

# Preface

Decoupling environmental degradation and resource consumption from economic and social development is an enduring challenge and requires a paradigm shift in our approach. Presently, green technologies are playing a significant role in changing the course of the world's economic growth towards sustainability and providing an alternative socio-economic model that will enable our present and future generations to live in a clean, healthy environment and in harmony with nature. The concepts of green technologies, if endorsed and disseminated into the lives of all people, will facilitate the aim of the Millennium Development Goals of keeping the environment intact and improving it for civilization to survive. This book focuses on the goals of green technologies, which are becoming increasingly important for ensuring sustainability. It provides a different perspective of green technology in sectors like energy, agriculture, waste management and transportation. This book also offers recent advancements made towards sustainable development in the field of bioenergy, nanotechnology, green chemistry, bioremediation and degraded land reclamation and helps bridge the gap between the scientific community and policymakers.

Safe, economic and effective disposal of domestic wastewater is one of the most challenging problems today. In response to the growing public concern and enforcement of environmental legislation, the greatest challenge has been in the sanitation sector to minimize domestic wastewater pollution. Chapter 1 presents an overview of the pros and cons, operational design variables and effectiveness of traditional and recently developed constructed wetland systems for the treatment of domestic sewage. The chapter also discusses the role of plants, media materials, microorganisms and oxygen transfer in domestic wastewater purification through constructed wetlands (CWs) along with the research needs for enhancing stability and sustainability of wetland systems. The continuous contamination of water bodies worldwide by the presence of emerging pollutants has raised several issues in the last decades. Although scientific data have made evident the potential threats of emerging pollutants to public and environmental health, there is still limited information on the ecotoxicity, concentration and distribution of these compounds in environment, which makes their ecological regulation, detection and treatment difficult.

Thus, the search for green technologies to detect and treat potential environmental pollutants is critical for ecologic and human health protection. Chapter 2 explores the potential of laccase enzyme as an element of biosensing and bioremediation and identifies the drawbacks that have to be overcome in order to demonstrate their feasibility and implement a large-scale process.

The quest for sustainable and environment-friendly energy sources has become a pressing need. Declining fossil fuel reserves, worldwide demand for energy and undesirable effects of greenhouse gas emissions have led to increased interests in biofuels worldwide. The generations, environmental benefits, compatibility, performance, emission characteristics and global perspectives of biofuels have been highlighted in Chap. 3. The need for developing sustainable criteria and certification of standards for biofuel production and trade has also been addressed. Chapter 4 deliberates on the role of biodiesel in greening the transport sector. Chapter 5 is dedicated to microalgae which play a quintessential role in the energy sector. The conversion of microalgae into liquid fuels provides an inherently renewable, economical, eco-friendly and sustainable alternative to fast-depleting fossil fuels. Moreover, the production of value-added by-products after biofuel extraction is an added advantage of microalgae. The role and performance of natural and synthetic flocculants in harvesting microalgae for the purpose of biofuel production has been conferred in Chap. 6. Chapter 7 deals with solar photovoltaics which is inexhaustible, affordable and the most promising of all the active solar energy technologies. The chapter presents a succinct picture of the solar PV technology along with its classification and application areas. The economic aspects, energy-exergy and status of the maturity of PV technology have also been addressed.

The crop–weed competition is one of the most important factors responsible for potential loss of crops around the world. Therefore, herbicides have become a major tool to tackle weed interference. Glyphosate is one of the widely accepted herbicides which has broad-spectrum activity and effectiveness. Its ubiquitous presence in the environment due to anthropogenic activities and recalcitrance has the potential to affect animal behaviour and interfere with ecological processes. Chapter 8 explores the available information on glyphosate biodegradation over the course of 40 years of study, the different pathways involving the C-Plyase, the genetic and physiological regulatory system that governs these processes and the factors limiting the development of glyphosate bioremediation technologies.

Urbanized areas cover less than 3% of the land, but the majority of the Earth's population and industry is concentrated in these areas. The development of reliable bioindicators on the basis of systematic approach would contribute greatly to rational land use and sustainable functioning of the urban environment. Chapter 9 aims to review the existing approaches to the bioindication of urban areas, i.e. microbial and plant bioindicators, as well as complexity of urban ecosystem, soil and its types, anthropogenic impacts, pollutants, effect on microbial community and other existing problems in this field, and suggests possible ways to solve them. Chapter 10 provides an overview to understand the concept of smart cities. The chapter highlights development theories, sustainability dimensions, indicators and key

challenges for smart cities. Chapter 11 discusses the need for an integrated approach towards environmental quality control in developing countries. Conceptual considerations along with challenges for sustainable development, the role of research and development in solving environmental problems, anticipatory actions, environmental quality control and approaches to solutions are presented here. With increased urbanization, solid waste management has emerged as one of the major concerns. Among various categories of municipal solid waste, postconsumer waste, which is no longer recycled and has the possibility of creating aesthetic pollution is the focus of Chap. 12. The chapter presents vermitechnology as the simplest, cost-effective technology for the management of post-consumer wastes.

Nanotechnology is an area which touches almost every aspect of the modern world, ranging from research application, medicine and information technology to consumer goods. At present, smart nano-biomaterials have gained much attention. Nanocellulosic fibres in particular have diverse applications. The sources, types, properties, production cost and future perspectives of nanocellulosic fibres have been covered in Chap. 13. The synthesis of metal nanoparticles in bulk is a challenge to researchers due to their aggregation behaviour. Thus, the stabilization of metal nanoparticles becomes a challenging task. In the last decade, ionic liquids (ILs) were found to be a potent alternative for the stabilization of metal nanoparticles. Chapter 14 aims to contribute to the understanding of the synthesis of metal nanoparticles with tetrazolium ring-based ionic liquid as a solvent and stabilizer. Greener approaches for synthesizing nanoparticles are presently becoming popular due to their eco-friendly nature and cost-effectiveness. The plants which are being used for the synthesis of metal nanoparticles have been documented in Chap. 15.

Green analytical techniques refer to approaches that decrease or completely remove preservatives, reagents, solvents and other substances that are harmful to mankind and the environment. Chapter 16 discusses the basic principles of green analytical techniques which aim to reduce the impact of chemical activities on man and the environment. Emphasis has been placed on green separation techniques, green spectrophotometric techniques, the basics of green analytical techniques and the problems associated with the formulation of ideologies of green analytical chemistry to existing analytical laboratories.

Arsenic is a toxic element whose widespread contamination in highly populated regions of the world has led to environmental and human health concerns. As the extent of the problem is large, there is a need to devise cost-effective measures to tackle this problem. Chapter 17 focuses on different bioremediation strategies for arsenic removal/stabilization such as microbial and phytobial remediation and phyto-, myco- and phyco-remediation. The chapter also discusses prospects of utilizing biological components for restricting arsenic entry into crop plants, specifically rice. Detailed information on the biological methods which are practiced for the treatment of distillery wastewater with major emphasis on microalgae is given in Chap. 18. The merits and demerits of existing processes have been also summarized in this chapter.

Chapter 19 provides a brief insight into the need for ecologically restoring degraded land sites, factors influencing them, the choice or selection of species for undertaking such a work, indicators of ecological restoration that can be applied for monitoring purposes and some of the popular models of ecological restoration in India that have been successfully established and the techniques used in these models. Biochar is one of the modern, inexpensive, rapidly scalable and widely applicable technologies that can be used for climate mitigation and soil health enhancement. The production processes and diverse applications of biochar have been revealed in Chap. 20.

This book will be beneficial as a source of educational material to graduate and postgraduate students, faculty, researchers, chemists, environmentalists, soil scientists, agronomists, policymakers and industrial personnel who are interested in green technologies for sustainable development. It could also be used as a reference book by research scholars, scientists, academicians and readers from diverse backgrounds across various fields such as biotechnology, nanotechnology, chemistry, environmental science, water engineering and energy. We hope that the chapters of this book will provide readers with valuable insights into the major areas of green technologies.

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