Evaluation and management of arsenic contamination in agricultural soil and water - AgriAs

Deliverable 4.3. Risk assessment of arsenic in the soils of two selected target sites

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Public Summary

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The report describes the preliminary assessment of the risks from arsenic in the soils of the two target sites studied within the AgriAs project.

Health risks have been estimated using the exposure model developed within the AgriAs project. Risks to the environment have been studied in other work packages in AgriAs (WP2 and WP3) and are summarised in this report.

Risk assessments were carried for both sites before and after remediation measures have been applied. Initial risk estimates were carried out for the two test sites in Saxony, Germany and Verdun, France, using site-specific input data, as far as possible.

For the Saxony site, the results of the investigations carried out in AgriAs were used to derive the median concentration in topsoils. Arsenic concentrations in grains and fodder and site-specific plant uptake factors (grains and fodder) both before, and after, mitigation measures, were derived from the results of AgriAs. Earlier studied of the Saxony area were used to derive input values for arsenic concentrations in groundwater and surface water, plant uptake factors for a number of plant species (barley, winter wheat, pasture, grass and herb species), arsenic concentrations in some animal products, dust concentrations in air and arsenic concentrations in dust.

For the Verdun site the concentrations in soils were derived from the results of field investigations. The concentrations of arsenic in groundwater and surface water were derived from the results of field investigations with reference to the results of the experimental studies. Arsenic concentrations in plants and plant uptake factors were derived for lettuce and barley from the experimental studies within AgriAs. The concentrations and plant uptake factors of some other plant groups could be derived from the results of field studies. The arsenic concentrations in some further fodder and food groups (including some animal products) could be taken from a previous study of arsenic in a similar ammunition-destruction site. Plant uptake factors were higher for grains than for other plant groups. Only generic data were available for non-leafy vegetables, root vegetables and fruit.

The measured concentrations of arsenic in animal products at both sites were used to validate the generic fodder to animal-product transfer factors that are included in the model. The modelling results for animal products showed that for some animals (beef cattle and sheep), ingestion of soil can be as important as fodder consumption for the total intake of arsenic.

For both sites the preliminary assessment showed that the risks from exposure to arsenic at the contaminated site dominated the total arsenic exposure. For the Verdun site, on-site exposure gave more than 75% of the total exposure due to intake of plant- and animal produce. The corresponding value for the Saxony site was 90%.

The most important exposure pathways were the intake of vegetables and fruit from the contaminated site. The intake of animal products also gave a significant contribution to the total exposure, followed by the direct oral intake of soil and dermal contact at the contaminated site.

The inhalation of dust gives an insignificant contribution to the total dose at both sites. Sensitivity analyses showed that even if the dust concentration in the air is assumed to be high, the inhalation exposure pathway is not important. However, inhalation of dust concerns only the PM10 fraction of dust, which passes the larynx to the lungs. Larger dust particles are cleared from the airways to the throat, where they are swallowed. Exposure due to larger dust particles is therefore included in the oral intake pathway. Because of the way that the intake of soil in people is measured, it is difficult to separate these two exposure pathways entirely. Ingestion of inhaled dust is expected to be most important for agricultural workers.

Transport to groundwater is not important at either of the test sites, since the consumption of drinking water taken from groundwater does not occur at either site. If the groundwater aquifer was a drinking water source, and became contaminated, this would change the results.

The preliminary risk assessment gives conservative estimates of the risk. For a small site, such as the Verdun site, the scenario considered is unrealistic because it is not possible to grow all the different types of crops considered and also raise animals on land with the size of the contaminated site. For both sites, estimates of bioavailability used in the preliminary assessment are most likely conservative. Conservative estimates are also made concerning the extent that people living on or near the sites have direct contact with soil (direct oral intake, skin contact and inhalation of dust) to the extent assumed in the preliminary assessment.

The effect of the soil amendments that have been studied for the Verdun site were estimated to reduce the lifetime exposure to arsenic by about 30% when applied to the production of all crops. The soil amendments studied for the Saxony site were estimated to reduce the lifetime exposure to arsenic by about 40% when applied to the production of all crops, and by about 30% when applied to the production of grains.

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