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

Recommendations for the sustainable management of the risks linked to the land and aquatic environments

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Public Summary

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The AgriAs project has summarized national and European databases and developed recommendations and guidelines for the sustainable management of arsenic (As) in the soils of agricultural areas. Research institutes, universities and companies from five European Union countries have participated in the project.

In European agricultural soils, some arsenic anomalies can be linked to the natural geochemical background, but some have an anthropogenic origin. The AgriAs project has two As-contaminated study sites. The French study site is an area where World War I chemical ammunition was destroyed. It is located in a sensitive zone both for agriculture and groundwater. The German site is characterized by 800 years of mining and ore processing.

Arsenic treatment technologies have been developed and demonstrated.

Biological tools have been tested or developed and then applied to assess ecological and environmental risks.

In the stakeholder workshops organized in Freiberg, Germany, in September 2017, in Tampere, Finland, in June 2018 and in Orleans, France, in September 2018, interaction and active discussions between farmers, authorities and researchers took place. Recommendations have been developed in Saxony where local authorities annually update recommendations how to manage contaminated soils used for agriculture and gardening. The studies of the Verdun site (field, microcosm and laboratory studies) focused on the mobility, phytoavailability and phytoxicity of As and the transfer of As to the water systems. Promising results were obtained with microbial and plant bio-indicators of the availability and toxicity of arsenic. The effects of soil amendments on the uptake of arsenic by crops were studied at both sites.

Numerous data gaps were identified for future research. For example, no data were available in the European-wide mapping programmes from two countries: Moldova and Turkey, and Romania were missing from the GEMAS survey and Norway from the LUCAS survey otherwise carried out on the European level. There is no up-to-date data on As concentrations in European groundwater related to agricultural sites. More data should be collected from surface waters if they are in the same watershed to As-rich soils in small catchment areas. Data on the transfer of arsenic in the food chain (from soils, to crops, to animals and to food products) are lacking for a number of important foods.

Development of risk assessment models is recommended so that the physical and chemical form of arsenic in the releasing and receiving environments can be included. This will allow the effect of important environmental factors, such as redox conditions, to be taken into account.

The exposure of people to arsenic in certain areas is equal to or exceeds the exposure which is considered to be a low-risk level. Therefore, reduction of exposure is appropriate in these areas. We recommend that the authorities should make efforts to keep As concentrations as low as reasonably possible in food and drinking water by applying effective soil and water treatment processes.

For drinking water, the minimum requirement is the WHO guideline for arsenic concentration, i.e. 10 µg/L. Treatment methods for soil can be divided into two main

categories: methods for the removal of pollutants (soil washing, in situ soil flushing, electrokinetic treatment, phytoremediation, biological treatment) and methods for the immobilization of pollutants (solidification, vitrification, soil amendments/adsorbents). The most commonly used technologies for water treatment are precipitation, adsorption and membrane processes. These technologies meet the requirements for sufficient arsenic removal efficiency for drinking water. Thus, particular attention should be paid to the environmental sustainability of the methods as well as the economic aspects. Technologies, which require a minimum amount of chemicals and which minimize the amount of secondary waste are the most favorable when selecting the treatment methods. The purification technology should be chosen case-specifically considering the characteristics of the water to be treated.

Treatment processes for soil can be divided into two main categories: methods for the removal of pollutants and methods for the immobilization of pollutants. The most commonly used technologies for the water treatment are precipitation, sorption and membranes processes. The most common treatment technologies for agricultural soils are immobilization of arsenic by soil amendments. Particular attention should be paid to the ecological sustainability of methods as well as the economic aspects. Technologies requiring a minimum amount of chemicals and minimizing the amount of waste are favorable when selecting the treatment methods. Environmental sustainability is expected to play a major role in the current climate change era.

We recommend that the future research should pay more attention to the interrelation of different contaminants in soil and water systems. In our test sites, and in many other As-contaminated areas according to our experience and the literature, other metals and organic contaminants are present in concentrations that imply risks to health and the environment. The effects of emerging contaminants like medical residues, hormones, pesticides, herbicides and microorganisms on the behavior of arsenic are poorly understood. Other contaminants are also important with regard to amelioration techniques for soil, as the immobilisation of arsenic can cause other contaminants to become more mobile.

The European Commission withdrew the drafts of the European Soil Protection Directive in 2016 but the results from our project show that the need for coordinated management of the problems of As-contaminated soils remains. This could be achieved with guidelines and regulations developed in close cooperation with the stakeholders both in the national and at the EU level. Soil contamination by arsenic can be caused by various sources: e.g., mining and processing of sulphide ores, residues of weapons, mineral occurrences, dust from smelters and pesticides. Soil contamination has consequences not only for agricultural products but also for the contamination of groundwater and air. Within the AgriAs project, regulatory solutions based on the German law are presented as examples.

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