IISD REPORTING SERVICES

GSOP Bulletin

A publication of the International Institute for Sustainable Development

Monday, 7 May 2018 Vol. 206 No. 6

SUMMARY OF THE GLOBAL SYMPOSIUM ON SOIL POLLUTION: 2-4 MAY 2018

Co-organized by the Food and Agriculture Organization of the UN (FAO) and its Global Soil Partnership (GSP) and Intergovernmental Technical Panel on Soils (ITPS), UN Environment, the Secretariats of the Basel, Rotterdam and Stockholm Conventions (BRS Conventions Secretariat), and the World Health Organization (WHO), the Global Symposium on Soil Pollution (GSOP18) convened from 2-4 May 2018 at the FAO headquarters, in Rome, Italy. The Symposium brought together more than 500 participants from 100 countries, comprising a wide array of stakeholders, including scientists and policy makers.

The Symposium featured plenary and parallel thematic sessions, organized around the following themes: soil pollution on agricultural fields and other land uses; the impact of soil pollution on food production and safety, the environment and overall human well-being; remediation of polluted sites; and developing policies and setting thresholds for addressing soil pollution and the global status of soil pollution.

An outcome document of the Symposium titled 'Be the Solution to Soil Pollution' will be drafted by the co-organizers, summarizing the scientific evidence and data, as well as ideas for overcoming existing challenges and for future steps, tabled by participants during the Symposium.

A BRIEF HISTORY OF THE SYMPOSIUM

GSOP18 is jointly organized by FAO, GSP and the ITPS, UN Environment, the BRS Conventions Secretariat, and WHO. The Symposium, the first of its kind, serves as a platform to elaborate on the latest information on the status, trends, and actions on soil pollution, and as a step in implementing the Voluntary Guidelines for Sustainable Soil Management, in accordance with the Sustainable Development Goals (SDGs).

GSP: The GSP was established under FAO in 2012 as a mechanism to develop an interactive partnership and enhanced collaboration between all stakeholders, in order to improve the governance and promote sustainable soil management. The Plenary Assembly constitutes GSP's decision-making body. It meets annually to review and prioritize GSP actions, while facilitating a balanced regional decision-making process. Among its outputs are the establishment of the ITPS and the production of the Voluntary Guidelines for Sustainable Soil Management.

View of the plenary room ©FAO

ITPS: The ITPS was established at the first GSP Plenary Assembly in 2013 and is composed of 27 top soil experts from all regions. Its main function is to provide scientific and technical advice on global soil issues to the GSP and to specific requests by global or regional institutions.

THE VOLUNTARY GUIDELINES FOR SUSTAINABLE SOIL MANAGEMENT: The voluntary guidelines were adopted by the 4th GSP Plenary Assembly and endorsed by the 155th session of the FAO Council in 2016. They provide technical and policy recommendations on achieving sustainable soil management.

IN THIS ISSUE

The *GSOP Bulletin* is a publication of the International Institute for Sustainable Development (IISD) <info@iisd.ca>, publishers of the *Earth Negotiations Bulletin* © <enb@iisd.org>. This issue was written and edited by Asterios Tsioumanis, Ph.D., and Veronica Lo, Ph.D. The Editor is Melanie Ashton <melanie@iisd.org>. The Director of IISD Reporting Services is Langston James "Kimo" Goree VI <kimo@iisd.org>. Funding for coverage of GSOP18 has been provided by FAO. IISD can be contacted at 111 Lombard Avenue, Suite 325, Winnipeg, Manitoba R3B 0T4, Canada; tel: +1-204-958-7700; fax: +1-204-958-7710. The opinions expressed in the *Bulletin* are those of the authors and do not necessarily reflect the views of IISD. Excerpts from the *Bulletin* may be used in other publications with appropriate academic citation. Electronic versions of the *Bulletin* are sent to e-mail distribution lists (in HTML format) and can be found at http://enb.iisd.org/. For information on the *Bulletin*, including requests to provide reporting services, contact the Director of IISD Reporting Services at <kimo@iisd.org>, +1-646-536-7556 or 300 East 56th St., 11D, New York, New York 10022, USA.

Maria Helena Semedo, Deputy Director-General, Climate and Natural Resources, FAO ©FAO

René Castro Salazar, Assistant Director-General, Climate, Biodiversity, Land and Water Department, FAO, and **Eduardo Mansur**, Director, Land and Water Division, FAO ©FAO

GSOP18 REPORT

OPENING OF THE SYMPOSIUM

On Wednesday morning, Maria Helena Semedo, Deputy Director-General of Climate and Natural Resources, FAO, emphasized that healthy soils make healthy foods, noting that soils are responsible for 95% of global food production and a quarter of the world's biodiversity, in addition to storing carbon and mitigating soil pollution. She stressed that soil pollution, caused mainly by human activities, is one of the major threats to human health.

Illar Lemetti, Deputy Minister of Rural Affairs, Estonia, reminded delegates of the global commitment to the SDGs and a land-degradation neutral world by 2030. He noted the role of waste in releasing harmful chemicals in soil, water, and air, and invited civic action to clean up illegal waste by participating in World Clean-Up Day on 15 September. Niu Dun, China, shared national efforts on soil contamination remediation and prevention. He highlighted a recently amended environmental protection law to address soil pollution, and noted the need to develop pilot projects and technologies on remediation and prevention of soil pollution.

Stressing that recent estimates on premature deaths attributed to soil, water, and air pollution range from 9 to 12.6 million people per year, Carlos Martin-Novella, Deputy Executive Secretary, BRS Conventions, highlighted the increasing pressure of population growth on the environment. He noted that in order to achieve SDG 12.4 (environmentally sound management of chemicals and wastes), increased international coordination will be needed. Astrid Schomaker, European Commission, noted that seven SDGs depend on healthy soils. Lamenting that soil pollution is not high on the international policy agenda, she presented relevant European initiatives, including the One Health Approach, and stressed the need for further research, especially on emerging contaminants.

INTRODUCTION TO THE GSOP18: Noting that the meeting has attracted more than 500 participants from 100 countries, René Castro Salazar, Assistant Director-General of Climate, Biodiversity, Land and Water Department, FAO, introduced the Symposium, presenting its objectives, structure and expected outcome.

SETTING THE SCIENTIFIC SCENE FOR GSOP18: Luca Montanarella, Chair, ITPS, provided an overview of the 2015 Status of the World's Soil Resources report. The largest assessment of its kind, the report contains the top threats regarding soil pollution in different regions. Emphasizing the linkages between food quality, soil pollution, and human health, he highlighted the 2017 Global Assessment of the Impact of Plant Protection Products on Soil Functions and Soil Ecosystems, the first contribution towards GSOP18 as part of the implementation of the Voluntary Guidelines for Sustainable Soil Management.

Mette Wilkie, UN Environment, noted that exposure to pesticides kills three million people annually, and that pollinating insects harmed by pesticides provide services worth an estimated US$ 153 billion per year. She said that soil pollution occurs on a daily basis, including through poor agricultural practices and improper waste management. Marco Martuzzi, European Centre for Environment and Health, WHO, underscored that 23% of all global deaths are linked to the environment, with pollution being among the most significant risk factors. He noted how informal industries can cause significant soil contamination and underscored the hundreds of thousands of industry-contaminated sites in Europe, highlighting the 2017 Declaration of the Sixth Ministerial Conference on Environment and Health (Ostrava Declaration).

Providing background information on the BRS Conventions, Melisa Lim, BRS Conventions Secretariat, focused on the Conventions' impact on pollution, including: regulatory actions; phase-out of persistent organic pollutants (POPs); production of global norms for sound environmental management; and fostering partnerships with stakeholders. She also stressed the importance of sound waste management, encompassing enhanced recycling, improved collection and disposal, and better enforced controls on imports and exports.

KEYNOTE SPEECHES: On Wednesday, Ravi Naidu, University of Newcastle, stressed soil pollution is the most under-investigated and poorly understood of all the essential risks humans face. He provided a global estimate of more than five million contaminated sites and highlighted that chemical pollutants in soil are linked to water and air. Naidu lamented that regulations fail as few chemicals are currently banned and approximately 2,000 new chemicals, some untested, are released each year, and called for a global initiative to address the issue.

Ravi Naidu, University of Newcastle ©FAO

Steve McGrath, Rothamsted Research, *inter alia*: distinguished between the terms 'contamination,' referring to any presence of pollutants above 'background concentration' and 'pollution,' addressing presence of pollutants above a 'selected threshold value' that can present harm; addressed the sources of metals for agricultural soils; discussed the extent of soil pollution in different world regions; noted that urban and peri-urban agriculture often takes place on contaminated soils; and highlighted that the solution to pollution is prevention. Esperanza Huerta Lwanga, College of the South Border, Mexico and Wageningen University, the Netherlands discussed recent research on microplastics uptake in earthworms, an important indicator of soil quality. She highlighted the role of gut bacteria in breaking down microplastics in earthworms with potential for soil remediation on a larger scale.

Roland Weber, Independent Consultant, discussed polychlorobenzodioxins and polychlorodibenzofurans (PCDD/Fs) soil contamination, from pesticides and other uses, affecting cattle and sheep raised in flood plains in Germany, and problematic polychlorinated biphenyls (PCB) and PCDD/F concentrations in soil for chicken egg and meat production. He noted for several POPs, that there are no concentration limits in soil or food/feed.

Presenting on soil remediation, Lena Ma, University of Florida, focused on clean-up standards. She distinguished between bioavailability and bioaccessibility; outlined research results from California on acceptable soil clean-up target levels for carcinogens, and from China on bioavailable metals in soils.

Lena Ma, University of Florida ©FAO

REGIONAL SOIL PARTNERSHIP REPORTS: Nsalambi Nkongolo, Institute of Agronomy of Yangambi, Democratic Republic of Congo, provided an overview of soil pollution in Africa. Stressing the need for capacity building, he highlighted the need for investment in research, equipment for monitoring soil pollution, and intense education and awareness raising. Olegario Muñiz Ugarte, Soil Institute, Cuba, noted that the main causes of pollution in soils and adjoining water bodies in the region are fertilizers and agrochemicals, mining, and oil spills. Underscoring the lack of control mechanisms, he stressed that the increased use of organic manures without consideration of their origins is increasing heavy metal contamination.

Pavel Krasilnikov, Eurasian Center for Food Security, noted highly polluted soils in Eurasia due to intensive industrial development, excessive militarization, and imbalanced use of agrochemicals. He noted high levels of radionuclide contamination in Ukraine, Belarus, Russian Federation, Kazakhstan, Uzbekistan, and Kyrgyzstan from local industrial, urban, and mining activities.

On the status of soil pollution in Europe, Ana Payá Pérez, Joint Research Centre, European Commission, explained the legal framework and related activities, including the Soil Thematic Strategy and the 7th Environmental Action Programme provision on land and soil protection. She noted the lack of threshold values in soil-related EU legislation, and called for harmonization of terminology and national legislation, networking, and knowledge sharing.

Focusing on the Colombian experience, Ana Maria Rivero Santos, Colombia, presented the national policy for sustainable soil management in a post-conflict environment. She highlighted institutional strengthening, harmonization of regulations, education and training, monitoring, research, and technology transfer. Presenting on the Pacific region, Siosiua Halavatau, Secretariat of the Pacific Community, stressed that islands are the most vulnerable to climate change, and the extent of pollution is high. He addressed historic uses of fertilizers and pesticides, negative effects of mining and waste disposal, and underscored the unfortunate legacy of nuclear testing, including in the Atolls of Mururoa and Bikini.

OTHER ACTIVITIES: On Wednesday evening, the book "Soil pollution: a hidden reality" was launched. It was developed within the GSOP18 framework, identifying the main knowledge gaps on soil pollution and serving as a basis for future discussions. Participants also attended a poster session with more than fifty posters, in parallel with an interpretative dance on soil pollution, followed by a cocktail reception.

Four side-events took place on Thursday. At midday, in a side-event co-organized by FAO and UN Environment, participants discussed the implementation of the UN Environment Assembly Resolution on addressing soil pollution in an effort to move the global soil pollution agenda forward. A parallel side event, organized by FAO, focused on water pollution from agriculture. In the afternoon, participants discussed policies, indicators, and assessments for tackling soil pollution in Europe in a side-event co-organized by FAO, the European Commission, and the European Environment Agency. Additionally, a side-event focusing on bioavailability of contaminants in soil, co-organized by FAO and the Interstate Technology and Regulatory Council, trained participants on: determining when a bioavailability assessment may be appropriate; selecting appropriate methods to evaluate soil bioavailability; and using tools to develop soil bioavailability estimates.

SOIL POLLUTION ON AGRICULTURAL FIELDS AND OTHER LAND USES

On Wednesday, in plenary, Michael McLaughlin, University of Adelaide, provided a general overview of geogenic and anthropogenic sources of soil pollution. He noted examples of geogenic contamination include fluoride from volcanic eruptions, and cadmium and nickel from rock weathering; and examples of anthropogenic contamination include fertilizers, waste, agricultural chemicals, and atmospheric diffuse sources. He highlighted cadmium as being unique among the trace elements in that it is readily taken up in plants and stressed the importance of considering how to reduce cadmium uptake in crops.

Michael McLaughlin, University of Adelaide ©FAO

Violette Geissen, Wageningen University and Research, highlighted the multitude of EU policies addressing soil contamination, lamenting the lack of legal limits for pesticide application. She provided an overview of risk assessments to determine environmental and human exposure, noting that wind-driven particulate transport remains a large research gap. She concluded that we should adapt approval procedures for pesticides by testing pesticide mixtures, monitoring water and wind transport, and using a holistic approach inclusive of soil biota.

DRIVERS OF SOIL POLLUTION IN AGRICULTURAL FIELDS: On Thursday, in the first parallel morning session, Ganling Zhang, China Institute of Soil Sciences, discussed how agricultural film residue in greenhouse soil has become a critical problem in China. Tom Wassenaar, CIRAD, France, described how assessments of agricultural soil pollution risks from organic waste recycling can help inform regional participatory waste management. Mark Kibblewhite, Cranfield University, discussed the contamination of agricultural soils by highways in urban and peri-urban zones.

Violette Geissen, Wageningen University and Research, the Netherlands ©FAO

Rosalina Gonzalez, La Salle University, Colombia, described the use of partitioning models to understand how soil properties are affected by glyphosate and paraquat pesticides in corn and coffee bean crops grown in Colombia.. Yevheniia Hladkikh, Ukraine Institute for Soil Science and Agrochemistry Research, discussed heavy metal crop contamination caused by agricultural irrigation water. Sara Marjani Zadeh, FAO, discussed water pollution from agriculture and its implications for soil pollution, noting the recent publication by FAO and the International Water Management Institute titled 'Water Pollution from Agriculture, a Global Review.'

Olegario Muñiz Ugarte, Cuba, described the assessment of heavy metals in Cuban soils and risks of soil pollution posed from organic manure, such as urban solid residues. He described the development of heavy metal criteria based on the correlation between heavy metals in the manure and the heavy metals content in crops and established reference values. Vera Silva, Wageningen University and Research, discussed the contamination of agricultural soils in Europe by pesticide residues. Through large scale sampling she noted that 83% of soils tested contained pesticide residues, underlining the need for pesticide residue monitoring to inform comprehensive risk assessments.

Magalie Lesueur Jannoyer, CIRAD, discussed the long-term organochlorine soil pollution in agriculture, "from soil to fork." She drew on lessons learned from soil pollution in the French West Indies originating from chlordecane application to banana cropping systems, and called for an interdisciplinary 'Eco health approach.' Yueling Qi, Wageningen University and Research, noted the limited information on microplastics pollution in terrestrial compared to aquatic ecosystems, stressing that soils are a major sink for microplastics. She described recent research on the effects of macro- and micro-plastic residues on wheat growth, testing different types of mulch film, and found lower wheat biomass in samples with biodegradable mulch films. However, she noted that the presence of earthworms have the potential to reduce the negative effects of macro- and micro-plastic residues on wheat growth.

An interactive discussion took place on this theme took place on Friday, and was summarized by Luca Montanarella, ITPS Chair. He noted the key messages included:

- the difficulty to distinguish between agriculture and other land uses;
- the polluter pays principle was not explicitly addressed; and
- agriculture is more a victim than a cause of soil pollution.

DRIVERS OF SOIL POLLUTION IN OTHER LAND USES: In Thursday afternoon's session, John Vijgen, International HCH and Pesticides Association, addressed hexachlorocyclohexane (HCH) and lindane contaminated sites. Ana Lima, University of Waterloo, focused on surface mining, discussing remediation, restoration, reclamation, and rehabilitation. Claudia Fontana, Council for Agricultural Research and Economics, presented on radionuclide soil pollution.

Hans Slenders, NICOLE, EU, highlighted land stewardship, discussing investing in the natural, societal, and economical capital of industrial land. Geoffrey Siemering, University of Wisconsin, described the effectiveness of organic soil amendments, which are organic additions that can improve the soil's physical properties, in remediating lead contamination in mine-scarred sites. Ivan Holoubek, Masaryk University, highlighted experiences, problems, and solutions related to contaminated sites in the Czech Republic.

On Friday morning's parallel session, Boudewijn Fokke, Tauw, provided an overview of the sustainable management of soils contaminated with dichlorodiphenyltrichloroethane (DDT) pesticide in Lâm Hoá, Vietnam. He discussed selecting from various remediation options using multi-criteria decision analyses, balancing environmental risk and economic cost considerations. Dmytro Semenov, Ukraine Institute for Soil Science and Agrochemistry Research, described efforts to determine the nature and magnitude of soil contaminants in the Ukraine, which include heavy metals, radioactive nuclides, hydrocarbons, and pesticide residues, noting an increase in the rate of soil degradation due to pollution.

Amanullah Kahn, University of Agriculture, Peshawar, Pakistan provided an overview of best management practices to reduce soil pollution, drawing from experiences in Peshawar, including: agricultural waste management; integrated crop management; integrated soil fertility management, including use of organic fertilizers; precision agriculture; and drone technology. Valentina Pidlisnyuk, Jan Evangelista Purkyně University in Ústí nad Labem, drew on experiences in the Czech Republic, and described sustainable soil management techniques in polluted military sites, focusing on phytostabilization with silvergrass, a biofuel crop, and stressing the importance of addressing the hidden pollution in military sites.

Daniel Arenas Lago, University of Vigo, described research on the use of hydroxyapatite, hematite and maghemite nanoparticles for remediating heavy metal-contaminated soils. Drawing on research in the Iberian Pyrite Belt, Portugal, he compared the advantages and disadvantages of nanoremediation with phosphate amendments, stressing the importance of understanding the fate of nanoparticles in the environment.

Adriano Garlato, ARPAV Soil Protection and Remediation Service, Italy, discussed the network sampling method to assess levels of POPs in soils of the Veneto region, Italy, including dioxins, furans, and PCBs. He described the establishment of critical thresholds for different types of soils as an effective tool to assess pollution by POPs.

An interactive discussion took place on Friday morning, and theme chair Luca Montanarella, summarized the key messages including:

- the existence of a lot of estimated data, but relatively few validated datasets;
- the lack of a consistent inventory of contaminated sites; and
- contamination is caused by development, therefore more evidence of contamination is produced by developed countries than by developing ones.

Luca Montanarella, ITPS Chair ©FAO

Montanarella also summarized relevant recommendations for future steps, highlighting the need for an action plan to limit and reverse soil pollution, which would, *inter alia*, include:

- establishing monitoring activities and data collection;
- developing guidelines for detecting pesticides and emerging new compounds in soil;
- focusing on prevention rather than remediation;
- harmonization of methods and data;
- creating a platform/forum to share existing experiences and connect existing networks;
- establishing a working group on the sustainable management of polluted soil sites, as well as a participatory system of thresholds' adoption, taking into account local specificities; and
- fully implementing the polluter pays principle

THE IMPACT OF SOIL POLLUTION ON FOOD PRODUCTION AND SAFETY, THE ENVIRONMENT AND OVERALL HUMAN WELL-BEING

On Wednesday, in plenary, David Ingram, Food and Drug Administration, the US, discussed national standards for growing, harvesting, packing, and holding of fresh fruits and vegetables for human consumption. He described produce safety rules that involve identifying all potential contributing factors for microbial contamination. Eric Stevens, Food and Drug Administration, US further highlighted the use of whole genome sequencing for detecting outbreaks.


Christina Siebe Grabach, National Autonomous University of Mexico ©FAO

Christina Siebe Grabach, National Autonomous University of Mexico, discussed pollutant accumulation in soils irrigated with untreated wastewater for more than a century. She underscored that: long-term health risks can be avoided by primary water treatment; antibiotic resistance increases with wastewater irrigation; and that conventional water treatment creates new challenges, like sludge disposal.

SOIL POLLUTION AND FOOD SAFETY: On Thursday, during the first parallel morning session, Frank Swartjes, RVM National Institute for Public Health and Environment, the Netherlands, discussed exposure pathways for various pollutants with a focus on indoor air inhalation. He emphasized the need to use multiple lines of evidence and tiered approaches, in addition to acknowledging local conditions.

Tomohitio Arao, Central Region Agricultural Research Center, Japan, discussed arsenic contamination in fish, shellfish, seaweed, and rice. He outlined strategies for reducing cadmium and arsenic concentrations in rice, including flooding and aerobic treatment. Pietra Lavazzo, Regional Agency for Agriculture and Forestry Service, Italy, discussed the transfer of PCBs and heavy metals from agricultural soils to crop plants. He stressed the need for more knowledge on bioavailability of the contaminants to assess toxicity in humans, and called for legal limits for soil contamination.

Takuro Shinano, Tohaku Agricultural Research Station, Japan described the various methodologies used to decontaminate agricultural fields and mitigate radioactive cesium uptake seven years after the Fukushima Daiichi nuclear disaster, as well as the related challenges. Providing a legal perspective on the prevention of soil contamination, Cristina Lull, Technical University of Valencia, noted the differences in limit values across countries for use of fertilizers. She called for incorporating traceability in quality control systems and improving soil pollution laws and regulations.

Margot de Cleen, Ministry of Infrastructure and Water Management, the Netherlands, discussed the restoration of contaminated land in connection to the SDGs, underscoring the need for new business models to address soil pollution. In a joint presentation, Filippo Montalbetti, UN Environment, Dragana Vidojevic, Serbian Environmental Protection Agency, and Marco Falconi, Italian Institute for Environmental Protection and Research, described how the improvement of soil pollution monitoring in industrial sites assisted Serbia in the implementation of multilateral environmental agreements.

Warshi Dandeniya, University of Peradeniya, Sri Lanka, spoke on the prevalence of antibiotic-resistant bacteria in poultry litter-based manures and potential threats to food safety using carrot crops as a case study. Nazaria Marchi, Geological, Seismic, and Soil Service of the Emilia-Romagna Region, Italy, described preliminary results from an analysis of the bioavailability of some metals in the soils of the Emilia-Romagna plain.

Warshi Dandeniya, University of Peradeniya, Sri Lanka ©FAO

An interactive discussion took place on Friday morning, and theme chair Gary Pierzinsky, Kansas State University, explained the key messages included:

- soil pollution influences the quality and safety of food through the introduction of food-borne pathogens, human pathogens, dispersion of antibiotic resistance, reductions in yield, and reductions in soil biodiversity with unknown effects;
- if soil pollution is not addressed, it will affect long-term food production and safety; and
- actions towards preventing soil pollution in the food chain include: refining existing, and creating new soil protection standards; addressing chemical mixtures; capacity building; and continuing to identify and remediate contaminated sites.

RISK ASSESSMENT OF SOIL POLLUTION ON THE ENVIRONMENT AND HUMAN HEALTH: On Thursday afternoon, Kahraman Ünlü, Middle East Technical University, Turkey, presented the development and implementation of national health risk-based soil guidelines. Paolo Giandon, ARPAV Soil Protection and Remediation Service, Italy, assessed background values of metals and metalloids in soils of the Veneto region, Italy. Dmytro Semenov, Institute for Soil Science Agrochemistry Research, Ukraine, addressed the variation in geochemical and anthropogenic heavy metals in Ukraine. Gunnar Bengtsson, Bengtsson Enterprises, discussed past, present, and future exposure to natural elements in relation to soil pollution.


Andrea Otteson, Food and Drug Administration, US ©FAO

Andrea Ottesen, Food and Drug Administration, US, focused on bacterial microbiota of soils managed with methyl bromide, methyl iodide and dimethyl disulfide. Shadananan Nair, Centre for Earth Research and Environment Management, India, addressed soil pollution issues in a tropical agricultural wetland in India. Baogen Gu, FAO, evaluated pesticide risks to soil biodiversity. Valéria Cristina Palmeira Zago, Federal Center for Technological Education of Minas Gerais, Brazil, presented on mining and sustainability, drawing from a case study in Minas Gerais, Brazil.

Andrew McCartor, Pure Earth, US, addressed lead exposure from lead-acid battery recycling. Drawing from research in India and Indonesia, he called for: holistic reforms of national battery recycling regulations; national blood-lead monitoring in children; and risk-reduction projects in contaminated sites. Julian Campo, Centre for Desertification Research, Spain, discussed emerging contaminants in soil and sediment of Mediterranean catchments from a study in the Valencia region, Spain. Stressing that emerging POPs are not yet covered by international conventions, he focused on perfluoroalkyl substances (PFASs) and organophosphate flame retardants (PFRs), highlighting the presence of PFASs and PFRs in soil, sediment and wastewater.

Oloth Sengtahuanghoung, Agriculture Land-Use Planning Center, Lao People's Democratic Republic, addressed the interactions between land use, fluxes of water and sediments, and the spread of bacterial contaminants in the uplands of northern Lao PDR. He noted that planting teak trees and managing their vegetation structure can be an economically and environmentally sound remediation practice. Taher Ajmi, General Directorate of Land Development and Conservation Tunisia, presented a comparative study of morphology and texture impacts on the distribution and mobility of metal trace elements between three sites at the Madjredah watershed, Tunisia, calling for setting national standards for heavy metals in cultivated lands.

Serena Caucci, UN University, focused on understanding the linkages between water, waste, and soil (water-waste-soil nexus) for improved land use management. She addressed Safe Use of Wastewater in Agriculture, stressing that secondary treated wastewater contains significantly higher levels of antibiotic-resistant bacteria than freshwater.

An interactive discussion took place on Friday morning, and theme chair Gary Pierzinsky, noted the key messages included:

- the impact of polluted soils on nearby downstream ecosystems transported by dust, water, and the food chain are significant, and containment of these should be part of the remediation strategy;
- the risk posed by polluted soils on the environment should be assessed by understanding the global extent of soil pollution, and by refining risk assessment procedures, moving from measuring concentrations to measuring effects, using bioassays and multiple indicator species; and
- FAO has an important role in standardizing terminology and indicators, including those related to achieving the SDGs.

Pierzinsky also summarized key recommendations, including:

- the need to better understand the impacts of soil pollution, antimicrobial resistance, and emerging contaminants including microplastics and POPs; and
- the value of long term studies, whole genome sequencing and related techniques for assessments of the soil microbiome to understand the impacts of decreases in soil microbial diversity.

REMEDIATION OF POLLUTED SITES

On Wednesday, in plenary, Lucia Buvé, NICOLE, Belgium, provided an overview of NICOLE, a European network linking contaminated land management professionals. Stressing the need to incorporate sustainability aspects in remediation, she discussed traditional remediation versus green remediation and the sustainable remediation concept, noting that sustainable remediation is a holistic approach, as well as an iterative process with feedback loops.

Lucia Buvé, NICOLE, Belgium

Talal Darwish, National Council for Scientific Research, Lebanon ©FAO

Talal Darwish, Lebanon National Council for Scientific Research, discussed the status of heavy metals in agricultural soils and the need for adapted soil thresholds, drawing on a case study of soil pollution in the Bekaa plain, Lebanon. He noted the longstanding history of heavy metal contamination in the region and discussed the consequences for human health given the intense vegetable production in the area. He also noted that in some areas, the heavy metal contamination of groundwater ha rendered the water neither suitable for human consumption nor for agricultural use.

MONITORING SOIL POLLUTION: On Thursday, during the first morning parallel session, Phillip Owens, Department of Agriculture, US, focused on the geostatical mapping of metal elements distribution across conterminous US. He concluded, *inter alia,* that: areas with higher elemental concentrations had a higher prediction error; and cadmium was best predicted, whereas nickel had the lowest prediction performance.

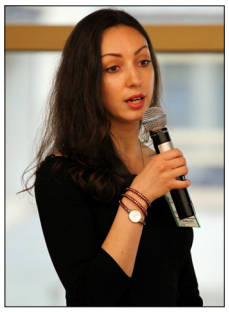
Claudio Colombo, University of Molise, Italy, discussed the bioacessibility of lead and arsenic in contaminated urban soil. He highlighted the application of visible and near-infrared reflectance spectroscopy to develop diagnostic screening tests for soil contaminants, noting both good performance and cost-effectiveness. Hussam Husein, General Commission for Scientific Agricultural Research, Syria, addressed the mapping of heavy metal pollution of agricultural soil in the Orontes Basin, Syria, which demonstrated significant accumulations of cadmium, lead, zinc, and copper in water and soil.

Joseph Adu-Gyamfi, International Atomic Energy Agency, addressed the application of nuclear techniques to assess the sources and transport of antibiotics from agricultural areas to the environment. He stressed that stable isotopes can be used to characterize and quantify sources and transport of solutes. Abdelaziz Belal Belal, National Authority for Remote Sensing and Space Sciences, Egypt, discussed the detection

of soil contamination using remote sensing and Geographical Information Systems (GIS), noting these tools provide detailed spatial information on soil contamination.

Donato Visconti, University of Naples Federico II, Italy, characterized soils contaminated by leather tannery waste disposal, noting the potential for *Cynodon dactylon* as a plant species for phytoremedation.

Bernd Bussian, Environmental Consultant, addressed state of the art techniques of mapping, monitoring and modelling soil pollutants. Tatyana Stefanovska, National University of Life and Environmental Sciences, Ukraine, presented the development and preliminary assessment of using the biological indicators to evaluate the soil quality of silvergrass production at the contaminated abandoned sites.



Anna Paltseva, Brooklyn College of the City University of New York, US ©FAO

Matar Thiombane, University of Naples Federico II, Italy, addressed the point source patterns of zinc, lead, chromium, and nickel through a compositional discrimination analysis. Anna Paltseva, Brooklyn College of the City University of New York, US, discussed the application of GIS to characterize garden soil contamination in New York City.

An interactive discussion took place on Friday morning, and was summarized by theme chair Melinda Lim, BRS Secretariat, who said the key messages included:

- protocols for assessing and mapping point source pollution have been developed and refined over the past decades in many developed countries and are available for dissemination;
- these approaches can be applied to other parts of the world, but adaptations are needed to address national priorities, existing legislations, availability of resources, and technical capacity; and
- more efforts are needed to assess and monitor diffuse pollution and develop strategies for prioritizing pollutants of concern;

STATE OF THE ART OF REMEDIATION TECHNIQUES OF POLLUTED SITES: On Thursday afternoon, Engracia Madejón, Institute of Natural Resources and Agrobiology of Seville, Spain discussed soil restoration strategies in southern Spain. The assisted natural remediation techniques involved removal of soil, addition of lime compost and manure amendments, harrowing, reforestation of the area with indigenous species, and the establishment of a green corridor. Yevheniia Hladkikh, Institute for Soil Science and Agrochemistry Research, Ukraine, addressed the remediation of technogenic contaminated soils using innovative methods.

Petr Sharov, Pure Earth, discussed the remediation of soil contaminated with POPs in Sumgait, Azerbaijan, which involved removing the top-most contaminated layer of soil for proper containment, replacing it with clean soil, and planting native and rare vegetation. Describing a case study on the Ivory Coast, Nicola Testa, UN CGS, Italy, discussed the remediation of polluted sites in UN field missions using enhanced natural attenuation. The remediation process included determining initial contamination levels, treatment reduction, and re-vegetation.

Ángel Faz Cano, Technical University of Cartagena, Spain, presented research on aided phytostabilization to remediate soil pollution from mine tailings, drawing from a field case study in the mining district of Cartagena-la Union, Spain. Deyi Hou, Tsinghua University, China, discussed the use of green and sustainable remediation, stressing the need to use a lifecycle perspective and incorporate additional sustainability considerations. Hans Kristian Westrum, Soil Steam International, Norway, noted that soil steaming reduces fight weeds, fungus, and nematodes, and is a sustainable alternative to chemical methods. He underscored its potential contribution to increasing crop production and enhancing global food security.

During Friday morning's parallel session, Domenico Morabito, INRA, France, and University of Molise, Italy, described the use of biochar to decrease lead and arsenic contamination in soils, enabling assisted phytoremediation of multi-contaminated technosols using tree species. Ana Lima, Federal University of Espírito Santo, Brazil, discussed the emergence of environmental electrokinetics as a complement to conventional soil remediation techniques, highlighting its role in sustainable remediation.

Samuel Tetsopgang, University of Bamenda, Cameroon, discussed rock fine amendments to enhance crop yield and decrease soil acidity, drawing from a case study in tropical soils in the northwest region of Cameroon,. Vishal Tripathi, Banaras Hindu University, India, provided a comparative analysis of leaf litter and biochar for the on-site remediation of hexachlorocyclohexane-polluted soils. Jeyanny Vijayanathan, Forest Research Institute, Malaysia, discussed reversing soil degradation via phytoremediation techniques from tin and gold mines. Karen Ghazaryan, Yerevan State University, Armenia, discussed copper phytoremediation and its potential for growing wild plant species in mine-polluted areas of Armenia.

An interactive discussion took place on Friday morning, and theme chair Melisa Lim, said the key messages included:

Melisa Lim, Secretariat of the Basel, Rotterdam, and Stockholm Conventions ©FAO

- human health impacts should be a priority criterion for determining whether a polluted site can/must be remediated;
- determination of remediation requirements must be site-specific;
- in developing countries, financial resources, human capacity, and availability of analytical tools are limitations to remediation;
- better tools are needed to fully understand the complexity of sub-surface pollution; and
- polluted sites can be restored for safe food production, especially in cases of broad scale, low-level pollution.

Lim also summarized relevant recommendations, including:

- the development of best practice guidance on the assessment and remediation of polluted sites, and the establishment of an expert group to develop such guidance;
- raising political and public awareness on the benefits of soil remediation, and developing appropriate human health and economic metrics for doing so; and
- building capacity in developing countries for soil pollution assessment and remediation.

GLOBAL STATUS OF SOIL POLLUTION

On Wednesday, in plenary, Dietmar Müller-Grabherr, Austrian Environment Agency, focused on frameworks for understanding risks and viable solutions related to experiences in managing soil pollution. He summarized the mission and activities of the International Committee on Contaminated Land, and highlighted: the 'triple-loop learning,' consisting of incremental improvement, reframing, and transforming; classic and systemic approaches for deriving contaminant thresholds; and changing paradigms for better governance and remediation policy.

Dietmar Müller-Grabherr, Austrian Environment Agency

Esther Goidts, Ministry of the Environment of Walloon Region, Belgium, and Marie Jailler, SPAQuE, Belgium, discussed setting thresholds as a tool to address soil pollutants. Explaining the evolution of calculating soil thresholds in the region, Goidts stressed that soil thresholds are useful as triggers for action, but site-specific risk assessments should be used in problematic situations. Jailler focused on uses of arsenic and lead thresholds, expressing concern since the new thresholds are lower than background concentration levels.

DEVELOPING POLICIES AND SETTING THRESHOLDS FOR ADDRESSING SOIL POLLUTION: On Thursday, Ana Payá Perez, Joint Research Center, European Commission, focused on policy questions addressing the management of contaminated sites in Europe. Co Molenaar, Ministry of Infrastructure and Water Management, the Netherlands, focused on national soil policy, explaining the dynamics of joint policy making. Griet Van Gestel, Public Waste Agency of Flanders, Belgium, discussed human health issues and local food production, as well as the way thresholds interlink with policies on contaminated land in Flanders.

Koen Oorts, ARCHE Consulting, Belgium, presented a flexible approach for incorporating bioavailability into the development of thresholds to determine ecotoxicological effects of metals in soil. Erik Smolders, Catholic University of Leuven, Belgium, deliberated upon concepts, models, and challenges related to threshold-setting for addressing pollution of soils with trace metals.

During the second morning parallel session, Cristina Lull, Technical University of Valencia, Spain, highlighted ways to increase students' awareness on soil contamination. Reminding participants that GSP's second pillar involves awareness-raising, she noted that soil pollution education stimulates critical thinking. Johan Ceenaeme, Public Waste Agency of Flanders, Belgium, provided an overview of lessons learned after 20 years of soil remediation policy implementation in Flanders, emphasizing that via the Soil Certificate, the market can guarantee soil investigation and remediation have been completed.

Jussi Reinikainen, Finnish Environmental Institute, Finland ©FAO

Eloana Janice Bonfleur, Federal University of Paraná, Brazil, discussed reference values for potentially harmful elements in soils from the Atlantic rainforest in Brazil. Jussi Reinikainen, Finish Environment Institute, discussed the derivation and application of soil guideline values (SGVs), stressing that SGVs can never replace a proper site-specific risk assessment.

An interactive discussion took place on Friday morning, theme chair Natalia Rodríguez Eugenio, FAO, summarized the following key messages, including the need for:

- raising awareness on the importance of soil and on the effects of soil pollution on human health and the environment;
- refining policy questions and conducting joint policymaking process;
- implementing and improving existing international agreements;
- developing international protocols to derive threshold values at national level; and
- developing a technical panel on soil pollution.

CASE STUDIES AT GLOBAL, NATIONAL AND REGIONAL SCALES: In Wednesday afternoon's parallel session, Ismail Ithnin, Department of Environment, Malaysia, discussed policies and the legal framework around contaminated land management in Malaysia. Raul Lavado, University of Buenos Aires, addressed the state of contamination in Pampas soils, noting concerns around the use of herbicides.

Nandula Raghuram, Guru Gabind Singh Indraprastha University, India, focused on the Indian Nitrogen Assessment, including: key sources and estimates of nitrous oxide emissions; greenhouse gas emissions from agriculture; crop residue burning; and groundwater nitrate content. Johan Ceenaeme, Public Waste Agency of Flanders, Belgium, discussed the national Soil

Certificate as a tool to create awareness about soil pollution. He stressed that the Soil Certificate is linked to every land transfer, making landowners aware of the impact of soil contamination on the economic value of their land. Alan Thomas, Environmental Resources Management, UK, discussed ways to embed sustainability in contaminated soil management. He stressed that the new international standard ISO 18504 provides clarity and an international benchmark for sustainable remediation, adding that aligning sustainable remediation with broader corporate goals may increase as industry gradually incorporates the SDGs.

Tamara Kukharchyk, Institute for Nature Management, Belarus, addressed sources and levels of soil pollution by PCBs in Belarus. She called for the creation of a system of PCBs management, noting, as a key element, an inventory of PCB-containing equipment. Tom Bruulsema, International Plant Nutrition Institute, Canada, stressed that keeping soils healthy depends on evidence-based risk assessment rather than risk avoidance. He highlighted the 4R nutrient stewardship, explaining it incorporates the right fertilizer source, at the right rate, at the right time, and in the right place.

An interactive discussion took place on Friday morning, theme chair Natalia Rodríguez Eugenio, outlined the key messages, including:

- the case studies described at the Symposium indicated overall extensive global soil pollution;
- organic compounds and emerging contaminants represent the main challenges;
- there is a need to increase research to support informed decision-making;
- a global assessment of soil pollution should include modeling chemical production and emissions, prioritize highly contaminated sites, and assess at country level the main contaminants and impacts; and
- the need for developing accessible technologies to assess soil pollution.

Rodriguez Eugenio also summarized next steps, including strengthening the science-policy interface to develop informed legal instruments at national and regional levels, and promotion of capacity building to assess threshold levels of soil contaminants under different conditions and soil types.

Natalia Rodríguez Eugenio, FAO ©FAO

CLOSING PLENARY

On Friday, during closing plenary, an interactive panel discussion among various stakeholders took place, facilitated by Ronald Vargas, GSP Secretariat,.

Mario Arvelo Caamaño, Chair, Committee on World Food Security, emphasized the role of technical experts in helping to inform policy recommendations and voluntary guidelines. Patrick Heffer, IFA, underscored the need to encourage farmers to use best management practices in nutrient application. Bavo Peeters, European Commission, stressed that efforts must continue to "convince all that soils matter," using the link between soil health and human health. He called for a more coordinated approach at EU level to set a common vision with targets.

Highlighting the role of the private sector as part of the solution, Siroj Loikov, PhosAgro, emphasized research and development, awareness raising and education to fertilizers' end users, and product labelling. Cristina Grandi, International Federation of Organic Agriculture Movements, stressed that soil health, quality, and fertility constitute the basis of the organic system. She called for extension services for organic farmers and support for mainstreaming agroecological techniques in the whole of the agricultural sector. Elena Havlicek, Swiss Federal Office for the Environment, noted that Switzerland is importing 50% of its food, thus is also responsible for sustainable soil management in other countries. She stressed that due to urban pollution, there is no more pristine soil in the country, highlighting fragmented data as the main challenge for drawing a full picture of the state of pollution in Swiss soil.

Vargas, announced plans for establishing two working groups; one on developing guidelines for assessing, mapping, monitoring and reporting on soil pollution, and the other on managing soil pollution. He highlighted several needs including: targeted research and technical cooperation; a platform for research findings on soil pollution and database of successful practices; and the creation of a neutral fund for supporting research on soil pollution, particularly for young researchers. Noting that "soil pollution is a reality and a fact, and should not be hidden or ignored any longer," he called for a multidisciplinary approach to address soil pollution, encouraging participants to join the campaign "Be the solution to soil pollution" and to organize continual regional and national awareness-raising initiatives.

CLOSURE OF THE SYMPOSIUM: Melisa Lim, underscored the need to prevent soil pollution, rather than finding ways to mitigate it. Mette Wilkie, stressed that the Symposium promoted research and development, strengthened the science-policy interface, improved knowledge dissemination, and promoted a coordinated effort to combat soil pollution.

Luca Montanarella, addressed the challenges of bringing together scientists and policy-makers, stressing the importance of a roadmap for future actions. He explained that part of this roadmap will be the Symposium's outcome document 'Be the Solution to Soil Pollution,' to be prepared by ITPS and the cooperating agencies. René Castro Salazar, noted that "the

René Castro Salazar, Assistant Director-General, Climate, Biodiversity, Land, and Water Department, FAO ©FAO

optimist invented the plane and the pessimist the parachute," stressing that "we need everyone on board to convey the message that there is no time to waste."

Moderator Lucrezia Caon, thanked all participants and closed the Symposium at 5:12 pm.

UPCOMING MEETINGS

International Symposium on Soil health and Sustainable Development: Organized by FAO and the GSP, the Beijing Municipal Agriculture Bureau, and the Beijing Soil Fertilizer Extension Service Station, the Symposium aims to review the knowledge and status of adoption of sustainable soil management practices, as well as the related gaps and barriers that need to be addressed for full implementation. **dates:** 24-26 May 2018 **location:** Beijing, China **contact:** GSP Secretariat **phone:** + (+39) 06 57051 **email:** GSP-Secretariat@fao.org **www:** http://www.fao.org/global-soil-partnership/resources/highlights/detail/en/c/1100241/

6th GSP Plenary Assembly: The GSP Plenary Assembly constitutes the main venue where all GSP partners come together to make important decisions about the global soil agenda. **dates:** 11-13 June 2018 **location:** Rome, Italy **contact:** GSP Secretariat **phone:** +39 06 57051 **email:** GSP-Secretariat@fao.org **www:** http://www.fao.org/global-soil-partnership/about/plenary-assembly/sixth-session-2018/en/

CBD SBSTTA-22 and SBI-2: The 22nd meeting of the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), and the second meeting of the CBD Subsidiary Body on Implementation (SBI) will be held consecutively. SBSTTA-22 will address, *inter alia*: marine and coastal biodiversity, biodiversity and digital sequence information on genetic resources. SBI-2 will discuss: review of progress in the implementation of the Convention and the Strategic Plan; biodiversity mainstreaming; national reporting, and assessment and review; and review of effectiveness of the processes under the CBD and its Protocols. **dates:** 2-7 July 2018 (SBSTTA-22) and 9-13 July 2018 (SBI-2) **location:** Montreal, Canada **contact:** CBD Secretariat **phone:** +1-514-288-2220 **fax:** +1-514-288-6588 **email:** secretariat@cbd.int **www:** https://www.cbd.int/meetings/SBSTTA-22

24th Session of the FAO Committee on Forestry (COFO 24) and World Forest Week: The biennial sessions of COFO bring together heads of forest services and other senior government officials to identify emerging policy and technical issues, seek solution, and advise FAO and others on appropriate action. **dates:** 16-20 July 2018 **location:** Rome, Italy **contact:** COFO Secretariat **phone:** +39 06 57051 **email:** COFO-2018@fao.org **www:** http://www.fao.org/about/meetings/cofo/en/

21st World Congress of Soil Science (WCSS): Hosted by the International Union of Soil Science, the Brazilian Soil Science Society, and the Latin American Soil Science Society, the 21st World Congress of Soil Science will take place under the theme 'Soil Science: Beyond food and fuel.' **dates:** 12-17 August 2018 **location:** Rio de Janeiro, Brazil **contact:** 21st WCSS Secretariat **phone:** +39 06 57051 **email:** 21wcss@21wcss.org **www:** http://www.21wcss.org/

International Symposium on Black Soils: Under the aegis of the GSP, the International Network of Black Soils was established as a platform for knowledge sharing for countries with black soils to discuss common issues related to the conservation and sustainable management of these soils. The Symposium aims to promote these objectives, identifying relevant research gaps. **dates:** 10-12 September 2018 **location:** Harbin, China **contact:** GSP Secretariat **phone:** + (+39) 06 57051 **email:** GSP-Secretariat@fao.org

1st Global CleanUp Congress: Led by the Cooperative Research Centre for Contamination Assessment and Remdiation of the Environment (CRC Care), the Congress will provide a global forum to discuss all aspects of contaminated site assessment, management, and remediation. **dates:** 21-24 October 2018 **location:** Coimbatore, India **contact:** CRC Care **phone:** +61 8 8302 6821 **email:** prashant.srivastava@crccare.com **www:** http://gcc2018.cleanupconference.com/about_gcc2018/

GLOSSARY

BRS Conventions	Basel, Rotterdam, and Stockholm Conventions
FAO	Food and Agriculture Organization of the UN
GSP	Global Soil Partnership
ITPS	Intergovernmental Technical Panel on Soils
PCBs	Polychlorinated biphenyls
POPs	Persistent Organic Pollutants
SDGs	Sustainable Development Goals
WHO	World Health Organization