

Lee Newman · Abid Ali Ansari ·
Sarvajeet Singh Gill · M. Naeem ·
Ritu Gill *Editors*

Phytoremediation

Management of Environmental
Contaminants, Volume 7

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Editors

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 Springer

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*This book is dedicated to
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Foreword

The soil is the great connector of lives, the source and destination of all. It is the healer and restorer and resurrector, by which disease passes into health, age into youth, and death into life. Without proper care for it we can have no community, because without proper care for it we can have no life. – Wendell Berry, *The Unsettling of America: Culture and Agriculture*

We are living in an environment which is being seriously challenged by human interventions, and the soil and water are significantly contaminated with chemicals, pesticides, heavy metals and metalloids by anthropogenic activities. The onset of global climate change further aggravated climatic conditions which result in extreme drought conditions, temperature alterations (very high and low), prolonged flooding and submergence conditions, luxurious application of agrochemicals (fertilizers and pesticides), soil salinization and compaction, degraded soil and rhizospheric microbial health, depleting water table, war and war-like situations pose an obvious threat to cultivable land and food security thus human health. To get optimal crop production, the health of agriculturally viable land is one of the very important components. Therefore, it becomes imperative to look for options to remediate the health of soil and water to ensure soil quality, crop growth and productivity in a sustainable manner. Phyto-remediation has vast potential to remediate contaminated lands in an ecofriendly manner.

The editors of the seventh volume ‘Phytoremediation: Management of Environmental Contaminants’ have done admirable job of assembling a wealth of information on some new approaches for remediation of contaminated soil and water bodies. Editors have compiled chapters from expert authors from all over the world. The number of chapters included in different sections brought comprehensiveness to the book. Sections starting with overview of the component chapters will definitely attract the reader’s attention. There are excellent chapters on nano-phytoremediation and NPs-mediated remediation of polluted sites. This comprehensive volume with twenty-seven chapters written by experts from countries USA, Italy, Brazil, Argentina, Nigeria, India, Pakistan, Saudi Arabia, Thailand, Turkey, China and Algeria proves useful for basic researchers, plant scientists, teachers and students interested in phytoremediation.

I would like to congratulate the publisher Springer Nature and Editors of the book (Lee Newman, Abid Ali Ansari, Sarvajeet Singh Gill, M. Naeem and Ritu Gill) for their labour for preparing this valuable scientific resource.

Narendra Tuteja
ICGEB
New Delhi, India

Preface

Land is becoming a diminishing resource for agriculture, in spite of a growing understanding that the future of food security will depend upon the sustainable management of land resources as well as the conservation of prime farmland for agriculture. – M. S. Swaminathan

Volume 7 of 'Phytoremediation: Management of Environmental Contaminants' book series adds recent literature concerning modern phytoremediation techniques such as use of bioformulations, application of electroremediation-coupled phytoremediation, microorganisms consortium mediated phytoremediation, phytostabilization of biogeochemical and microbiological processes, plant root exudates and microbial interactions, nano-phytoremediation, nano-bioremediation and nano-biotechnology for the cleanup environmental contaminants from soil and water. The book chapters in Volume 7 comprehensively provide additional examples that illustrate how phytoremediation applications can be strengthened and serve as one of several useful components in the overall management and control of contaminants using relatively low-cost solar-driven physiological/biochemical mechanisms common to most plants. This volume exclusively deals with the use of nano-particles and nano-biotechnology for the removal of pollutants from contaminated sites.

Volume 7 has been subsectioned into six different sections for the ease of readers, which defines as Part I: Overview of current phytotechnology and phytoremediation applications; Part II: Planning and engineering applications to phytoremediation; Part III: Phytoremediation applications for contaminated water and soil; Part IV: Phytoremediation using microbial assemblages in water and soil; Part V: Phytoremediation of organic and inorganic contaminants and organic-inorganic mixtures; and Part VI: Nanotechnology in management of environmental contaminants. Part I contains six chapters namely Phytoremediation and Management of Environmental Contaminants: An Overview; Phytoremediation and Contaminants; Phytoremediation by Wild Weeds: A Natural Asset; Phytoremediation: Sustainable and Organic Technology for the Removal of Heavy Metals Contaminants; Structure and Function of Heavy Metal Transporting ATPases in Brassica species; and Bioformulations for Sustainable Phytoremediation of Heavy Metal Contaminated Soil written by the authors from India, Italy, USA and Pakistan; Part II contains a chapter on Application of Electroremediation Coupled with Phytoremediation

Techniques for the Removal of Trace Metals in Sewage Sludge; Part III contains a chapter on Phytoremediation of Heavy Metals by *Trapa natans* in Hokersar Wetland: A Ramsar Site of Kashmir Himalayas; Part IV contains four chapters namely Spinoffs of Phytoremediation and/or Microorganisms Consortium in Soil, Sediment and Water Treatments and Improvement: Study of Specific Cases and Its Socioeconomic and Environmental Advantages; Applying Amendments for Metal(loid) Phytostabilization: Effects on Biogeochemical and Microbiological Processes in Soils; Rhizodegradation: The Plant Root Exudate and Microbial Interactions, and Role of Microorganisms in the Remediation of Toxic Metals from Contaminated Soil; Part V contains three chapters namely Prospects for the Use of Sorghum Bicolor for Phytoremediation of Soils Contaminated with Heavy Metals in Temperate Climates; Comparative Effect of Cadmium on Germination and Early Growth of Two Halophytes: *Atriplex halimus* L. and *A. nummularia* Lindl. for Phytoremediation Applications, and Phytoremediation of Soils Polluted by Heavy Metals and Metalloids: Recent Case Studies in Latin America provided by the scientists from Russia, Argentina and Algeria; and Part VI encompasses twelve chapters namely Nano-phytoremediation and Its Applications; Potentials and Frontiers of Nanotechnology for Phytoremediation; Nanotechnology in the Management of Environmental Contaminants; Nanotechnologies and Phytoremediation: Pros and Cons; Nanotechnology in Phytoremediation: Applications and Future; Nano-phytoremediation: The Successful Combination of Nanotechnology and Phytoremediation; Nano-bioremediation and Its Application for Sustainable Environment; Nanoparticles Assisted Phytoremediation of Polluted Soils: Potential Application and Challenges; A Systematic Analysis of Nanotechnology Application in Water Contaminations Removal; Nanoparticles-Based Management of Cadmium Toxicity in Crop Plants; Heavy Metal Remediation by Nanotechnology; and Phytoremediation and Management of Environmental Contaminants: Conclusion and Future Perspectives written by the experts from the countries Italy, Brazil, Nigeria and Pakistan. The editors and contributing authors hope that this book will include a practical update on our knowledge for improving phytoremediation potential to de-contaminate environmental contaminants. This book will lead to new discussions and efforts to the use of various tools for the improvement of phyto-remediation techniques.

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Part I
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