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INTERNATIONAL CONFERENCE CONTAMINATED SITES 2018
08 – 10 OCTOBER 2018 • BANSKÁ BYSTRICA • SLOVAKIA

OP KŽP | European Union Cohesion Fund | MINISTRY OF ENVIRONMENT OF THE SLOVAK REPUBLIC | SLOVAK ENVIRONMENT AGENCY

09 OKTOBER 2018	**7.30 – 8.45**		**REGISTRATION, POSTERS ARRANGEMENT**
	8.45 – 10.40		**SESSION 1**
	CHAIR: Vlasta Jánová Slovak Republic + **Richard Přibyl** Czech Republic		
Nr.	**TIME**	**Presenter** Country	**PRESENTATION TITLE**
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2	9.20 – 9.40	**Richard Přibyl** Czech Republic	CONTAMINATED SITES IN THE CZECH REPUBLIC – PRESENT STATE AND PERSPECTIVE
3	9.40 – 10.00	**Gábor Hasznos** Hungary	CONTAMINATED SITES IN HUNGARY – PRESENT STATE AND PERSPECTIVE
4	10.00 – 10.20	**Grzegorz Siebielec** Poland	CONTAMINATED SITES IN POLAND – PRESENT STATE AND PERSPECTIVE
5	10.20 – 10.40	**Soline Mourmant** Belgium	DEVELOPMENT OF DATABASE AND PROTOCOLS TO SELECT PHYSICAL, CHEMICAL AND TOXICOLOGICAL PARAMETERS FOR ALMOST 280 POLLUTANTS IN WALLONIA (BELGIUM)
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	11.00 – 13.00		**SESSION 2**
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6	11.00 – 11.20	**Marco Falconi** Italy	ITALIAN SOIL GAS GUIDELINE 2018
7	11.20 – 11.40	**Yuliya Vystavna** Czech Republic	TRANSBOUNDARY LOADING OF PRIORITY SUBSTANCES AND EMERGING COMPOUNDS FROM CONTAMINATED WASTEWATERS: RISK FOR FULFILMENT THE REQUIREMENTS OF EU WATER DIRECTIVE
8	11.40 – 12.00	**Andrzej Greinert** Poland	HISTORICAL AND CONTEMPORARY SOIL POLLUTION IN THE CITY OF ZIELONA GÓRA (POLAND)
9	12.00 – 12.20	**Jozef Kobza** Slovak Republic	CURRENT STATE OF MAIN RISK ELEMENTS IN AGRICULTURAL SOILS OF SLOVAKIA
10	12.20 – 12.40	**Lilit Sahakyan** Armenia	CONTAMINATION ISSUES OF ARMENIAN'S MINING SITES
11	12.40 – 13.00	**Nosir Shukurov** Uzbekistan	DISTRIBUTION, MINERAL FORMS, AND BIOAVAILABILITY OF HEAVY METALS IN SOILS, THEIR IMPACTS ON SOIL BIOGEOCHEMICAL PROPERTIES (ANGREN-ALMALYK MINING-INDUSTRIAL AREA, UZBEKISTAN)
	13.00 – 14.20		**LUNCH**

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	14.20 – 16.20	**SESSION 3**	
	CHAIR: Claudia Neculau Belgium + **Karel Waska** Czech Republic		
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13	14.40 – 15.00	**Karel Waska** Czech Republic	CHEMICAL AND BIOLOGICAL REMEDIATION OF KUWAIT GROUNDWATER AFTER THE GULF WAR: LABORATORY TESTING
14	15.00 – 15.20	**Giovanni Preda** Italy	CASE HISTORIES OF CONTAMINATED SITES REMEDIATION AND SEDIMENT MANAGEMENT IN ITALY: TECHNOLOGY AND RESULTS
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INTERNATIONAL CONFERENCE CONTAMINATED SITES
ZNEČISTENÉ ÚZEMIA
MEDZINÁRODNÁ KONFERENCIA

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10 OCTOBER 2018		**8.00 – 8.30**	**REGISTRATION**
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Nr.	**TIME**	**Presenter** Country	**PRESENTATION TITLE**
22	8.30 – 8.50	**Leonid Perelomov** Russia	ADSORPTION OF HEAVY METALS BY NATURAL AND MODIFIED HUMIC SUBSTANCES
23	8.50 – 9.10	**Leonard Mgbeahuruike** United Kingdom	LEACHING PROFILE OF CONTAMINATED SOIL IN NIGERIA AND ITS POTENTIAL FOR EX SITU REMEDIATION USING DIFFERENT CHELATING AGENTS BY SOIL WASHING
24	9.10 – 9.30	**Elena Bocharnikova** Russia	SILICON-BASED APPROACH TO DETOXIFICATION AND PURIFICATION OF CONTAMINATED SITES
25	9.30 – 9.50	**Marie Hechelski** France	AN ORIGINAL APPROACH IN GREEN CHEMISTRY: FROM ASSISTED-PHYTOREMEDIATION OF CONTAMINATED SOIL TO UPCYCLING OF PLANT BIOMASS FOR BIOSOURCED CATALYST PRODUCTION
26	9.50 – 10.10	**Tatiana Minkina** Russia	COMBINING SELECTIVE SEQUENTIAL EXTRACTIONS AND X-RAY ADSORPTION SPECTROSCOPY FOR Zn SPECIATION IN SPOLIC TECHNOSOLS
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27	10.40 – 11.00	**Davit Pipoyan** Armenia	RISK ASSESSMENT OF Cu AND Mo EXPOSURE THROUGH CONSUMPTION OF VEGETABLES GROWN UNDER THE IMPACT OF KAJARAN'S MINING COMPLEX
28	11.00 – 11.20	**Ivan Alekseev** Russia	TRACE ELEMENTS CONCENTRATION IN SELECTED URBAN SOILS OF THE RUSSIAN ARTIC
29	11.20 – 11.40	**Adeline Janus** France	INFLUENCE OF TWO AMENDMENTS ON PHYTO- AND SANITARY AVAILABILITY OF METALS IN HIGHLY CONTAMINATED SOILS: A GREENHOUSE STUDY
30	11.40 – 12.00	**Palaniswamy Thangavel** India	ROLE OF HYPERACCUMULATORS IN PHYTOMANAGEMENT OF METAL CONTAMINATED SITES
31	12.00 – 12.20	**Van Xuan Nguyen** France	IMPORTANCE OF ENVIRONMENTAL AND TOXICOLOGICAL AVAILABILITIES OF Cd AND Pb IN MANAGEMENT OF DREDGED SEDIMENTS
		12.20 – 12.40	**DISCUSSION/CONCLUSION**
		12.40 – 14.00	**LUNCH**

CONTAMINATED SITES IN THE CZECH REPUBLIC – PRESENT STATE AND PERSPECTIVE

Richard Přibyl

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At such a relatively small territory we have about 5 000 sites contaminated mainly in consequence of industrial activities developed here for several hundreds years. Activity of the industrial enterprises led to contamination of soils and ground water in thousands of sites in the Czech Republic. Also army bases, especially airports, were often heavily contaminated. Many of the contaminated sites is possible to consider as Brownfields. After the 1989, the political changes enabled the clean-up programmes to be started in our country. A great problem in elimination of environmental burdens from the past in the Czech Republic is the lack of an unambiguous legislative framework, that would permit a complex solution for all legal entities. The basic principle implemented in elimination of environmental burdens arising nowadays is that the burden should be eliminated by the party that caused it (the "polluter pays principle"). One of the key difficulties lies in burdens from the past for which the responsible party no longer exists or is not capable of eliminating the burden. In this case remediation process carried out using a variety of programs using a variety of financial resources.

The best results were achieved in remedy of contamination connected with the process of privatization and with the stay of the former Soviet Army. In the former case, decontamination measures are paid from the National Property Fund (now from the Ministry of Finance) and in the latter, from the state budget. Principle documents governing remedial of contaminated sites in the privatisation process are the Government Regulation No. 51/2001 and Directive of MoE and Ministry of Finance No. 4/2017. These documents form the basic framework for the process of remediation works. Czech republic, however, as the former proprietor is responsible for remediation of contaminated sites, which contamination occurred before they were privatised. For this purpose, environmental contracts are concluded. The Czech Environmental Inspectorate, as the independent administrative body of the MoE, on the basis of the results of risk analysis, issues a site-specific remedial order, in which the extent of the environmental burden is specified and the site clean-up standards and deadlines are delimited. In the period 1991 and 2017, Government of the CR approved 325 "remediation" contract guarantees. Remediation works were finished at 179 sites and payments were made in an amount of 61,6 bil. CZK (2,4 bil. EUR). Works on other sites continues, but the trend of slowing down is evident, as can be seen from the following table, which shows the annual cost of removing old environmental burden.

Financing trends in individual years (bil. CZK)

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
4,7	3,6	5,4	3,5	3,4	3,4	2,3	1,2	0,8	0,7	0,7

In the period from 2008 to 2014, the Ministry of Finance slowed down the pace of new procurement, which was reflected in the following years, when the number of completed projects was gradually declining without adding new projects. Fortunately, the number of new orders is gradually increasing since 2014, but this will only affect the coming years.

Concerning Soviet Army, the sites with the most extensive contaminated areas and the highest risk levels include the former Hradčany airport in the former military training area of Ralsko and in the original training area of Mladá in the vicinity of Milovice. Clean up the stay of the former Soviet Army cost 60 mil EUR yet.

Another source of funding for the remediation process are EU Structural funds that can be used to remediation of sites owned by municipalities and sites contaminated by non-existent polluters (e.g. bankrupt companies, closed mines, brownfields etc.). Eligible costs are remediation activities and preparation activities - including

TRACE ELEMENTS CONCENTRATION IN SELECTED URBAN SOILS OF THE RUSSIAN ARCTIC

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Soils play a crucial role in Arctic ecosystems functioning determining their geochemical regime directly through accumulation, migration and transformation of energy and matter. Increasing rates of anthropogenic forcing on natural and urban ecosystems in the Arctic requires development of more detailed environmental monitoring. In this context, studying of background trace elements contents seems to be actual goal. In addition, soils play very significant role for various ecosystem services (Morel et al., 2015).
On the one hand, trace elements are naturally present in parent materials and soils occurring in the form of sulfides, oxides, silicates, and carbonates (Antcibor et al., 2014). At the same time trace metals are considered as the major group of anthropogenic contaminants in soils. Studies conducted earlier, showed that trace metals can reach the Arctic by different paths both anthropogenic and natural origin (Akeredolu et al., 1994; Barrie, 1985, 1992; Rahn al., 1997; Rovinskiy et al., 1995; Thomas et al., 1992). Metallurgical and energy industries are usually accompanied by the emission of acid-forming substances. These substances can be transported over long distances and can contribute leaching of such labile elements as aluminum, cadmium, zinc (Nikitina et al., 2015).
Studying of pollutant behavior in both urban and natural soils seems to be one of the most important issues for investigations in further decades. Such investigations could be used for making accurate risk assessments concerning such aspects as human health and long-term ecological effects. Approaches to establishment of limit values and identifying priorities concerning the remediation of contaminated sites could be also developed (Linde, 2005). Data concerning the trace elements content in soil of the Arctic is limited and should be state as insufficient. Evaluation of anthropogenic impacts on Arctic ecosystems requires not only background levels of trace metals, but also landscape distribution of elements in permafrost-affected soils in relation to soil properties (Antcibor et al., 2014).
This study is aimed to evaluation of trace elements content of urban soils in Yamal region and Murmansk.

Our investigation isconducted on the territory of Yamal autonomous region within the settlements (Aksarka, Kharsaim, Kharp, Labytnangi, Salekhard) and Murmansk. Both regions are referred to the zone of discontinuous permafrost.

Table 1. General field information on studied key plots

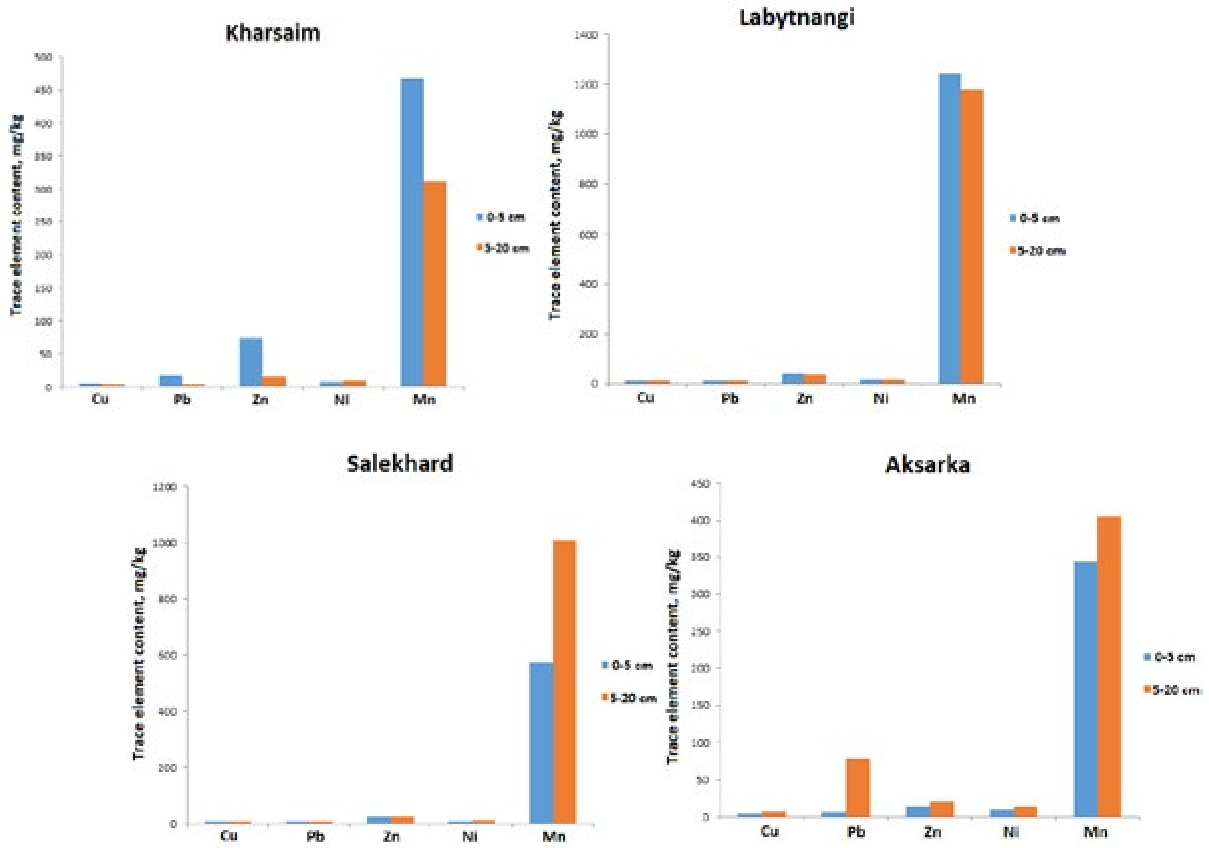
Key plot	Geographical coordinates	Functional zone/Landscape description	Name of the soils in WRB (2014); Russian soil classification system (2008)
Aksarka	N 66°33´54,3´´ E 67°48´04,8´´	Recreational functional zone	Urbic Technosol; Urbanozem
Kharsaim	N 66°35´54,7´´ E 67°18´34,2´´	Recreational functional zone	Urbic Technosol; Urbanozem
Salekhard	N 66°33´31,9´´ E 66°34´07,2´´	Residential functional zone	Urbic Technosol; Urbanozem
Labytnangi	N 66°40´01,1´´ E 66°20´59,6´´	Industrial functional zone	Urbic Technosol; Technozem
Kharp	N 66°48´34,0´´ E 65° 47´08,0´´	Industrial functional zone	Urbic Technosol; Technozem
Murmansk	N 68°58´45´´ E 33°05´33´´	Recreational (x2)/Industrial/Residential functional zone	Urbic Technosol/Histic gleyic Podsol/Urbic Technosol/Entic Podzol; Torfyano-stratozem/Torfyano-Podzol gleeviy/Urbo-stratozem/Torfyano-Podbur gleeviy

Soil classification was conducted according to "Classification and diagnostics of Russian soils" (Shishov et al., 2004) and World Reference Base for Soil resources (FAO, 2014). Detailed description of studied key plots is given in Table 1.

Ecotoxicological state of Russian Arctic cities is underestimated. That is why this study was aimed to investigate trace metals content in soils of both Yamal and Murmansk urban environments, and to deduce profile trends of distribution trace metals in permafrost-affected soils of studied urban areas. During the investigation 12 sites in Yamal region and four sites in Murmansk were studied.Samples were taken from a depth of 0-5 cm and 5-20 cm. Soil samples have been collected in industrial (Labytnangi, Kharp, Murmank), residential (Salekhard), recreational functional zones (Aksarka, Kharsaim, Murmansk). Laboratory analysis was conducted in the Komi Scientific Centre Laboratory of the Russian Academy of Sciences. Trace elements contents (Pb, Cu, Ni, Zn, Mn) were determined with an X-ray fluorescent analyzer "Spectroscan-MAX" (OST 10-259-2000).The values obtained were compared with the permissible concentrations and maximum allowable concentrations adopted in Russia named in GN 2.1.7.2511-09 (GN 2.1.7.2511-09), GN 2.1.7.2041- 06 (GN 2.1.7.2041-06) and SanPin 42-128-4433-87 (SanPiN 42-128-4433-87).

Results on trace elements content for investigated key plots in urban environments of Yamal region and Murmansk are summarized in Figure 2. The highest concentrations for Cu, Zn, Ni were found in the Kharp key plot which seems to be caused by existing chrome-processing factory. The highest median values for Pb were found in soil samples from Aksarka and Labytnangi key plots. Soil samples from Kharsaim and Kharp key plots were characterized by the highest median values for Zn. This can be explained by geological origin and high regional background concentration element for this trace element (Moskovchenko, 2010).

Soil samples collected in Murmansk are characterized by highest medians in Pb, Ni and Mn in topsoil horizons, and Mn in lower horizons (*Mur1 and Mur3* – recreational functional zone); Mn and Zn (*Mur2* – industrial functional zone); Mn and Ni in topsoil horizon, Mn and Zn in lower horizon (*Mur4 – residential industrial zone)*. Since soil samples in Murmansk were collected from less-disturbed soils (compared to highly human-mixed soil material in settlements of Yamal autonomous region) profile distribution of trace elements seems to be similar to those in natural soils of the Arctic region reported in previous works (Tomashunas, Abakumov, 2014; Moskovchenko, 2010; Nikitina et al., 2015). It means that the highest contents of trace elements occur in histic topsoil horizons or on the biogeochemical barriers (which can developed on the active layer-permafrost border or in redoximorphic conditions).



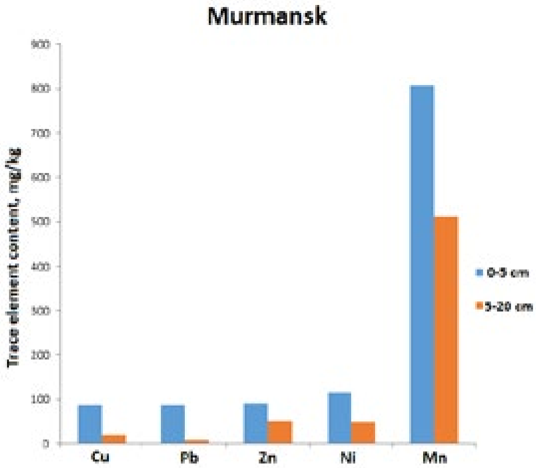


Fig. 2 Trace elements content in urban soils of Yamal region and Murmansk

It has been also performed calculation of Saet´s index (Zc). During its calculation it was used not only average arithmetic values of coefficient of concentration (Kk), but also its average geometric values. Most of the soil samples are characterized by non-hazardous (Zc <16) levels of total soil contamination. It characterizes soils as unpolluted. Saet´s index has been determined at levels of (16 < Zc < 32, moderately dangerous level) just in few soil samples from Aksarka and Kharp. The rest soil samples are characterized by Zc<16 (undangerous level of contamination).

Degradation of permafrost could alter the behaviour of trace elements in soils. It will affect the rates of accumulation, transformation, translocation, leaching and transportation of trace elements and other pollutants within the permafrost-affected landscapes. Consequently, ecosystem services provided by urban soils should be investigated in context of predicted climate change.

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INFLUENCE OF TWO AMENDMENTS ON PHYTO- AND SANITARY AVAILABILITY OF METALS IN HIGHLY CONTAMINATED SOILS: A GREENHOUSE STUDY

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KEYWORDS
Contaminated soils, biochar, iron grit, metals, ryegrass, phytoavailability, oral bioaccessibility

ABSTRACT

Soil is an essential and non-renewable resource which can perform a high number of economic, social and environmental functions as biomass production, source of raw materials or protection of humans and environment (Blum, 2005). However, the soil functionality becomes increasingly compromised due to contaminations caused by human activities. In 2006 and in 39 countries, the European Environmental Agency inventoried approximately 3 million of sites where pollutant activities occurred with more than 1.8 million potentially contaminated sites (CGDD 2013). In 2012, the most frequently identified contaminants were metals (35 %), hydrocarbons (24 %) and polycyclic aromatic hydrocarbons (11 %).
Until recently, the most common remediation technique was the excavation of contaminated soil and its disposal as landfill. However, this kind of method is considered inappropriate because it generates considerable disturbances, is expensive and economically unfeasible on a large scale. Thus, other remediation techniques (*ex* and *in situ*) have been developed to overcome these disadvantages. Among them, a technique consists in adding inorganic or organic amendments to the contaminated soils in order to decrease the mobility and bioavailability of pollutants in soils (Kumpiene et al., 2008; Vangronsveld et al., 2009; Bolan et al., 2014; Nejad et al., 2017). The most often used amendments are phosphate compounds, liming materials, metal oxides and biochars, used alone or in combination (Waterlot et al., 2017; Lahori et al., 2017; Oustrière et al., 2017).
The goal of the present work consists in evaluating the ability of two amendments (woody biochar and iron grit, used alone or in combination) to immobilize Cd, Cu, Pb, and Zn in contaminated soils under greenhouse conditions.

Two metal contaminated soils with different physico-chemical parameters were used in this study (Table 1). The first one, named MAZ, was collected in a brownfield located on an old settling basin where residues from a plastic industry were deposited (Mazingarbe, France). The second one, named ME, is an agricultural soil contaminated by past atmospheric emissions from lead smelter (Evin-Malmaison, France).

Tab. 1 Physico-chemical characteristics of the two soils studied

	Cd (mg kg^{-1} DW)	Pb (mg kg^{-1} DW)	Zn (mg kg^{-1} DW)	Cu (mg kg^{-1} DW)	pH_{water}	C_{org} (g kg^{-1})	$CaCO_3$ (g kg^{-1} DW)
MAZ	4.8	84.7	658	86.3	7.9	17.9	438.7
ME	15.3	812	1016	37.3	7.5	48.0	4.1

The first amendment used was a woody biochar (BC) made from hardwood plants (hornbeam, beech and oak) at 400°C during 12 h (La Carbonerie, Crissey, France). The second amendment was iron grit (IG), provided by Arena (GH120, Marquette-lez-Lille, France).
The pot experiment consisted in four treatments for each soil: 1) untreated soil (T), 2) soil + 2 % BC (BC), 3) soil + 1 % IG (IG) and, 4) soil + 2 % BC + 1 % IG (BC/IG). After watering, the pots (2.1 kg of soil) were placed under semi-controlled conditions in a greenhouse during 5 weeks for equilibrium. Then, 1.5 g of ryegrass (*Lolium perenne* L. var. Cantalou) were sown per pot. They were watered regularly and shoots were harvested 6 weeks after sowing.
The aerial biomass and Cd, Pb, Zn and Cu concentrations in ryegrass shoots were determined. The sanitary availability of metals in soils was evaluated by *in vitro* oral bioaccessibility test, using the Unified Bioaccessibility Method (UBM; Wragg et al. 2011). The UBM test consisted of two parallel sequential extractions and provided information on the metal availability in the gastric (G) and gastrointestinal (GO) phases.

The Table 2 presents the aerial biomass of ryegrass for the two soils studied. In the MAZ soil, the input of iron grit alone positively affected the plant biomass by increasing it from 8.43 to 9.83 g pot^{-1}. The biochar alone or in