sites that have already been polluted, remediation efforts can reduce the level of pollution. The Gorlovka Chemical Plant is an abandoned industrial site located in the Ukraine. The plant, a former chemical and explosives production facility, has thousands of tons of toxic chemicals leaking into soil and groundwater including a highly toxic chemical intermediary called mononitrochlorobenzene (MNCB). The plant posed a significant and immediate threat to the local population because MNCB was leaking from open drums and tanks directly into groundwater and running off the property through surface waters. Beginning in 2009, Blacksmith conducted a detailed site assessment. Based on a demonstration project done by Blacksmith, the Ukraine government implemented a project to remove the MNCB. The MNCB has now been safely removed from the area and stored properly. Other issues at the site are still being resolved.

75 Buccini, J. "The Global Pursuit of the Sound Management of Chemicals." The World Bank Group. Washington, DC. 2004. Available at: http://siteresources.worldbank.org/INTPOPS/Publications/20486416/GlobalPursuitOfSoundManagementOfChemicals2004Pages1To67.pdf

SOURCE #10: DYE INDUSTRY

Dyes are used primarily in the production of consumer products, including paints, textiles, printing inks, paper, and plastics. They add color and patterns to materials. Natural dyes extracted from vegetables, fruit and flowers have been used since 3500 BC to color fabrics and other materials.[76] These dyes were replaced by chemical dyes that bond with the fabric, providing and retaining richer color throughout washing and exposure.[77]

Many different types of dyes consisting of varied chemical compounds are used in production, depending on the type of textile or product being dyed. There are more than 3600 different types of textiles dyes alone. Other dye types include acid dyes for coloring animal fibers, basic dyes for use on paper, direct dyes for use on cotton-wool or cotton-silk, and pigment dyes used in paint and inks.[78] These dyes are manufactured out of a number of different chemicals, but most notably, sulfuric acid, chromium, copper and other metallic elements are used. Dyes are mixed, synthesized in a reactor, filtered for impurities, dried out and then blended. Along the way many other additives, solvents and chemical compounds are used to instigate reactions.[79] The variation in chemical use is closely tied to the high demand for variable patterns

76 Kant, R. "Textile dyeing industry and environmental hazard." Natural Science. Vol 4. No.1 22-26. 2012.

77 Ibid.

78 "Dye Manufacturing". Pollution Prevent and Abatement Handbook. World Bank Group. 1998

79 Ibid.

and unique colors for clothing and other textiles.[80] These constantly evolving demands result in a highly fluctuating and diverse waste stream. The textile industry is one of the largest sectors globally and produces an astonishing 60 billion kilograms of fabric annually, using up to 9 trillion gallons of water.[81] This massive water use is a key component of pollution. Water is used as cooling water, to clean equipment, and for rinsing and processing dyes and products.

The dye industry is responsible for almost 50 sites in the Blacksmith Institute's database, potentially putting more than one million people at risk. The majority of problematic dye industry sites are in South Asia, a global center of textile production; however the dye industry is global in scale and is spread over many different countries. Dye plants can range from small and informal to large and organized, in India for example there are estimated to be about 1,000 small-scale entities and 50 large industrial plants.[82] While the organized dye industry does dominate the market, there are many unorganized small-scale plants that disproportionately add to the problem of pollution.

EXPOSURE PATHWAYS

Wastewater is a key pathway for exposure. In legacy pollution sites wastewater from the dye industry is directly dumped into surface waters without treatment. Wastewater carries a host of different chemicals from the processing of dyes and The World Bank estimates that textile dyeing and treatment contribute up to 17-20 percent of total industrial water pollution. The majority of pollution exposure in the Blacksmith Institute's database comes from ingestion of contaminated water and ingestion of food, which has been irrigated with contaminated water.

TOP POLLUTANT(S)

The top pollutants by population at risk found in the Blacksmith Institute's database are chromium, lead and cadmium. Other harmful pollutants include sulfur, nitrates, chlorine compounds, arsenic, mercury, nickel and cobalt. Chromium is a known carcinogen and lead produces neurological and developmental damage in children and cardiovascular disease in adults.

GLOBAL BURDEN OF DISEASE

The dye industry is the lowest contributor to DALYs on the top ten list, contributing an estimated 400,000 DALYs to the total burden of disease in the 49 countries assessed. These DALYs are all a result of the health impacts from chromium and lead.

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80 Parvath, C. et al. "Environmental impacts of textile industries." Indian Textile Journal. November, 2009.
Available at: http://www.indiantextilejournal.com/articles/FAdetails.asp?id=2420

81Zaffalon,V. "Climate Change, Carbon Mitigation and Textiles." Textile World. July/August 2010.
Available at: http://www.textileworld.com/Articles/2010/July/July_August_issue/Features/Climate_Change_Carbon_Mitigation_In_Textiles.html

82 Mangal, V.P. "The Future of Indian Dyes & Dye Intermediates". Textile Review. August 23, 2010.
Available at: http://www.fibre2fashion.com/industry-article/29/2887/the-future-of-indian-dyes-and-dye-intermediates1.asp

WHAT IS BEING DONE?

Projects are underway internationally to raise awareness about the pollution impacts of the dye industry. Preventative measures being implemented include reducing and recycling water in the process, substituting or minimizing the use of the most toxic chemicals, and providing education on the safe storage and treatment of waste. Remediation efforts include the use of activated carbon in the absorption of chemicals in waste from the dye process, which has shown to greatly reduce some of the pollutants in the waste.[83] Also, new technologies are being developed to reduce the massive amount of water use and control pollution. The trick is getting these potentially expensive new technologies to informal small-scale dye factories.

Blacksmith is currently partnering with local groups to bring some lower cost technologies and education to hotspots polluted by the dye industry. In 2008 Blacksmith assessed the city of Jodhpur, a city in India, which contains the biggest bloc of textile dyeing and printing industries. About 215 textile industries exist in Jodhpur, with a population of nearly 900,000. Blacksmith documented that various dyes were being used and considerable wastewater was discharged, degrading the water quality in this water-scarce region. Partnering with industries and local representatives, Blacksmith identified hotspots of dumping and active contamination. Bringing in a technical expert, Blacksmith held demonstration workshops to show how to use Bio-filters to remove heavy metals and chemicals from effluents. Filters were installed to remediate polluted water.

THE REMAINING FIVE SOURCES

The following list of sources contains industries that Blacksmith believes contribute significantly to toxic pollution problems, but are either unquantifiable because of lack of data, or represent a smaller impact than the above top ten list.

SOURCE: PETROCHEMICAL PROCESSING

Petrochemicals are chemical products derived from petroleum or other fossil fuels. Petrochemicals refer to a wide array of chemicals and could include chemicals discussed earlier in this report. They are chemicals that are used in adhesives, carpeting, cosmetics, paint, rubber, fabrics, fertilizers and plastics. Petrochemical processing is especially unique because fossil fuels such as oil and natural gas are used to create the building blocks of these chemicals. Because of this, petrochemical processing is often done in oil producing regions and occurs alongside other oil refining processes.

Pollution from oil use and production is generally outside of the scope of Blacksmith Institute's work, due

83 Kant, R. "Textile dyeing industry and environmental hazard." Natural Science. Vol 4. No.1 22-26. 2012.

to the globally pervasive nature of this industry and number of sites impacted by oil pollution. Inclusion of this industry within our work would overwhelm current resources and lead to poorer understanding of the impact of other industries. The petrochemical industry is the exception.

Pollution from petrochemical processing and production contributes to 75 sites in the Blacksmith Institute's database, potentially exposing more than 2.2 million people to pollution from petrochemical processing sites. Blacksmith has investigated polluted petrochemical sites in Africa, South America, Eastern Europe and South Asia. The petrochemical sites in the Blacksmith industry are largely polluted by untreated wastewater and sludge being disposed of in surface water sites. Untreated waste from petrochemical sites can contain very toxic pollutants and is tightly regulated in developed countries. The majority of investigated sites are contaminated by lead, but a large array of chemicals is found. These include, cadmium, mercury, volatile organic compounds, PCBs and oil or petroleum products. Health impacts from these sites include neurological damage, lung irritation and disease and forms of cancer.

SOURCE: ELECTRONIC WASTE RECYCLING

E-waste is the general term for electronic waste from discarded computers and printers, cell phones, televisions and other related consumer products. Consumer demand drives the technological innovation that creates a cycle of obsolescence in which new devises are turned over almost yearly. This constant stream of new products results in an urgent and complex waste problem, it is estimated that 500 million computers became obsolete in the U.S. between 1997 and 2007, and computers represent only a small percentage of e-waste.[84] Total global e-waste estimates number between 20 and 50 million tons annually.[85] The waste is rarely processed in developed countries; an estimated 70 percent of it is imported to China.86 In the Blacksmith Institute's database there are almost 50 sites polluted by e-waste, potentially putting close to 600,000 people at risk. Of the 50 sites, majorities are located in China with Africa and South America holding several sites as well.

E-waste is made up of a mixture of different materials. Its complicated make up of metals, chemicals and plastics make it a unique stream of waste that requires specialized solutions. Many of the components contain a mix of heavy metals, and chemicals like PCBs and brominated flame-retardants.[87] The waste must be dismantled and the components extracted before recycling or disposal can take place. Many of the methods used, even in formal e-waste disposal sites, are unsafe and release hazardous elements. Recycling operations observed in developing countries have exposed open burning and dismantling of waste, cracking

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84 Zeng, H.N.E. "Law Enforcement and Global Collaboration are the Keys to Containing E-Waste Tsunami in China." Environ. Sci. Technol. 43, 3991–3994. 2009

85 "E-waste pollution threat to human health." Institute of Physics. May 31, 2011. Available at: http://www.iop.org/news/11/may/page_51103.html

86 Zeng, H.N.E. "Law Enforcement and Global Collaboration are the Keys to Containing E-Waste Tsunami in China". Environ. Sci. Technol. 43, 3991–3994. 2009

87 Zeng, H.N.E. "Law Enforcement and Global Collaboration are the Keys to Containing E-Waste Tsunami in China". Environ. Sci. Technol. 43, 3991–3994. 2009

of cathode ray tubes containing high levels of lead, and unsafe dumping of waste products.[88] These processes release large amounts of toxins into the air where they are inhaled by e-waste workers and settle on the surrounding environment. Pollutants found in polluted e-waste sites from the Blacksmith Institute's database include lead, chromium, cadmium, and polychlorinated biphenyls or PCBs. These pollutants cause neurological damage, lung irritation and disease and forms of cancer.

Increasingly, countries like China and India are creating laws to regulate the flow of e-waste imports; however there is still a vast market of illegal e-waste dumping and processing that is outside the realm of regulation. The Basel Ban forbids the export of e-waste to developing countries, but often e-waste is sent to low-income countries under the guise of donations. Recently countries in Africa, like Ghana and Nigeria, have come under a deluge of e-waste through a loophole that allows electronic goods to be exported as 'working products'. When the "donations" are received, often times few of the items are even functioning, half a million PCs arrive in Lagos every month, and only 1 in 4 work. [89] The waste is usually burned to recover some of the materials or dumped, as the countries have no infrastructure to support recycling.

SOURCE: HEAVY INDUSTRY

Heavy industry refers to metal casting, stamping or rolling production processes that create very large sized and heavy metal parts. These parts are usually designed and created for use in other large industrial processes such as electric plants and automotive plants. The industry processes varies greatly depending on the material used and type of product produced. Possible materials include steel, iron, brass or aluminum. It is a multi-step process that features many different chemical additives, heating and melting of elements and large amounts of water. Chemical additives include but are not limited to benzene, formaldehyde, toluene, cyanide salts and hydrofluoric acid.[90]

Most large heavy industry plants in developed countries are now closely regulated and their emissions and pollutants are monitored. There are advanced pollution controls and waste treatment options for the industry. Despite this, there are over 70 polluted heavy industry sites in the Blacksmith Institute's database, potentially putting almost 3 million people at risk. The majorities of polluted heavy industry sites in the Blacksmith Institute's database are abandoned sites or are small-scale plants that are unlicensed, lacking controls and have little resources to invest in new technologies or controls. The sites are geographically widespread with China, Eastern Europe, South and Southeast Asia having a large percentage of pollution incidences from heavy industry.

The key pollutants present at heavy industry sites include chromium, cyanide, cadmium, arsenic, and VOCs. Lead is the top pollutant at these sites, contributing the most to the global burden of disease

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88 Ibid.

89 "The Real Deal: E-waste: West Africa continues to drown in the rich world's obsolete electronics." Consumers International. April 2008

90 "Guides to Pollution Prevention: Metal Casting and Heat Treating Industry." U.S. Environmental Protection Agency. Washington, DC. 1992. Available at: http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=30004KGC.txt

and affecting the largest population. Pollutants from heavy industry enter the environment through contaminated wastewater and air that affects soil, food and drinking water for the surrounding communities. Health effects from these potential exposures include neurological damage, lung cancer, leukemia and other lesser effects.

SOURCE: PESTICIDE MANUFACTURING, STORAGE AND USE IN AGRICULTURE

Pesticide is an umbrella term used for any substances that prevent or destroy pests and it includes insecticides, herbicides and bactericides. They are important components of our agricultural system since roughly one-third of agricultural crops are produced with pesticides.[91] In addition, pesticides like DDT are used to combat the spread of malaria through mosquitos. Pesticides are chemical compounds with an active ingredient, that are then mixed with other chemicals to produce specific effects or to suit the delivery method intended.[92] During manufacturing pollutants can be created from the reaction, from the filtering and purification systems, and from drying and extraction activities.[93]

Polluted pesticide manufacturing and storage sites and sites contaminated by agricultural practices investigated by the Blacksmith Institute potentially put close to 8 million people at risk at nearly 200 sites in the developing world. Pesticides are widely used throughout the world; key problem regions in the Blacksmith Institute's database include Eastern Europe, Central and South America and South Asia; China has become the largest pesticide producer and exporter in the world.[94]

Decaying storage facilities, waste from manufacturing processes and agricultural applications cause the majority of pesticide pollution. Over 4.6 million tons of pesticides, made up of 500 different types, are sprayed on crops annually.[95] When sprayed, only 1% of pesticides end up being effectively utilized, in most instances they are distributed into the air and water.[96] Surrounding communities directly consume pesticides through inhaling of contaminated air, ingesting or bathing in contaminated waters and ingesting food unknowingly covered with pesticides. When crops are irrigated the water picks up pesticides and carries them to surrounding waterways via runoff. The breadth and reach of dispersed pesticides is alarming:

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91 Zhan, W., et al. "Global pesticide consumption and pollution: with China as a focus." Proceedings of the International Academy of Ecology and Environmental Sciences. 1(2):125-144. 2011.

92 "Pesticide Industry: A Profile – Draft Report." Research Triangle Institute. Prepared for the U.S. Environmental Protection Agency, December 1993. Available at: http://www.epa.gov/ttnecas1/regdata/IPs/Agricultural%20Chemicals%20(pesticides)_IP.pdf.

93 "Environmental, Health, and Safety Guidelines for Pesticide Manufacturing, Formulation and Packaging." The World Bank Group. Washington, DC. April 2007. Available at: http://www1.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/IFC+Sustainability/Sustainability+Framework/Environmental,+Health,+and+Safety+Guidelines/

94 Zhan, W., et al. "Global pesticide consumption and pollution: with China as a focus." Proceedings of the International Academy of Ecology and Environmental Sciences. 1(2):125-144. 2011.

95 Zhan, W., et al. "Global pesticide consumption and pollution: with China as a focus." Proceedings of the International Academy of Ecology and Environmental Sciences. 1(2):125-144. 2011.

96 Ibid.

studies have detected levels of DDT, lindane and aldrin in tree bark at the equator and in Greenland ice sheets and Antarctic penguins.[97]

Blacksmith previously sited pesticides as a top pollution problem, while this remains true, health impacts from exposure to pesticides are difficult to quantify. There are many and varied forms of pesticides, some are more hazardous than others and there is a limited understanding of the health impacts of some pesticides. As an example of toxic pesticides, lindane and DDT are found frequently in polluted sites in the Blacksmith Institute's database and both are toxic to the liver and lindane is toxic to kidneys. DDT has also been defined as a probable carcinogenic in high doses and lindane as a possible carcinogenic for its link through animal studies to liver cancer. However, DDT in lower doses has not been proven to cause cancer and is still used to combat mosquitos in developing countries because of the overwhelming positive upside to reducing the incidence of malaria.

The technology and resources are available to remediate legacy pesticide storage sites and prevent exposure from manufacturing processes. Education and investment in newer manufacturing technologies could help prevent many instances of pollution. Currently, there are several international agreements and treaties that advance the safe management of pesticides. For example, the U.S., EU and 90 other countries signed the Stockholm Convention on Persistent Organic Pollutants, a UN treaty, in May 2001. The Stockholm Convention compels countries to reduce or prohibit production, use or release of 12 persistent organic pollutants, including several pesticides such as aldrin and DDT. In 2009, nine additional pollutants were added to the agreement, including the pesticide lindane.98 These type of international agreements help reduce human exposure to toxic pollutants and help countries safely manage chemicals.

SOURCE: URANIUM PROCESSING

Uranium processing for the purpose of creating nuclear energy is a complex, multistep process that includes the mining, processing, and refining of uranium ores, which then undergo enrichment processes. The problem with uranium processing is the amount and toxicity of the waste created. However, the very complex questions of spent nuclear waste disposal are beyond the scope of Blacksmith.

There is only a small number of nuclear fuel processing sites in the Blacksmith Institute's database, however these sites potentially put more than 1.3 million people at risk for severe health impacts. The majority of the sites are in Eastern Europe, the bulk of them located in Russia. Half of the sites are still in operation, while the other sites are legacy pollution sites that have been abandoned. Radionuclides such as uranium and cesium are the major pollutants at these sites. At the legacy pollution sites, radioactive waste was often disposed of directly into surrounding waterways, with no treatment or processing. At other sites, unintended spills or accidents released radioactive waste into the environment. Radionuclides are found in the water, soil and food chain of these contaminated areas and many serious health effects have been

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97 Ibid.

98 More information available at: Stockholm Convention Homepage at http://chm.pops.int/Convention/tabid/54/Default.aspx

observed. In addition to fuel processing, mining of uranium in low- and middle-income countries frequently contributes toxic pollutants to the environment, as discussed in the mining and ore processing section of this report.

Radionuclides are naturally occurring elements that are radioactive, meaning that they have atoms with unstable nuclei. As elements or materials decay, they will emit radiation up to an end point in the decay process. Some materials decay quickly, but some, like uranium, can continue to be radioactive for millions of years. During the decay, different levels of radioactivity with different health effects can be generated. Uranium radionuclides can cause damage to kidneys and to the genetic code, which can often impact fetal development. Other radionuclides, such as radon, can lead to leukemia and decreases in white blood cell counts.

CONCLUSION

This report illustrates the tremendous burden put on the health of the world's population by the release of toxic pollution from industrial and mining processes. As noted, these estimates of global disease burdens from toxic pollution are likely undervalued as many of the suspected and known health impacts of pollution are currently unquantifiable. In addition, pathway types, sampling capabilities, demographic data and access to polluted sites limited these estimates. However, this first attempt to assign DALYs to top polluting industrial sources clearly demonstrates the scope of the problem.

In total, the 2600 sites investigated by the Blacksmith Institute and Green Cross Switzerland put close to 80 million people at risk for a wide range of health impacts. From this research Blacksmith Institute estimates that close to 125 million people are at risk from industrial pollution worldwide. The total global DALYs attributable to pollution from industrial sources are estimated to be 17 million. This is large enough to be compared to disease burdens from other well-documented widespread diseases such as tuberculosis and malaria. The international community aggressively targets these diseases and continually allocates resources to eradicating them in developing countries. These well placed resources have made great strides in lowering the DALYs associated with these diseases. Unfortunately, despite the fact that the global burden of disease from toxic pollution is as serious, very limited resources are allocated to the prevention and remediation of polluted sites. Developing countries need the support of the international community to design and implement clean up efforts, improve pollution control technologies, and provide educational trainings to industry workers and the surrounding community.

Blacksmith, along with Green Cross Switzerland continues to identify and assess sites contaminated by toxic pollution in order to reduce the significant human health risks it causes. Continuing research and analysis of these sites will prove to further establish the expanding scope of this slow-moving public health disaster.

The scale of these issues is too large to be addressed solely by NGOs. Country governments are making important progress in dealing with the problem. However, further efforts are required and international support for country governments is essential.

While the problem of toxic pollution is invasive and prevalent, the solutions to treat and prevent it already exist and are ready to be implemented. The project examples presented in this report prove that the solutions to toxic problems are typically cost-effective and technically feasible. By engaging local entities and working together with public and private partners Blacksmith has proven that solutions can be delivered efficiently and effectively. The power to prevent hundreds of thousands of deaths and improve the quality of life of millions is in our hands; all that is missing is the determination and resources to implement the solutions.

ESTIMATED DALYS

	LEAD	CHROMIUM	ASBESTOS	CADMIUM	MERCURY	INDUSTRY TOTAL
Lead Smelting	2,600,000	0	0	0	0	2,600,000
Industrial Estates	1,000,000	60,000	0	0	0	1,060,000
Product Manufacturing	550,000	236,000	0	0	0	786,000
Mining and Ore Processing	2,000,000	380,000	140,000	100	1,500	2,521,600
Battery Recycling	4,800,000	0	0	0	0	4,800,000
Tanneries	130,000	1,800,000	0	0	0	1,930,000
Industrial Dumpsites	1,200,000	34,000	0	0	0	1,234,000
Chemical Manufacturing	300,000	465,000	0	0	0	765,000
Artisanal Mining	1,000,000	9,000	0	0	12,000	1,021,000
Dye Industry	80,000	350,000	0	0	0	430,000
Subtotal	13,660,000	3,334,000	140,000	100	13,500	
TOTAL DALYS	17,147,600					

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