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

Deliverable 1.3. Evaluation of test methods for ecotoxicological tests, purification methods, risk assessment methods – Public Summary

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Executive Summary

Arsenic (As) and its compounds are toxic and ubiquitous in the environment. It has been estimated that over 220 million people are exposed to As from drinking water or food. Arsenic in agricultural soils and water, and its entering into the food chain can cause risk to human health, as As can accumulate in plants such as rice or barley. High As concentrations reduce crop yields. In many European countries agricultural topsoil is affected by elevated arsenic concentrations. The occurrence of As in the environment, its toxic effects in water ecosystems, as well as technologies for the removal of As have been widely studied over the past decades. However, several important gaps remain and that is why the European project AgriAs was initiated. The overall goal of the project is to provide the European Union with reliable data on the existing risks of As exposure through agriculture, a complete summary of existing tools available for As remediation as well as an array of tools for ecotoxicity and bioavailabilty assessment. One important target of this project is also to distribute knowledge about the fate of As in agriculture and therefore, cooperation with stakeholders plays an important role. For this purpose, stakeholder workshops are carried out within the framework of AgriAs. The present deliverable report should provide an introductory material for these and future workshops. It compiles information about existing test methods for ecotoxicological tests, purification methods and risk assessment methods, that are available for As polluted soils and waters. Moreover test work performed within AgriAs is introduced.

In order to understand the ecotoxicological effects and risk assessment of As as well as the fundamentals of treatment processes, the **interactions of As with the surrounding environment** must be looked at. Chapter 2 will give an overview about that.

In chapter 3, **treatment technologies for soil remediation** are explained. Remediation of contaminated soil aims at eliminating or reducing the risk of harmful effects on existing ecosystems. Treatment processes can be divided based on their fundamental approach into methods for the removal of pollutants (soil washing, in situ soil flushing, electrokinetic treatment, phytoremediation, biological treatment) or methods for the immobilization of pollutants (solidification, vitrification, soil amendments/ adsorbents). Literature research revealed that the development status of treatment processes differs a lot and that there are various advantages and disadvantages for each process. When applying methods to agriculturally used land, particular attention must be paid to ecological sustainability of methods as well as economic aspects.

Treatment options for polluted water are compiled in chapter 4. Arsenic contamination can affect groundwater through fertilisers, pesticides, mineral dissolution, mining, geothermal processes, desorption in oxidizing and reductive environments, and volcanic activity. According to UN and WHO, arsenic poisoning is the second most hazardous to human health and that is why the treatment of drinking water from polluted groundwater sources is indispensable. Treatment possibilities (oxidation process, adsorption, coagulation-flocculation, ion exchange, membrane filtration, subsurface removal, biological treatment) are explained and assessed regarding their market availability and economy. Results showed that the market for As removal can be simplified into three major categories such as precipitation processes, sorption processes, and membrane processes.

Before remediation measures are applied, it is necessary to assess both the extent and the effects of pollutants on the sites. Once the risk potential has been proven, it must be examined which remediation technologies are best suited for economic and sustainable remediation. In case of

agricultural land, it is important to take measures to allow ongoing use of the land. **Ecotoxicological tests** are used to determine the effect of a hazardous substance on biological organisms, at the population, community and biosphere scales. Suitable tests for As in soils (based on acute toxicity to earthworms, earthworm reproduction, nematodes reproduction, development of terrestrial plants) and water (based on the immobilization of water organisms, development of water plants, enzymatic activities of cells) are given in chapter 5. This information is used for the prediction of the effect of pollution on an ecosystem and the derivation of suitable measures for prevention or remediation. Moreover, specific bio-indicators (e.g. the abundance and activity of As(III) oxidizing or As(V) reducing microbes, plant`s omega-3-index for oxidative stress) can be applied to assess the bio-availability of As in soils. Such additional tests can not only be used to support the results of ecotoxicological tests but also to allow an evaluation of the impact of agricultural amendments on As availability for organisms.

The determination of an existing risk for human and the environment can be derived with a **risk assessment**, which is explained in chapter 6. By relating the risk of a substance to the amount of substance to which a person is exposed, the likelihood of both a health hazard and its severity can be estimated. For this purpose, risk assessment of a substance can be conducted in four consecutive steps: 1. identification of a potential hazard, 2. description of the hazard potential, 3. evaluation of exposure and 4. risk characterization. The results of risk assessment should end in an adapted risk management strategy. In most cases, large-scale soil remediation of agricultural sites in a conventional way is not applicable due to high expenses that are disproportionate to the results attained. Hence, further measures must be taken to protect individuals and control the transport of pollutants. A sound risk assessment forms the basis for the selection of such measures for an optimized land use of As polluted agricultural sites.