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

Assessment and Evaluation of Existing Recommendations and Guidelines on Arsenic in the Environmental Systems

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Public Summary

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Arsenic (As) is a naturally occurring metalloid. Arsenic contamination of water is known to affect humans and an estimated 200 million people worldwide are exposed to high As concentrations through drinking water. While drinking water remains the major source of exposure, there has been a growing evidence that As in the food chain has a significant contribution to the overall exposure. The AgriAs project is focused on the filling the gaps in knowledge about the occurrence of As in European soil and water, its toxic effects in water ecosystems, as well as on the technologies for the removal of As from soil and water. A framework for the management of agricultural land with elevated arsenic concentrations in soil will be developed.

The objective of this study (Task 5.1) is to carry out a baseline assessment and evaluation of the existing recommendations and guidelines for As in soil and water systems relevant for the scope of the AgriAs project.

A review of available criteria for inorganic As in environmental media shows that toxicological reference values for As have been reviewed by EFSA, but that the toxicological reference values based on the risks for lung cancer, skin cancer and bladder cancer, are at about the same order of magnitude as earlier toxicological reference values. In Europe, the lifetime risk of cancer due to As exposure are for some populations already at the level of 1 per 100.

The WHO guideline value of 10 µg As/l complies with the drinking water standards of the EU, US EPA and several other regulatory authorities across the world. However, in the Netherlands, the guideline value for drinking water has recently been lowered to 1 µg As/l, in view of the ability of water treatment methods to reduce As concentrations, and the resulting reduction in risk from As exposure through drinking water.

Guideline values for As are not available for a comprehensive range of foodstuffs; at present criteria are available only for rice and one or two other groups of foodstuffs. There are few criteria for arsenic in animal fodder. In addition, criteria for arsenic in soil may lead to an overestimation of the risks from arsenic in agricultural soils as they do not take into account site specific variations in bioavailability, mobility and uptake into the food chain. Criteria for protection of the soil environment and the aquatic environment have been derived by a small number of organisations, but the resulting criteria are associated with large uncertainties. It is not possible to use these criteria to account for the effect of site-specific properties on As toxicity.

Exposure models for As consider different combinations of exposure pathways, but most include consumption of contaminated water and foodstuffs, and direct exposure to As contaminated soils. For some exposure pathways, there is a lack of data concerning the transfer of As, for example As uptake in plants and arsenic transfers to animal products, uptake of arsenic following dermal contact, and the bioavailability of As for uptake by plants and gut-uptake by humans and animals.

An exposure model is being developed to study the exposure of people to As from agricultural soils. The model can estimate exposure from measured concentrations in environmental media. Where measured concentrations are not available, estimates may be made using generic transfer factors. The model will consider ingestion of contaminated drinking water (groundwater or surface water), ingestion of contaminated foodstuffs (several categories of plant and animal products and fish), and direct exposure to the soil (direct oral intake, skin contact, dust inhalation). The modelling of individual exposure pathways is based on existing models, including the Swedish model for guideline values for contaminated soils, and the Caltox model. The exposure model may be used together with a soil model, considering changes in the As concentrations in the soil due to As leaching, uptake by biota and other losses as well as return of arsenic to the soil, for example in unharvested parts of plants, in manure, deposition from the air. Parameters of the soil model and the bioavailability parameters in the exposure model may be adjusted to take site specific factors and the results of geochemical modelling into account.

Biogeochemical mechanisms that control the fate and transport of As in environmental systems are complex and therefore geochemical modeling may help in risk assessment. In the AgriAs project, BRGM is developing a reactive transport model which will be included in the modelling of As mobilization in the agricultural soils.

There are gaps in knowledge needed for reliable risk assessment and risk management of arsenic in agricultural soil. Existing guidelines and recommendations for the countries where the AgriAs test sites are situated, Germany and France, are described. The future research needed as background information for the compilation of the recommendations will be discussed in more detail in the last deliverable of WP5, D5.3, but the issue is also briefly touched in the conclusions of this report.

Many sections of this report have been copied and modified from Jones et al. (2018).

Reference: Jones, C., Elert, M., Jordan, I., Lions, J., Battaglia, F., Mueller, I., Bhattacharya, P., 2018. Deliverable 4.1. Collation of evaluation criteria for assessment of the risks from arsenic in agricultural soils. Deliverable 4.1. of the AgriAs project ‘Evaluation and management of arsenic contamination in agricultural soil and water’, Water JPI Joint Call, ERA-NET Cofund WaterWorks2015. 45 p.

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