



# OPEN Ecological risk assessment of trace elements (TEs) pollution and human health risk exposure in agricultural soils used for saffron cultivation

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Contamination of farmland soils by trace elements (TEs) has become an international issue concerning food safety and human health risks. In the present research, the concentrations of TEs including cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), manganese (Mn), nickel (Ni), lead (Pb), zinc (Zn) and iron (Fe) in soils of 16 farmlands were determined in Gonabad, Iran. In addition, the human health risks due to exposure to the TEs from the soils were assessed. Moreover, the soil contamination likelihood was evaluated based on various contamination indices including contamination factor (CF), enrichment factor (EF), geo-accumulation index (I<sub>geo</sub>), and pollution load index (PLI) calculations. The soil mean concentrations for Cd, Co, Cr, Cu, Mn, Ni, Pb, Zn and Fe ranges as 0.102, 6.968, 22.550, 29.263, 475.281, 34.234, 13.617, 54.482 and 19,683.6 mg/kg in farmland soils. The mean concentrations of the TEs decreased in the order of Fe > Mn > Zn > Ni > Cu > Cr > Pb > Co > As > Cd. Levels of all metals in this study were within the FAO/WHO and Iranian soil standards. The HQ values from investigated elements for adults and children in the studied farms were less than the limit of 1, indicating no health risks for the studied subpopulations. The results of the present research indicated no significant carcinogenic health hazards for both adults and children through ingestion, skin contact and inhalation exposure routes. CF values of Ni and Zn in 100% and 6.25% of farmlands were above 1, showing moderate contamination conditions. EF values of metals in farmlands were recorded as “no enrichment”, “minimal enrichment” and “moderate enrichment” classes. Furthermore, it can be concluded that the all farms were uncontaminated except Ni (moderately contaminated) based on I<sub>geo</sub>. This is an indication that the selected TEs in the agricultural soils have no appreciable threat to human health.

Issues arise from the rapid process of urbanization, industrialization and land use has attracted worldwide public attention from both environmental and health perspectives<sup>1,2</sup>. Soil is the skin of our globe and is necessary for living organisms as it provides elements and nutrients for plants growth and serves as habitat for microflora and fauna<sup>3</sup>. The growing population in world significantly increase pressure on the farmlands. In order to improve the yield and profit of agricultural products, the excessive cultivation has inevitably resulted in the contamination of the soils by TEs. Farming is considered to be one of the main sources of As, Cu, Zn, Fe and Pb in the soils<sup>4–7</sup>. Among toxic and persistent pollutants found in agricultural soils, a special attention is paid on heavy metals. Heavy metals (including both metals and metalloids) are the most widely distributed elements of concern in

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# Ecological Risk Evaluation Of Polluted Soils

**Glenn W. Suter II, Rebecca A.  
Efroyimson, Bradley E. Sample, Daniel S.  
Jones**

## **Ecological Risk Evaluation Of Polluted Soils:**

*Ecological Risk Evaluation of Polluted Soils* Jean-Louis Rivi re,2000 This work presents an holistic view of the fundamental principles and practicable methods of polluted soils A set of definitions is presented and different aspects of the evolution of pollutants and their toxicity are developed

**Environmental Risk Assessment of Soil Contamination** Maria C. Hernandez Soriano,2014-03-26 Soil is an irreplaceable resource that sustains life on the planet challenged by food and energy demands of an increasing population Therefore soil contamination constitutes a critical issue to be addressed if we are to secure the life quality of present and future generations Integrated efforts from researchers and policy makers are required to develop sound risk assessment procedures remediation strategies and sustainable soil management policies Environmental Risk Assessment of Soil Contamination provides a wide depiction of current research in soil contamination and risk assessment encompassing reviews and case studies on soil pollution by heavy metals and organic pollutants The book introduces several innovative approaches for soil remediation and risk assessment including advances in phytoremediation and implementation of metabolomics in soil sciences

**Ecological Risk Assessment of Contaminants in Soil** N.M. Van Straalen,Hans L kke,2012-12-06 Many industrialized and developing countries are faced with the assessment of potential risks associated with contaminated land A variety of human activities have left their impacts on soils in the form of elevated and locally high concentrations of potential toxicants In several cases sources have not yet been stopped and contamination continues Decisions on the management of contaminated sites and on the regulation of chemicals in the terrestrial environment require information on the extent to which toxicants adversely affect the life support function of soils Ecological insights into the soil as an ecosystem may support such decisions This book reviews the latest ecological principles that should be considered in this respect

**Ecological Risk Assessment for Contaminated Sites** Glenn W. Suter II,Rebecca A. Efroymson,Bradley E. Sample,Daniel S. Jones,2000-04-21 Love Canal Exxon Valdez Times Beach Sacramento River Spill Amoco Cadiz Seveso Every area of the world has been affected by improper waste disposal and chemical spills Common hazardous waste sites include abandoned warehouses manufacturing facilities processing plants and landfills These sites poison the land and contaminate groundwater and drinking water A sequel to the bestselling Ecological Risk Assessment Ecological Risk Assessment for Contaminated Sites focuses on how to perform ecological risk assessments for Superfund sites and locations contaminated by improper disposal of wastes or chemical spills It integrates the authors extensive experience in assessing ecological risks at U S government sites with techniques and examples from assessments performed by others Conducting an ecological risk assessment on a contaminated site provides the information needed to make decisions concerning site remediation The first rule of good risk assessment is don t do anything stupid With the practical preparation you get from Ecological Risk Assessment for Contaminated Sites you won t

**Superfund Risk Assessment in Soil Contamination Studies** Keith B. Hoddinott,1992 Proceedings of an ASTM symposium held in New

Orleans in January 1991 Papers were selected in the categories of site characterization fate and transport toxicity exposures and receptors risk characterization and case studies and establishing cleanup levels The authors discuss the current mod

*Human and Ecological Risk Assessment* Dennis J. Paustenbach, 2017-05-22 Human and Ecological Risk Assessment Theory and Practice assembles the expertise of more than fifty authorities from fifteen different fields forming a comprehensive reference and textbook on risk assessment Containing two dozen case studies of environmental or human health risk assessments the text not only presents the theoretical underpinnings of the discipline but also serves as a complete handbook and how to guide for individuals conducting or interpreting risk assessments In addition more than 4 000 published papers and books in the field are cited Editor Dennis Paustenbach has assembled chapters that present the most current methods for conducting hazard identification dose response and exposure assessment and risk characterization components for risk assessments of any chemical hazard to humans or wildlife fish birds and terrestrials Topics addressed include hazards posed by Air emissions Radiological hazards Contaminated soil and foods Agricultural hazards Occupational hazards Consumer products and water Hazardous waste sites Contaminated air and water The bringing together of so many of the world s authorities on these topics plus the comprehensive nature of the text promises to make Human and Ecological Risk Assessment the text against which others will be measured in the coming years **Heavy Metals in the Environment**

Vinod Kumar, Anket Sharma, Artemi Cerda, 2020-11-21 Heavy Metals in the Environment Impact Assessment and Remediation synthesizes both fundamental concepts of heavy metal pollutants and state of the art techniques and technologies for assessment and remediation The book discusses the sources origin and health risk assessment of heavy metals as well as the application of GIS remote sensing and multivariate techniques in the assessment of heavy metals The various contamination indices like contamination factor geoaccumulation index enrichment factor and pollution index ecological risk index are also included to provide further context on the state of heavy metals in the environment Covering a variety of approaches techniques and scenarios this book is a key resource for environmental scientists and policymakers working to address environmental pollutants Covers state of the art techniques for the assessment and remediation of heavy metals Presents the interdisciplinary impacts of heavy metals including human health ecosystems and water quality Includes various contamination indices such as contamination factor geoaccumulation index enrichment factor pollution index and ecological risk index

*Soil and Groundwater Pollution* Alexander J.B. Zehnder, 1995-11-30 SCOPE the Scientific Committee on Problems of the Environment was established by the International Council of Scientific Unions ICSU in 1969 as an international non to governmental non profit organisation with the mandate advance knowledge of the influence of humans on their environment as well as the effects of these environmental changes upon people their health and their welfare with particular attention to those influences and effects which are either global or shared by several nations to serve as a non governmental interdisciplinary and international council of scien tists and as a source of advice for the benefit of

governments and intergovernmental and non governmental bodies with respect to environmental problems SCOPE has been established because critical environmental concerns call for a thorough evaluation of the issues at stake an assessment of their consequences at global and regional levels and the formulation of possible solutions Through its activities SCOPE identifies available knowledge then synthesizing it to point out where gaps and uncertainties exist and to recommend where efforts should be concentrated to develop explanations and solutions

**Soil Pollution** Teresa Rocha-Santos, Anabela Cachada, Armando C. Duarte, 2025-06-10 Soil Pollution From Monitoring to Remediation Second Edition provides a comprehensive overview of the causes of soil pollution distribution transport and fate of pollutants and transformation of pollutants in soil and metabolite accumulation Soil pollution has increased over the last decades and may pose a risk for human and ecological health The book expands and updates on current knowledge with an increased focus on PFAs and micronanoplastics The new edition also includes a new chapter on the One Health initiative In this book researchers and students in soil science will find appropriate and comprehensive information on organic inorganic and nanoparticle pollutants in soil methodologies for their monitoring and data reporting processes in order to gain adequate insights of pollution problems caused by these pollutants Provides concise and comprehensive coverage of soil pollution related issues along with techniques for pollutants monitoring protection and remediation Presents real examples to illustrate cases of soil pollution and of techniques used for monitoring the pollutants Includes discussions on the ecotoxicological and human effects of soil pollution

*E-Waste and Heavy Metals: Health Hazards and Environmental Impact* Baby Tabassum, Mohammad Imran Ansari, Sarfuddin Azmi, Mohd Kamil Hussain, Mirza Nuhanović, 2024-12-02 In recent decades information technology and electronic devices have undergone significant developments that have remarkably improved our quality of life Nevertheless as these electronic devices such as computer equipment smartphones and home appliances are discarded they contribute to the production of e waste harming our environment and in turn posing a danger to human health With one out of every three people accessing a computer or mobile device worldwide and the increasing use of heavy metals in fields such as medicine we are witnessing an ever increasing amount of hazardous e waste One of the major toxic components of e waste is heavy metals including arsenic cobalt copper lead mercury and nickel which need to be handled carefully due to the risks of occupational or residential exposure and the effects on public health The absence of a discerning and public health based approach to the disposal of e waste and heavy metals has resulted in significant public health risks Following human exposure these metals generate bio toxic chemicals that can permanently alter the structure of tissues and disrupt the biochemical and physiological mechanisms that keep living things functioning When heavy metals disperse leaches into our environment including our water supplies the toxic pollutant is bio magnified into the food chain and causes severe toxicity inside the organs of living things this includes silicosis cuts from cathode ray tube glass mercury inhalation acid contact with eyes skin and circulatory failure Nevertheless in many low and middle income countries this waste is being managed by the

informal sector further compounding the problem

*Mercury in the Environment* Michael S. Bank, 2012-05-31 Mercury pollution and contamination are widespread well documented and continue to pose a public health concern in both developed and developing countries In response to a growing need for understanding the cycling of this ubiquitous pollutant the science of mercury has grown rapidly to include the fields of biogeochemistry economics sociology public health decision sciences physics global change and mathematics Only recently have scientists begun to establish a holistic approach to studying mercury pollution that integrates chemistry biology and human health sciences Mercury in the Environment follows the process of mercury cycling through the atmosphere through terrestrial and aquatic food webs and through human populations to develop a comprehensive perspective on this important environmental problem This timely reference also provides recommendations on mercury remediation risk communication education and monitoring

**Soil and Sediment Pollution, Processes and Remediation** Hongbiao Cui, Chunhao Gu, Zhu Li, Jun Zhou, 2022-02-09 *Environmental Analysis of Contaminated Sites* Geoffrey I. Sunahara, Agnès Y. Renoux, Claude Thellen, Connie L. Gaudet, Adrien Pilon, 2002-03-12 Die Bioremediation ist ein Verfahren bei dem biologische Verfahren eingesetzt werden um industrielle Schadstoffe in verschiedenen Ökosystemen wieder in den natürlichen Stoffkreislauf zurückzuführen Ob die Bioremediation erfolgreich ist oder nicht hängt entscheidend vom Verständnis des biotechnologischen Prozesses und von den Stärken und Schwächen der eingesetzten toxikologischen Verfahren ab Environmental Analysis of Contaminated Sites diskutiert umweltanalytische Verfahren und Methoden zur Bewertung der erfolgreichen Sanierung kontaminierter Bodensysteme Ein zentraler Leitfaden der diese komplexe Thematik umfassend behandelt indem er Toxizitätstests für den Bodenschutz die Bioremediation und die Risikobewertung der Umweltgefährdung miteinander verbindet Darüber hinaus beschreibt er das Zusammenwirken von toxikologischer Labor- und Felduntersuchung Biotechnologie Consultants und verschiedenen internationalen Umweltkontrollbehörden und erklärt wie sie gemeinsam an einer erfolgreichen Auswertung sanierter Umweltsysteme arbeiten Mit zahlreichen Fallstudien zu erfolgreichen und gescheiterten Projekten

**Remediation and Health Risks of Heavy Metal Contaminated Soils** Qi Liao, Mariusz Gusiati, Weichun Yang, 2024-10-18 Soil is the essential foundation for human survival However soil pollution and environmental problems have become increasingly evident in recent years In particular heavy metal pollution at various sites poses a serious threat to human health and ecological safety becoming a significant social issue worldwide Greener and environmentally friendly remediation technologies coupled with accurate evaluation of the potential risks environmental impact and human health of heavy metals in the soil have become urgently required This Research Topic aims to gather the latest advancements in scientific research and applicable studies on i the potential risk or impact of recently problematic heavy metals such as Sb, Tl and cases of combined heavy metal pollution ii pollution formation migration and remediation of heavy metal in soil and groundwater iii novel methods to treat and reduce heavy metals in contaminated sites iv environmentally friendly remediation technology such as enhanced bioremediation and

in situ remediation and v assessment or modeling of the environmental or human health impact of heavy metals

*Ecological Risk Assessment* Glenn W. Suter II, 2016-04-19 The definitive reference in its field *Ecological Risk Assessment* Second Edition details the latest advances in science and practice In the fourteen years since the publication of the best selling first edition ecological risk assessment ERA has moved from the margins into the spotlight It is now commonly applied to the regulation of c      **Environmental Risk Assessment** Diana Mariana Cocârță, 2023-08-22 *Environmental Risk Assessment* familiarizes readers with risk assessment for the main environmental systems that are surveyed soil water and air The text aims to enable learners to develop knowledge and awareness about environmental risk management and take action to transform society into a sustainable one The eight edited chapters start with an introduction to the subject and an outline of good practices in risk assessment The latter half presents a risk based approach to the environment and provides a deep dive into risk management implementation for contaminated sites monitoring air quality evaluating drinking water for safety and risk analysis in waste management Concepts are explained in simple language with references included for further reading This book is an essential guideline for students who require knowledge of risk assessment in environmental engineering programs or related course modules      [Climate Change and Soil Microbial Control of Carbon Sequestration](#) Yang Yang, Anna Gunina, Peng Shi, Yan Xing Dou, 2025-06-09 As a major regulator of the dynamics of soil organic carbon SOC and nutrient availability soil microorganisms partake in a variety of biochemical reactions Soil microorganisms exert two primary contradictory impacts on controlling soil carbon dynamics firstly they enhance carbon release into the atmosphere via the catabolic activity secondly they prevent release through stabilizing SOC in a form that resists decomposition Because of the large soil carbon pool even small changes in the balance between inputs and outputs from the soil carbon pool can exert a significant impact on atmospheric CO<sub>2</sub> levels Over the past few decades the influence of climate change such as the increased CO<sub>2</sub> levels rising temperature sudden heat or drought stress and extreme weather events on soil carbon cycling have been intensively analyzed The focus on investigating the global carbon cycle due to its connection to climate change has led to an increasing number of studies on microbial control of SOC It has been extensively recognized that the extent of the soil SOC reservoir is determined by microbial involvement since soil carbon dynamics ultimately stem from microbial activity and growth However the mechanisms by which these microbe regulated processes cause soil carbon stabilization under climate change is still unclear This Research Topic of *Frontiers in Environmental Science: Soil Processes* focuses on climate change and its impact on soil microbial control carbon sequestration Brief Research Report Correction Data Report Editorial Hypothesis 2 Recent advancements in soil carbon dynamics under the influence of global climate change 3 Biogeochemical mechanisms connecting soil microbes and SOC 4 The role of soil microbes in the SOC conversion process 5 The new high throughput sequencing for soil microbes including metagenome transcriptomics metabonomics methods etc 6 Response of soil microbes to climate change and their impacts on SOC transformation and fixation 7 Addressing uncertainty in estimating

SOC pool at the local regional and global scales      *Encyclopedia of Quantitative Risk Analysis and Assessment* ,2008-09-02

Leading the way in this field the Encyclopedia of Quantitative Risk Analysis and Assessment is the first publication to offer a modern comprehensive and in depth resource to the huge variety of disciplines involved A truly international work its coverage ranges across risk issues pertinent to life scientists engineers policy makers healthcare professionals the finance industry the military and practising statisticians Drawing on the expertise of world renowned authors and editors in this field this title provides up to date material on drug safety investment theory public policy applications transportation safety public perception of risk epidemiological risk national defence and security critical infrastructure and program management This major publication is easily accessible for all those involved in the field of risk assessment and analysis For ease of use it is available in print and online      **Engineering Tools for Environmental Risk Management** Katalin Gruiz,Tamas Meggyes,Eva Fenyvesi,2015-04-27

Chemical substances physical agents and built structures exhibit various types of hazard due to their inherent toxic mutagenic carcinogenic reprotoxic and sensitizing character or damaging to the immune and hormone system The first steps in managing an environment contaminated by chemical substances are characterization of hazards and quantifi      Core List for an Environmental Reference Collection ,2002



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