Environmental Pollution 211 (2016) 346–353

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

The prevalence of toxic hotspots in former Soviet countries☆

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ARTICLE INFO

Article history:
Received 15 July 2015
Received in revised form
6 January 2016
Accepted 7 January 2016
Available online 18 January 2016

Keywords:
Pollution
Health
Environment
Assessment
Toxics
Post-Soviet

ABSTRACT

Using a global database of contaminated sites, toxic hotspots in eight former Soviet countries were analyzed to identify the prevalence, types and sources of toxic pollution, as well as their associated potential public health impacts. For this analysis, polluted sites in Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Ukraine, and Uzbekistan were compiled and analyzed. The levels of contamination of seven key pollutants were assessed in each country. 424 contaminated sites were identified using data from Blacksmith Institute. Pesticides, lead (Pb), radioactive metals, arsenic (As), mercury (Hg), chromium (Cr), and cadmium (Cd) were the most commonly identified key pollutants. Collectively, these sites pose health risks to an estimated 6.2 million residents. The existing data on toxic hotspots in former Soviet countries likely captures only a small percentage of actual contaminated sites, but suggests potentially severe public health consequences. Additional assessments are needed to understand the risks posed by toxic pollution in the region.

1. Introduction

A review of available literature does not correlate the occurrence of environmental pollution with potentially affected populations in former Soviet countries. This paper uses data collected by Blacksmith Institute, an international non-profit organization that addresses pollution and environmental health issues in low- and middle-income countries, to produce a descriptive analysis of highly toxic persistent pollutants in eight post-Soviet Union countries. The aim of the paper is to analyze the prevalence, types, and sources of toxic hotspots and assess the population potentially at risk of exposure. The eight post-Soviet Union countries examined are: Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Ukraine, and Uzbekistan.

2. Background

Following the end of World War II, mining, chemical production, weapons production and weapons testing in the former Soviet Union experienced unprecedented growth and wrought commensurate environmental degradation (Makhijani et al., 2000). Based on a calculated sum of the population at risk from Blacksmith Institute's Toxic Sites Identification Program, it is estimated that 17 million people, in both the eight countries under review and other former Soviet states, are at risk of exposure to an array of toxics resulting from those activities. In addition to potential affected populations, these industrial activities have also rendered as much as 40% of Russia's territory under moderately high to high ecological stress. (Glenn and Curtis, 1996a).

Prior to World War II, Russia had robust mining and smelting industries in the East European Plain, Ural Mountains, and Caucasus. During World War II much of this industry was moved to Central Asia and Southern Siberia. Mining activities in Eastern Siberia and Russia Far East were then expanded significantly following the end of the war. This unrestricted mining and industrial growth coupled with improper disposal of hazardous substances contributed to the significant active and legacy heavy metal pollution still affecting the region today. Lead and mercury

Abbreviations: TSIP, Toxic Sites Identification Program; ISS, Initial Site Screening; RSL, Regional Screening Level.

☆ This paper has been recommended for acceptance by Russell Dowling and Zachary Kashdan.

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http://dx.doi.org/10.1016/j.envpol.2016.01.019
0269-7491/© 2016 Published by Elsevier Ltd.

contamination from legacy mining and smelting industries are of particular concern as they have significant adverse health effects and can persist in the environment for a long time. (Horton et al., 2013).

From the inception of the Soviet nuclear project (circa 1943–44) until the Soviet Union's dissolution in 1991, an estimated 14,000 warheads, 700 tons of highly enriched uranium, and 100–150 tons of weapon-grade plutonium were produced. (Walker, 1992; Kurchatov, 1994) The resulting waste was often disposed in ways that would not be environmentally acceptable today. Some accounts reported that the waste was injected directly into the ground, or released into major sources of water, including the Techa River, and more notably, Lake Karachay. (Clay, 2001) Banned and obsolete pesticides also represent another important source of pollution in former Soviet countries. Stockpiles at collection points throughout the former Soviet Union can be found in unregulated burial sites and special landfills designed for the controlled storage of outdated pesticides. However, after the collapse of the Soviet Union, many burial sites were abandoned and exposure to obsolete pesticides increased dramatically. Pesticides were also occasionally excavated, repackaged, and illegally sold to local markets. (Vijgen and Egenhofer, 2009).

In the 1950s and 1960s, few protective environmental measures were taken due to the government's belief that the land could absorb pollution and repair damages from industry. (Glenn and Curtis, 1996b) Monitoring of pesticide concentrations in surface water was initiated in the late 1960s, though this involved only simple estimations until the early 1970s. (Kimstach et al., 1998) Stronger environmental regulations were not introduced until the 1980s. (Thomas and Orlova, 2001) Today, in almost all former Soviet countries, those regulations are still in place with few updates. After the collapse of the Soviet Union, industrial production decreased, but much of the pollution remains.

Blacksmith Institute has been identifying, assessing, and cataloging sites with high levels of contamination by persistent pollutants in a global database. Through the organization's Toxic Site Identification Program (TSIP) over 400 toxic sites have been identified in the following former Soviet countries: Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Ukraine, and Uzbekistan. This paper presents a descriptive analysis to deduce patterns of the contamination at these sites and recommendations for continued assessment and intervention.

3. Data source

In 2005, Blacksmith Institute initiated the Toxic Sites Identification Program (TSIP) for the purpose of identifying and screening toxic sites in low- and middle-income countries. TSIP was implemented in 47 countries as a collaborative effort between Blacksmith Institute, United Nations Industrial Development Organization, World Bank, European Commission, Asian Development Bank, and Green Cross Switzerland. The ongoing program endeavors to identify and screen contaminated sites where human health is potentially at risk. More than 3200 contaminated sites have been identified to date, and more than 1800 of those sites have been the subject of an on-site risk assessment that typically involves environmental sampling.

As part of the TSIP process, Blacksmith performs an Initial Site Screening (ISS) at selected sites that are suspected of having high concentrations of pollution and pose a risk to public health. The ISS is a modified version of the U.S. Environmental Protection Agency's (EPA) Hazard Ranking System. (Caravanos et al., 2014a, 2014b) The ISS processes the severity of potential human health risks through analysis of the following indicators:

- Concentration of the key pollutant;
- The exposure pathway;
- The size of the population at risk; and
- The severity of exposure taking into account spatial attenuation and medium migration.

Sites are identified through several methods including knowledge and expertise of local staff, stories in the press, investigation of previously identified legacy sites, collaboration with local governments or research organizations, and nominations. In former Soviet countries in particular, Blacksmith has a strong partnership with several research institutions such as the Russian Academy of Sciences. Once a potentially contaminated site is identified, contamination must be confirmed via soil, air, or water sampling. Blacksmith dispatches trained investigators to perform an ISS assessment during which they collect site information, environmental samples and other forms of data at selected sites. In rare cases where reliable environmental data is available from local partners and scientific institutions, site assessments are performed without site visits. Due to Blacksmith Institute's specialization in the remediation of abandoned "legacy" sites and sites contaminated by small-scale "artisanal" sources, sites fitting these descriptions are prioritized for site visits. The TSIP is an ongoing initiative, and the TSIP database does not capture every contaminated site in any country. However, in many countries it is the most comprehensive inventory available and captures a representative sample of contaminated sites.

After collecting the necessary information and entering it into Blacksmith's global database, the site entry goes through several levels of systematic review procedures to ensure quality and accuracy. (Ericson et al., 2013)

4. Methods

For this study, we selected sites in the TSIP database that met the following criteria: 1) the site is located Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Ukraine, and Uzbekistan, former Soviet countries where the TSIP program has adequate coverage; 2) the site has a specified key pollutant; and 3) the site is within the scope of TSIP—requiring there is a pollutant with known human health effects, is from a point-source, and has an identifiable migration route and exposure pathway to human populations. Sites were excluded from analysis if they did not meet all three inclusion criteria.

Two researchers confirmed the accuracy of site data by ensuring that a copy of the test or sample analysis results supported environmental sampling data. Furthermore, researchers confirmed global positioning system (GPS) coordinates using other known geographical information and Google Earth. Sites with supporting documents in Russian were reviewed by a bilingual researcher. The methodology for estimating the population at risk varies by sample medium. In the case of soil, investigators used Google Earth (Pro) or other satellite data to approximate the number of people in a one half mile radius of the site (based on numbers of houses or number of members per household on average for the country), since soil migration can be assumed at no more than 0.5 miles. Approximately 60% of samples included in the final analysis were soil samples.

Assessing water contamination is more difficult as it depends on the source (e.g. lake, river, etc) and determining the number of people that are exposed via all pathways (dermal, ingestion, etc). The same can be said for air pollution, as the number of people at risk can be difficult to determine due to the possibility for long distance migration. These sites represent only a small percentage of contaminated sites found in the database. In general, population