Preface

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1 Background

The collection of papers presented in this Special Issue is an outcome of the SSS8.1 Session “Soil Pollution and Remediation” of the General Assembly of the European Geosciences Union (EGU) held in Vienna (Austria) on May 2, 2014. This Special Issue is focused on new data about the source, fate, and behavior of inorganic pollutants such as heavy metals and metalloids, nitrogen compounds, and organic compounds such as PAH and others related to mine soils, coking and gas plants, backfills, etc. Obviously, this enormous variety of harmful substances that can produce local or diffuse soil pollution call for innovative technologies of prevention, monitoring, analytical techniques, risk assessment, and eco-friendly and cost-efficient remediation (bio and phytoremediation, thermal, soil washing, electrokinetic, etc.). The papers in this issue cover important aspects of fundamental and applied research and provide advances in relation to existing knowledge. This Special Issue contains 24 papers written by authors from 16 countries: Austria, Bulgaria, China, Croatia, France, Gabon, Italy, Jordan, Mexico, Mongolia, Pakistan, Portugal, Russia, Serbia, Spain, and Turkey. This collection of papers is focused mainly on seven topics: (1) metals mobility, (2) sequential extraction and analysis standardization, (3) urban soils, (4) mining site soils, (5) remediation of organic pollutants, (6) cautions in the use of sewage sludge and waste water as amendments, and (7) soil-plant interactions.

2 Research topics

2.1 Metals mobility

Two papers deal with this topic.

Kralj et al. (2015) used multi-element signatures of stream sediments to assess both natural and human-induced impact on the fluvial system in the River Neretva delta (Croatia) environment over time. The authors applied multivariate statistics, mainly performing regression lines of Al and TMs concentrations and the relative of R^2_{adj} and presented the statistical significance (P) to ascertain the capacity of the different properties for discrimination between sediment samples from the sub-catchments within the study area. The geochemical features of major and trace elements and ^{137}Cs activities show complex sediment provenances.

Petrovic et al. (2015) investigated the spatial and vertical distribution of ^{137}Cs in the eroded soils of the Poinja and South Morava River Basins (SE Serbia). The authors concluded that in most soil profiles, ^{137}Cs is present in the upper horizons decreasing with depth, as is typical on uncultivated soil. Its spatial distribution was very uneven among the surface horizons of the investigated sites, probably due to soil erosion. This hypothesis must be verified.

2.2 Sequential extraction and analysis standardization

Three papers constitute the second topic.

Jordán et al. (2015) proposed a methodology to determine electrical conductivity (EC) and a bioavailability assessment of heavy metals in biosolid pellets using the BCR sequential extraction procedure. The biosolids were selected from three different areas of the composting pile: the isolation surface, the mesophilus, and the termophilus areas. The authors thought that this method could be useful for establishing a general rule for

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measuring EC and heavy metal (HM) content in biosolid pellets.

Nevidomskaya et al. (2015) studied Pb^{2+} speciation in Chernozem soils and the relationship between the metal ion and soil components using X-ray absorption spectroscopy (XANES and EXAFS) and chemical sequential fractionation. The authors concluded that the increased degree of soil contamination with Pb is accompanied by a decrease in the stable connection between metal and soil components. Pb ions are incorporated in the positions of the inner-sphere complex replacing some Al ions in the octahedral sites. This results in changes of the Pb-O distances in Pb-bearing octahedrons. The authors suggest that Pb^{2+} is also sorbed by dimer (Pb-Pb) silicate and/or Al groups. The structure of adsorbent surface plays the key role in the sorption of Pb^{2+} by mineral phases.

Sager (2015) purposed standardized procedures for agricultural soil analysis in substitution of traditional methods that use different extractant solutions by the use of multi-element determination techniques like ICP-OES and ICP-MS. The author recommends a sequential leaching with dilute acetic acid and acid ammonium oxalate which enables to obtain information about common cations including trace elements and the non metals phosphorus, silicon, sulfur, boron, and iodine simultaneously and predict availabilities in shorter and longer periods of time.

2.3 Urban soils

Three papers are concerned with the third topic.

Bezuglova et al. (2015) studied the specific features of heavy metal contamination of soil cover in the city of Rostov (South Russia) and its agglomeration. The results showed the greatest concentrations of elements in the parent rock of Rostov-on-Don, which exceeded the background values; some elements surpassing the maximum permitted concentrations. The input from the anthropogenic sources is evidenced by the accumulation of such elements as Cr, Ni, and Zn in the surface horizons. The level of contamination is estimated as permissible ($Z_c < 8$). An exception was the profile close to the former location of the paint, varnish and lacquer plant.

Mombo et al. (2015) studied the management of human health risk in the context of kitchen gardens polluted by Pb and Cd near a Pb recycling company. The authors concluded that metal bioaccessibility measures integrate the influence of metal type, plant type, and soil physicochemical properties. Therefore, they proposed that human bioaccessible fraction of metals may be taken into account, as well as total metal quantities and bioaccumulation factors in risk assessment studies performed in gardens.

Timofeev et al. (2015) evaluated the geochemical transformation of soil cover of the Erdenet mining city (Mongolia) to assess the environmental risk associated with soil cover

contamination. The authors found that the major contaminants Mo, Cu, and Se were in the industrial zone with risk from soil pollution over one-fifth of the city. Maximum risk values were found at the Erdenet processing plant, which underscore the need for remedial action to reduce negative impacts of HMs and metalloids on workers' health.

2.4 Mining site soils

Seven paper in this Special Issue refer to this fourth topic.

Pérez-Sirvent et al. (2015) describe the environmental relevance of efflorescences, topsoils, and surface waters from the abandoned mine of Sierra Minera of Cartagena-La Unión (SE Spain).

The exposure of the population to arsenic and the associated risk were also assessed. The efflorescences are significant for monitoring purposes because they are involved in cycles of retention release of hydrogen ions, sulphate, and potentially toxic elements. It was observed that the arsenic in collected samples represent a potential risk for human health through ingestion.

Ermakov et al. (2015) evaluated the impact of natural and anthropogenic factors on migrations of heavy metals in the downstream and flood plain soils of the mining and industrial areas of the Misursk Mining Combine and its Arkhon-Khosta Tailings, which increase Pb, Cd, Cu, and Zn content to background values. A catastrophic mud flow of 2002 and the later construction of a gas pipeline and a dam for hydroelectric power station changed the landscapes and biota. A distinct particle size of the suspended matter of the Ardon river water mineralization was discovered. Algae were proved to adapt and to indicate both natural and anthropogenic changes of the environment. The heavy metals in the waters of the river appeared to be within the acceptable hygienic standards.

Armienta et al. (2015) assessed the mobility of As, Cd, Cu, Fe, Mn, Pb, V, and Zn in soils impacted by grey and red tailings at Zimapán, México. Total As and HM concentrations were estimated. The geochemical phase distribution of As, Cu, Mn, and Zn in selected samples was also determined using sequential extraction. The authors found that acid mine drainage and water and wind erosion of tailings have polluted nearby soils with As and HM. Soils impacted by grey tailing presented higher concentrations of As and HM during the rainy season. Highest As concentration was found in red tailing-impacted soils during the dry season. The important transportation of As and HM in residential areas represents a threat to the health of the population of Zimapán. Therefore, remediation actions must be implemented.

Korobova et al. (2015) compared the distribution of the most significant medium and long-lived ^{60}Co , ^{137}Cs , and ^{152}Eu radioisotopes in granulometric and organic fractions of alluvial soils downstream from the Krasnoyarsk Mining and Chemical Combine (KMCC) to reveal natural patterns in their

behavior and accumulation. The authors concluded that a specifically different association of the mentioned radioisotopes with particulate and organic fractions in river sediments and floodplain soils may be explained by a dominating discharge form (water soluble or particulate), affinity to organic substances of different mobility, sorption by minerals and their aggregates, and chemisorption.

Georgiev et al. (2015) studied the heavy-metal leaching from topsoil of the uranium mine in Curilo area (Western Bulgaria). The authors used a mixture of elemental sulfur and cut straw at a ratio of 1:1 as an efficient method for in situ bioremediation of acid mine drainage-affected soil. The joint action of acidolysis/complexolysis significantly reduced the heavy metal contaminant content in horizon A.

Wahsha et al. (2015) studied the distribution and mobility of Fe, Cu, Pb, and Zn in the soils of six abandoned mine sites in Italy and their transfer to wild flora. The authors estimated the phytoremediation ability of *Salix* species, *Taraxacum officinale* and *Plantago major* for heavy metals. *Salix* have good potential to be used in phytoextraction and *P. major* in phytostabilization.

2.5 Remediation of organic pollutants

2.5.1 Four papers cover the fifth topic

Dagois et al. (2015) studied the long-term effects of climate on soil with organic contaminations for natural attenuation assessment of industrial wastelands. The authors followed the evolution of a broad set of anthropogenic soil and especially the organic matter (OM) reactivity through climate aging factors. They found that the dissolved organic carbon (DOC) is a clear indicator of technogenic OM mobility, and the DOC variations were strongly linked with the silt fraction and the occurrence of vegetation cover after freeze-thaw cycles, heating wet soil, and heating on dry soil cycles.

Alexandrova (2015) investigated the implicit mediating activity of humic acids (HA) by the interaction between pollutants and soil through the electrochemical influence of HA on an active (hydrolysable) part of soil. The authors found different binding effects accompanied by different biological effects of pollutants in dependence on the amine base. These effects comprise the mediating activity of HA which pull amines with a weak base from the active part of soil, bind them covalently, and in turn promote to decrease bioavailability of pollutants with the aromatic amine.

Sushkova et al. (2015) proposed a new alternative method of benzo[a]pyrene (BaP) extraction from soils and its approbation in soil under technogenic pressure. The given method involves the use of subcritical water as an environmentally friendly solvent. The studies were conducted on the soils of monitoring plots subjected to emissions from Novochoerkassk Power Station (NPS), Rostov-in-Don, Russia. BaP

accumulation in soils depends on technogenic emissions to the atmosphere from NPS, the direction of prevailing winds, and the physical and chemical properties of soils (mainly texture, humus amount, and CEC capacity).

Falciglia and Vagliasindi (2015) conducted a techno-economic analysis of hydrocarbon-polluted soil treatment by using ex situ microwave (MW) heating. The authors studied the influence of soil texture and soil moisture on electric field penetration, operating conditions, and energy costs. The analysis suggests that soil horizons underneath 70 cm should be considered for ex situ remediation. Energy costs lower than \$180 t⁻¹ and short remediation times make MW heating a suitable alternative to conventional thermal or physicochemical treatments for the remediation of hydrocarbon-polluted soils.

2.6 Cautions in the use of sewage sludge and waste water as amendments

Three papers constitute the sixth topic.

Pérez-Gimeno et al. (2015) evaluated the leaching of inorganic nitrogen forms from sewage sludge compost and limestone residues used together with saline water in land rehabilitation to determine the possible presence of pollutants in surface and groundwater. The authors verified that in well drainage, the nitrates presence in leachates can increase according to water salinity.

Chen et al. (2015) evaluated the risk of long-term irrigation by treated papermaking wastewater (TPW) in reed wetland from Yancheng Biosphere Reserve of China on the soil and microbial viability and therefore the suitability of TPW reuse for irrigation. The authors found that although long-term TPW irrigation may increase the soil fertility and microbial activity, heavy metals such Cd and Pb and salinity can be accumulated in the soil. Therefore, more caution should be exercised in the reuse of TPW for irrigation.

Bravo-Martín-Consuegra et al. (2015) assessed the effect of the addition of sewage sludge as a fertilizer on a sandy vineyard soil site in Villarrubia de los Ojos, Ciudad Real, Spain, near the “Tablas de Daimiel,” a swampy area with a shallow groundwater table. The use of sewage sludge modified some soil properties, decreasing pH and increasing salinity and soil organic matter. The vineyard showed a higher uptake of elements. The long-term application of sludge can lead to the contamination of soil and groundwater of the sensitive area of “Tablas de Daimiel.”

2.7 Soil-plant interactions

Four papers deal with the seventh topic.

Santos et al. (2015) studied the chemical quality of leachates and enzymatic activities in Technosols with gossan and sulfide wastes from the São Domingos mine (Portugal). The

authors evaluated soil enzymatic activities, chemical quality of leachates, and *Cistus ladanifer* germination. The authors found that the amendments from gossan wastes improved the chemical characteristics of leachates, the biological activity of the materials, and stimulated germination and plant growth. Due to the great reactivity of sulfide wastes, their isolation from the atmosphere may be the best solution for rehabilitation.

Mandzhieva et al. (2015) assessed the plant contamination by Ni, Mn, Cd, Cu, Pb, Cr, and Zn in the impact zone of Novocherkassk Power Station (NPS), Rostov-on-Don, Russia. The results of long-term monitoring observations showed an increase of all studied heavy metal (HM) concentrations in the wild plants growing within 5 km from the NPS along the predominant wind direction, indicating that the NPS is the main source of aerotechnogenic contamination of plants and soils with the studied HMs on this area. *Tanacetum vulgare*, *Ambrosia artemisiifolia*, and *Chicorium intybus* were revealed to be potential accumulators of HM.

Abbas et al. (2015) investigated the relationship between phytoremediation and rhizosphere acidification using *Acacia ampliceps* and *Acacia nilotica* in two experiments (greenhouse and field). The authors concluded that the phytoremediation of the salt-affected soils can be performed by growing different acacia species. The key to phytoremediation is the rhizosphere acidification. They observed that *A. ampliceps* released more organic acids and showed higher ash alkalinity, due to which it caused more amelioration of the salt-affected soil compared to *A. nilotica*. Therefore, the authors recommend *A. ampliceps* for the phytoremediation of salt-affected soils.

3 Conclusions

All the papers described on the seven sections cover important aspects of fundamental and applied research on soil science and environmental sciences, and provide advances in relation to existing knowledge.

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