PREFACE

Environmental geochemistry and health (EGAH) Special Issue “reclamation of polluted soils for food production and human health: part 2”

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Background

This collection of papers submitted to this Special Issue is mainly an outgrowth from the Session SSS8.2. EGU 2019 “Soils under industrial and agricultural impact and their improvement to enhance the quality of food production and human health”, Vienna, April 2019.

Soils are the basis of terrestrial ecosystems and crossroad of biogeochemical cycles at the lithosphere–hydrosphere–biosphere–atmosphere interface. Soils are limited and vulnerable resource and soil quality must be preserved. Soil is subjected to physical and chemical degradation and needs reclamation. To survive and develop as species, humans should take urgent, short-term decisions and use scientifically based approaches to find a stable existence in a changeable noosphere. Humankind should optimise the eco-geochemical state of anthropized soils, improve the quality of agricultural and forestry

production and finally human health in conditions of man-made contamination.

This Special Issue contains 14 papers written by authors from 13 countries: Belarus, Botswana, Chile, China, Denmark, Egypt, Germany, India, Iran, Pakistan, Russian Federation, Spain, and Thailand.

In the following paragraph, I will summarize the content and main results of these papers published in this Special Issue. The order of papers is based on submission data.

Content and main results of the papers of this special issue

Gautam et al. (2022) investigated the stabilization of metals in sludge-amended soil using red mud (RM) and its effects on yield and oil quality of *Brassica juncea* cultivar Kranti. The authors conducted a pot experiment in open field conditions for five months to evaluate the metal(oid) (Al, Cu, Zn, Cd and Cr) stabilization potential of RM in sludge-amended soil and its effects aforementioned. The test plants were grown at different RM concentrations. Increasing RM concentrations in sludge-amended soil effectively stabilized Cd followed by Cr, Cu, Zn and Al, leaching to their reduced contents in plants coupled with enhanced growth performance and yield. Maximum plant (root and shoot) biomass (14.9%) and seed yield (40.4%) were found in 10% RM treatment, whereas oil content showed substantial increase with increasing

The articles “Adelisardou et al. (2022)” and “Popa et al. (2022)” are intended for the special issue “Reclamation of polluted soils for food production and human health: Part 2”. However, “Adelisardou et al. (2022)” was inadvertently published in the issue Vol. 43(10) and “Popa et al. (2022)” in the issue Vol. 43(1).

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RM treatments in sludge-amended soil. Metal(oid) content in seeds under RM treatments were within FAO/WHO limits for consumption.

Malik et al. (2022) evaluate the ameliorative role of melatonin against Cr toxicity in maize seedlings. The results showed that Cr toxicity exerted severe effects on growth and physiology of maize seedlings by retardation of biomass, hampering of root architecture, disruption of photosynthetic apparatus and reactive oxygen species (ROS) generation. Melatonin (MT) improved root structures and alleviated Cr-induced chlorophyll and carotenoids inhibition, improved water content and lowered proline and malondialdehyde (MDA) content in shoots. Lower accumulation of MDA and proline, and greater membrane stability indices indicate that the MT conferred better plant growth by playing the role of antioxidant and detoxifying oxidative stress creating substances. The MT provision helped the plants in maintaining leaf water status and reducing Cr translocation from the roots to shoots.

Luo and Lu (2022) investigated the inhibition of in situ coating of sediment ceramsite on sediment nutrient release of eutrophic lakes. The authors researched the inhibition effect of a ceramic lead wire cage on sediment resuspension on water quality and the growth of indigenous microorganisms through 25 experimental groups to simulate 5 flow patterns of eutrophic lakes. They are monitoring the change of suspended matter content and the change of ammonia nitrogen and soluble phosphorus. Results show that in a certain flow mode, the ceramic lead wire cage can effectively inhibit the resuspension of the sediments and promote the growth of microbial attachment.

Iqbal et al. (2022) assessed the Cd and Pb tolerance potential of quinoa and its implications for phytoremediation and human health. The authors exposed three-week-old quinoa seedlings to Cd (30, 60 and 90 mg kg⁻¹) and Pb (50, 100 and 150 mg kg⁻¹) levels along with a control. The results revealed that the quinoa plant shows different response to Cd and Pb toxicity such as physiological changes, membrane stability index and antioxidant enzymes activities. However, the Cd accumulation in seeds is higher than permissible limits suggesting that seeds grown on Cd contaminated soils are not suitable for human consumption. The index for health hazard shows that Cd values were greater than Pb for human health risk.

Guillén et al. (2022) assessed the human health risk of potentially toxic elements (PTE) in the urban-periurban soils from Huelva Township, SW Spain, evaluated by in vitro gastric extraction. The soils present high concentrations of PTE higher than permissible limits. A site-specific risk assessment of exposure (oral ingestion, oral inhalation and dermal contact) was conducted following the regulatory norms. The evaluation of oral bioaccessibility was made by dissolving the samples in a solution of HCl and 0.4 M glycine. The adjusted-relative bioaccessibility total carcinogenic risk for As exceeded the regulatory in almost all samples, indicating that children are more vulnerable, while non-detrimental health effects are expected for Pb. The adjusted hazard index for non-carcinogenic effects also overpassed the threshold values for adults and child. The reported soils should be classified as polluted and therefore decontaminated.

Tume et al. (2022) established background levels of potentially toxic elements in soils, in the city of Coronel, Chile and assessed the pollution and its origins. 129 samples from 49 sites in schoolyards in Coronel were collected (3 at each site, 0–10, 10–20 and 150 cm. depth. Principal component analysis (PCA), cluster analysis (CA) and depth ratios were applied to distinguish the origin of the contamination. The geoaccumulation index, contamination factor and the integrated pollution index were used to estimate the pollution. PCA and CA suggested that Co, Ni and Mn mainly derive from geogenic origin, while Ba, Cr, Cu, Pb, V and Zn from anthropic origin; Mn showed both sources. The contamination factor indicated that some soil samples are very highly contaminated by Ba, Pb, Zn and V.

Korobova et al. (2022) studied the identifying patterns in the distribution of pollutants in the elementary landscape-geochemical systems (ELGS) of the temperate zone. The authors used ¹³⁷Cs as a tracer in the Bryansk region in the Chernobyl abandoned area and applied an original technique of repeated ¹³⁷Cs measurements along cross sections accompanied by topographic survey and soil cores sampling. The results showed a complete absence of a constant increase in ¹³⁷Cs concentration downslope but revealed a steady regular variability of ¹³⁷Cs activity of a cyclical type. A specifically regular structure obviously formed under the set of

radionuclide water migration processes seems to be inherent in all systems of the studied type.

Jiang et al. (2022) investigated the source apportionment and health risk assessment of Cu, Pb, Cr, Zn, Ni, As and Cd in soil from Gannan mining areas in NW China. The pollution index values indicated that As and Cd have a moderate to high pollution levels. The geo-accumulation indexes indicated that Cu, Pb, Cr, Zn and Ni are likely of geologic origin, while As and Cd have been affected by anthropogenic activities. Potential ecological risk indexes showed that soils from mining areas pose a high potential ecological risk, and As and Cd were major risk contributors. The hazard index indicates that the ingestion of soil particles seems to be the main exposure route resulting in a higher risk, followed by dermal contact. The carcinogenic risk associated with As for local residents was higher than the acceptable levels.

Gong et al. (2022) studied if hand-to-mouth contact is the main pathway of soil and dust intake by children in Gansu, Guangdong and Hubei provinces, China. Children ($n = 240$) between the ages of 2 and 17 years were randomly selected from the aforementioned cities. The total amount of soil and dust (SD) on children's hands ranged from 3.50 to 187.39 mg (median = 19.49 mg). The four trace elements used in this study (Ce, V, Y and Sc) were screened and Ce performed best data to estimate the amount of hand SD and hand-to-mouth contact ($E_{\text{hand SD}}$) in the three provinces. The main factors affecting SD amount were location and age group, as identified using a conditional inference tree. Hand SD and the hand SD intake were highest in Gansu Province, followed by Guangdong and Hubei. Hand SD and SD intake rate was highest among children in primary school, followed by kindergarten and secondary school. Results show that hand-to-mouth contact is not the main route of soil intake for Chinese children in the three provinces.

Alekseenko et al. (2022) focused their study on the assessment and abatement of the eco-risk caused by mine spoils in the Novorossiysk industrial agglomeration on the Black Sea coast of the NW Caucasus, Krasnodar Krai, Russia. To assess the eco-risk, topsoil horizons of urban and mine-site Technosols and background Rendzinas were sampled and analysed. The cumulative pollution index of pedochemical anomalies reaches the high-risk level over the areas of up to 5 Km². To abate the risks of the dumps cost-effectively, reclamation actions including soil

stabilization by application of geosynthetic cover, hydroseeding of the mixture of soil improvers and seeds of herbaceous plants on the slopes and anti-erosion of *Juniperus oxycedrus* L. and *Cotinus coggyria* Scop. at subhorizontal surfaces.

Matveeva et al. (2022) developed a reclamation method based on the phosphogypsum utilisation as a mineral component of an organic-mineral mixture without preliminary purification is the most promising approach. In this case, the joint utilization of lignin sludge as an organic component is required. The absence of excess content of toxic elements and the presence of plant nutrients in the required quantities were established as a result of laboratory studies of soil additives. Also, the authors noted an increased content of Sr in phosphogypsum, ensured by fractional application. Strontium is replaced by covalent Ca when the components are absorbed by plants. The developed soil mixture should be considered as a single use organomineral additive with prolonged action.

Pongpiachan (2022) studied the geographical origin of rice from several Southeast Asian countries based on PAHs composition and hierarchical cluster analysis (HCA) and principal component analysis (PCA). This is the first study to carefully evaluate appropriateness of using PAH congeners to identify rice planting areas. Although the majority of rice samples studied were dominated by 5–6 ring PAH congeners, the percentage contribution of 3–4 ring PAHs detected in rice samples collected from Lao PDR was 67%. The results showed that the origin of the studied rice samples was: (1) with 5–6 PAH ring, 33%, Bali and Yogyakarta, Indonesia, West sides of Malaysia, Thailand, Myanmar, Cambodia, (2) with 4 PAH ring, Lao PDR, 46%, and (3) 3 PAH ring, 21%.

Manyiwa et al. (2022) assessed the heavy metal (HM) contamination in soil, plants and associated risk on grazing ruminants in the vicinity of BCL Cu-Ni mine in Selebi Phikwel, Botswana. The quantification of HM in 82 plant samples revealed that some plants such as *Boscia albitrunca* and *Boscia foetida* are metallophytes suitable for phytoremediation. Soil contamination was manifested by acidification, a high EC, high contamination factor and a pollution index between 8.31 and 10.79. Daily intake showed a risk associated with Pb and Cu contamination among grazing animals in the study area.

Martínez-Sánchez et al. (2022) evaluated the uptake of potentially toxic elements (PTE) by three edible plants for human consumption and farm animal consumption, broccoli, lettuce and onion, in one uncontaminated soil and different Technosols. These Technosols were obtained from soils and sediments of mining origin and amended with residues of high CaCO_3 concentrations: limestone filler and construction and demolition wastes. The experiment was carried out in a greenhouse and the total metal(oid)s concentration (As, Pb, Cd, Cu, Fe, Mn and Zn) of the soil, rhizosphere, aqueous leachates and plant samples were monitored and the translocation and bioconcentration factors calculated. The results showed that the levels of PTE present in the cultivated species with calcareous amendments are within the range of values mentioned in the literature, but when the plants grown in contaminated soils, the PTE levels varied greatly according to the species, being higher in onions than in lettuce.

Conclusions

The subject of the Part 2 of this Special Issue is of great importance and 14 papers cover significant aspects of fundamental theoretical and applied research in reclamation of contaminated soils for food production and human health and providing advances to existing knowledge.

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