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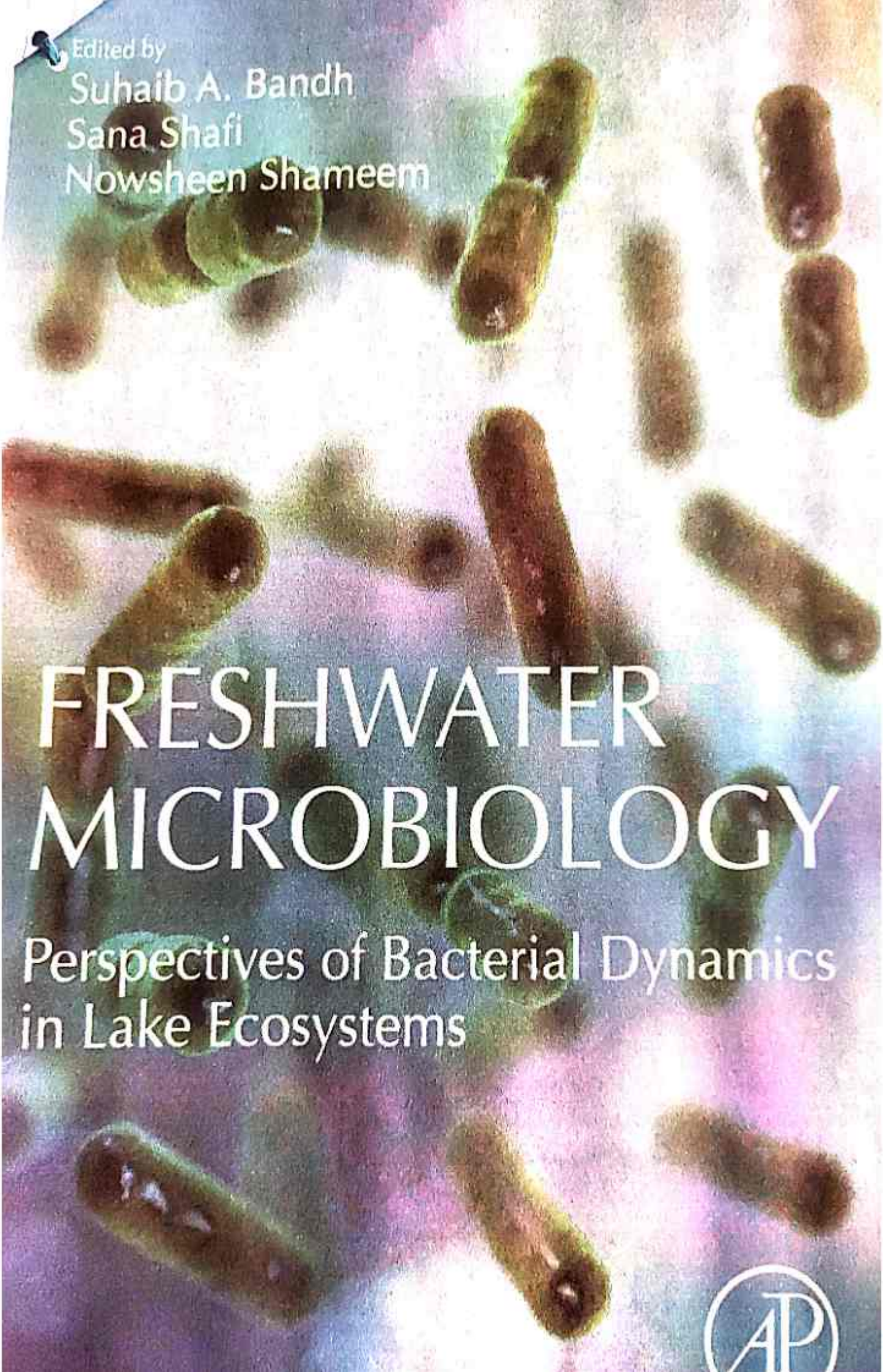
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Perspectives of Bacterial Dynamics in Lake Ecosystems
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FRESHWATER MICROBIOLOGY

Perspectives of Bacterial Dynamics in Lake Ecosystems

Edited by

SUHAIB A. BANDH
SANA SHAFI
NOWSHEEN SHAMEEM

P. G. Department of Environmental Science
Sri Pratap College Campus
Cluster University, Srinagar, India

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Climate Change and Microbial Diversity

Advances and Challenges

Suhaib A. Bandh
Javid A. Parray
Nowsheen Shameem
Editors

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Climate Change and Microbes
Impacts and Vulnerability

Editors: Javid A. Parray, PhD
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This book provides an enlightening picture of the role of microbes for sustaining life systems and how climatic factors change the course of the processes. **Climate Change and Microbes: Impacts and Vulnerability** explores the little-addressed issue of the effects of climate change on microbial ecosystems and the influence of climate change on microbiome diversity across various habitats and regions.

Recent years have seen the evidence that microbial communities are neither immune to disruption nor do they have the capacity to recover completely after a stressful climate event. This volume documents the important role of microorganisms as climate engineers and considers mitigation and adaptation strategies as well. It goes on to present the research that addresses a diverse array of topics on the impact of climate change on plant-microbe interactions and microbial aquatic life, change-induced aggravations in microbial populations and processes. The book also addresses microbial foodborne diseases resulting from challenging climates. Other topics include algae as indicators of climate change and strategies for facilitating sustainable agro-ecosystems.

This book will be immensely helpful in the study of plant microbiology, agricultural sciences, biotechnology, climate science, and environmental microbiology. It will also be applicable to the field of microbial biotechnology, agricultural, and other life and environmental sciences.

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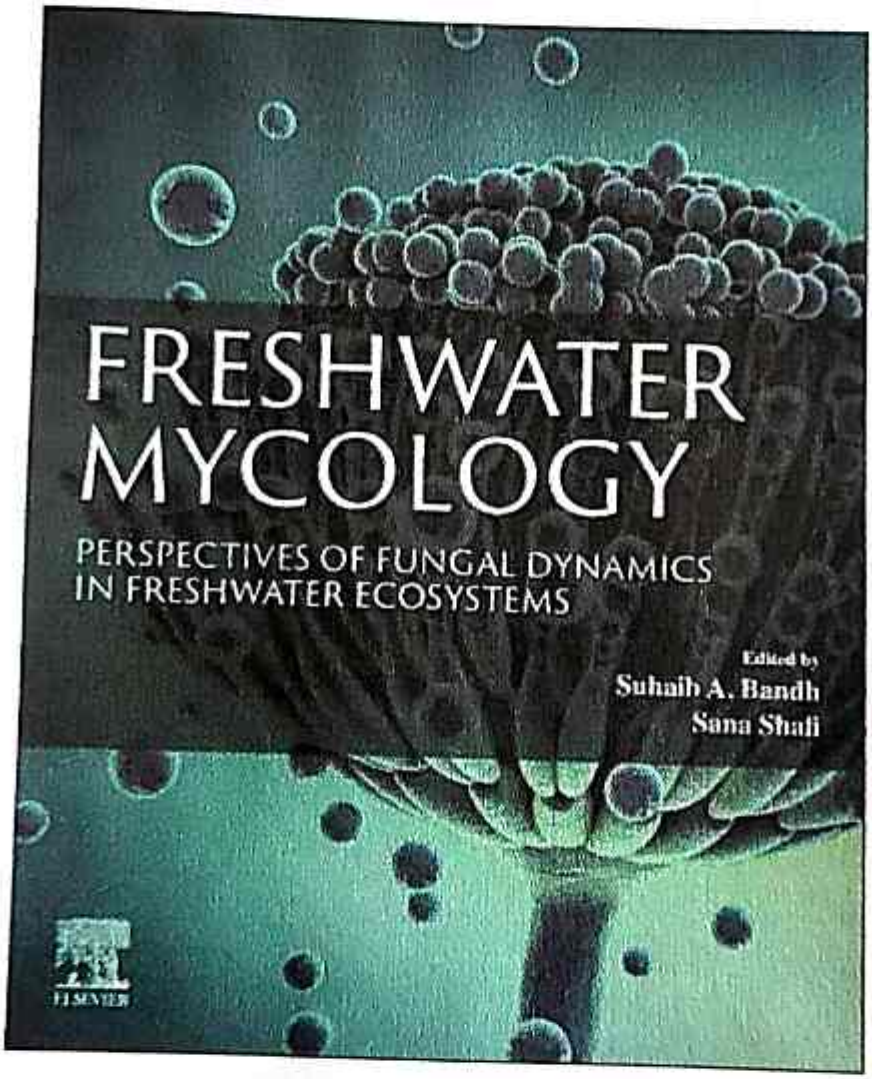

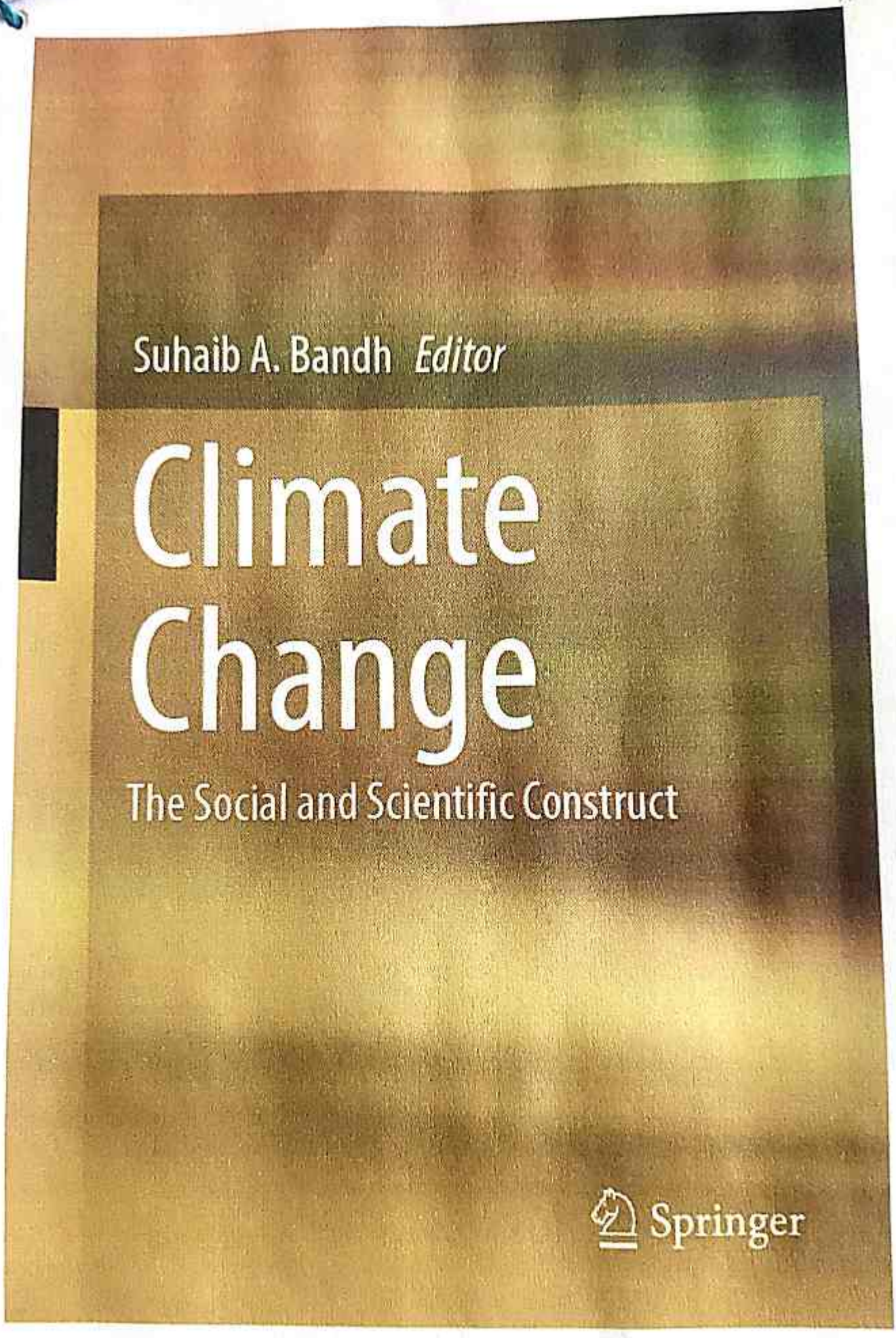
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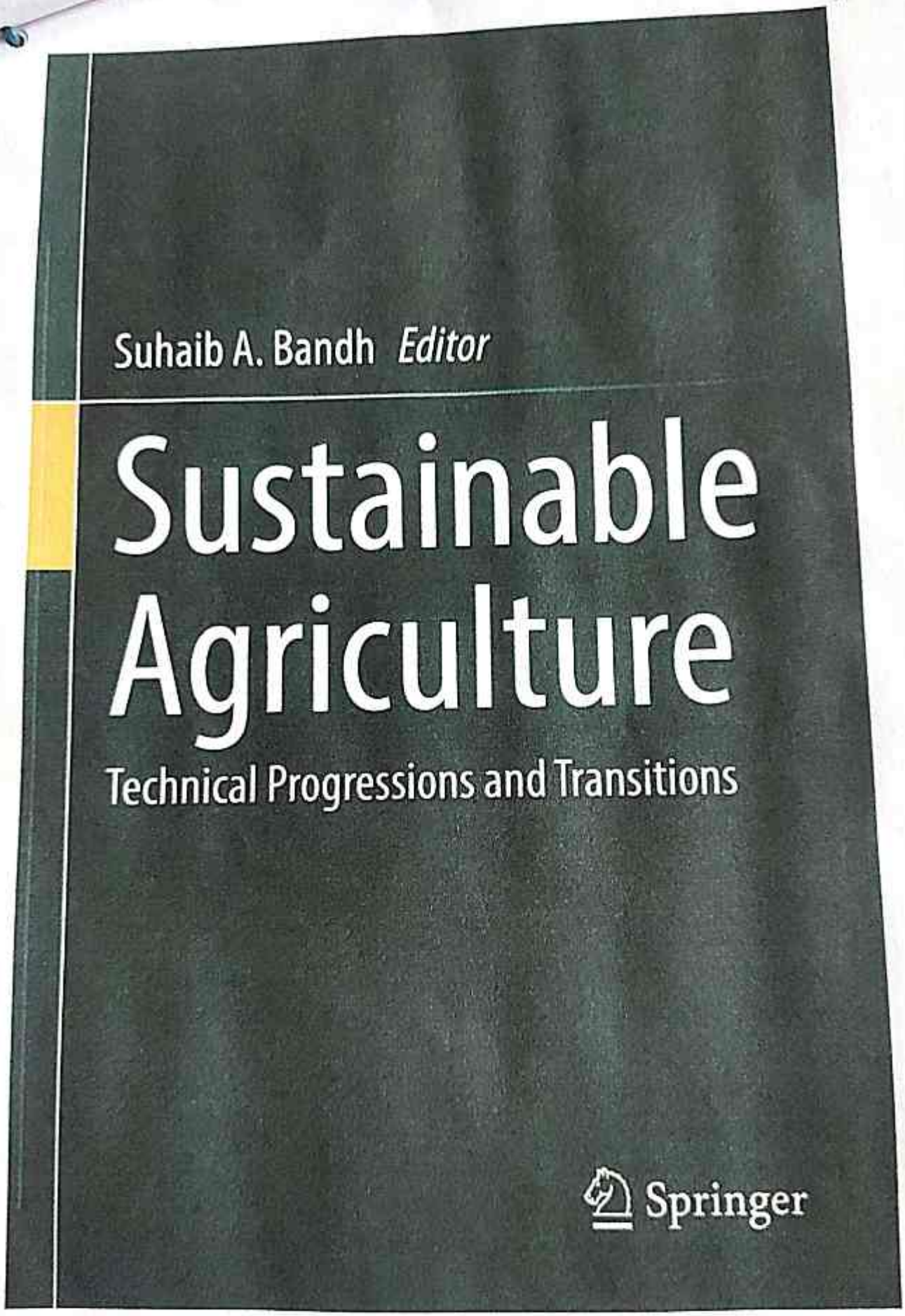
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Valorisation of Microalgal Biomass and Wastewater Treatment

EDITED BY SUHAIB A. BANDH AND FAYAZ A. MALLA

Valorization of Microalgal Biomass and Wastewater Treatment provides tools, techniques, data, and case studies to demonstrate the use of algal biomass in the production of valuable products such as biofuels, food, and fertilizers. Valorization has several advantages over conventional bioremediation processes as it helps reduce the costs of bioprocesses. Examples of several successfully commercialized technologies have been provided throughout the book, giving insights into developing potential processes for the valorization of different biomasses. Wastewater treatment by microalgae generates the biomass, which could be utilized for developing various other products, such as fertilizers, and biofuels.

The book will equip researchers and policymakers in the energy sector with the scientific methodology and metrics needed to develop strategies for a viable transition in the energy sector. It will be a key resource for students, researchers, and practitioners seeking to deepen their knowledge of energy planning, wastewater treatment, and current & future trends of biofuels.

Key features:

- Presents a detailed coverage of the tools and techniques for the valorization of algal biomass
- Includes detailed updates on the life cycle assessment of microalgal wastewater treatment and biomass valorization, its challenges, prospectus, regulations & policies
- Includes case studies, presenting real-life examples for researchers to replicate and learn from

Edited by:

Suhaib A. Bandh
Assistant Professor, Environmental Science, Higher Education Department, Government of Jammu and Kashmir, Srinagar, India

Dr. Fayaz A. Malla
Assistant Professor, Department of Environmental Science, Govt. Degree College Tral, Jammu and Kashmir, India

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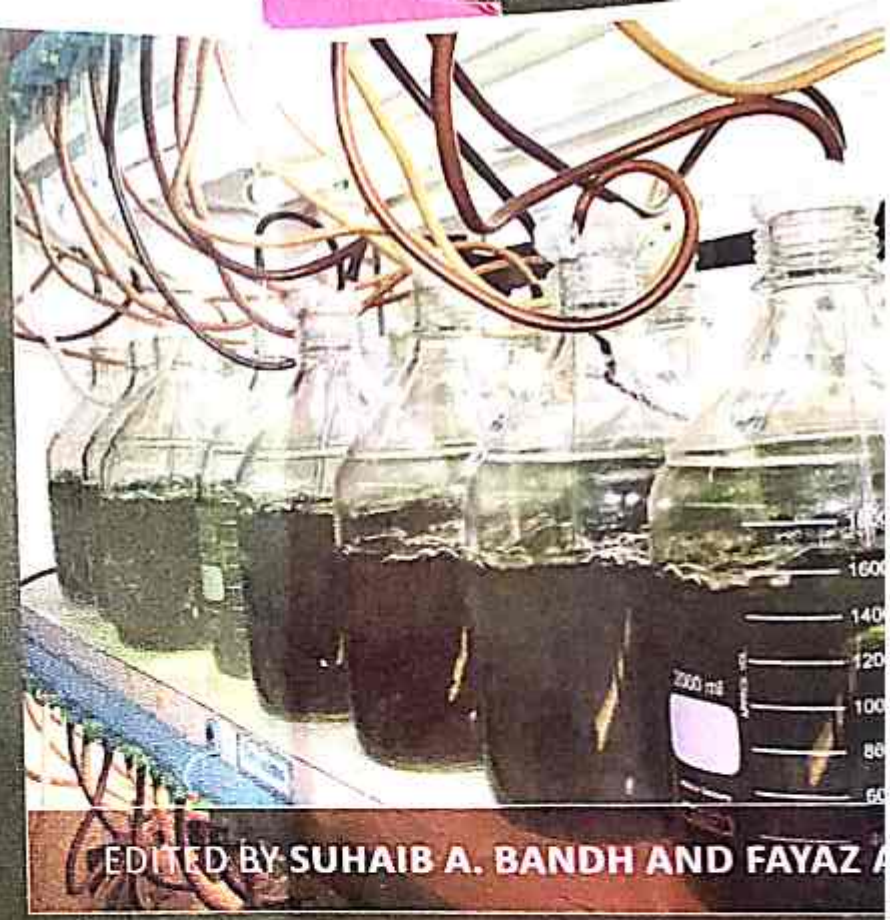
Valorisation of Microalgal Biomass and Wastewater Treatment



EDITED BY SUHAIB A. BANDH AND FAYAZ A

Valorisation of Microalgal Biom
and Wastewater
Treatment

Understanding Climate Change: Scientific Opinion and Public Perspective

Fayaz A. Malla, Aiman Mushtaq, Suhaib A. Bandh, Irteza Qayoom, Anh Tuan Hoang, and Shahid-e-Murtaza

Abstract Since the late nineteenth century, the earth's average surface temperature has risen by about 1.18 °C, mainly due to increased carbon dioxide emission into the atmosphere and other anthropogenic activities. Most of the warming happened during the last four decades, with the most recent seven years being the warmest. As shown by global observations, climate change is ongoing, and extensive scientific analysis shows that the greenhouse gases released by human activity are its primary causes. Based on well-established data, most climate science and the Fourth Assessment Report of the Intergovernmental Panel on Climate Change agree that climate change occurs primarily due to human-induced causes and therefore affirm this stance. Although natural activities contribute significantly to climate variability, several evidence suggests that human influences have had an increasingly dominant impact on the observed global warming since the mid-twentieth century. It is a crucial problem that threatens to cause significant natural, social, and economic impacts worldwide. So, it becomes imperative to clearly understand the phenomenon to adopt appropriate mitigation measures with good accuracy and precision.

Keywords Climate change · Understanding · Public perspective · Scientific opinion · Climate scientists

F. A. Malla (✉),
Department of Higher Education, Government Degree College Tral, Srinagar, Jammu and Kashmir, India

A. Mushtaq · I. Qayoom
Sri Pratap College Campus, Cluster University Srinagar, Srinagar, India

S. A. Bandh
Department of Higher Education, Government Degree College D.H. Pora, Kulgam, Srinagar, Jammu and Kashmir, India

A. T. Hoang
Institute of Engineering, Ho Chi Minh City University of Technology (HUTECH), Ho Chi Minh City, Vietnam

Shahid-e-Murtaza
Department of Higher Education, Government Degree College Pulwama, Pulwama, Jammu and Kashmir, India

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CHAPTER

7

Mycoloop: Role in shaping aquatic ecosystems

Vincent Happy Ogwugwa[a], *Joy Ogwugwa*[b], *and Suhaib A. Bandh*[c]

[a]Department of Microbiology, University of Lagos, Lagos, Lagos, Nigeria [b]Delta State University, Cleveland, MS, United States [c]Environmental Science, Department of Higher Education, Government of Jammu and Kashmir, Srinagar, India

1 Introduction

Marine habitats have long been recognized to harbor fungi. Obligate marine fungi differ from terrestrial and freshwater fungi in taxonomy, morphology, and adaptations to aquatic environments (Gozari, Alborz, El-Seedi, & Jassbi, 2021). They're more explicitly described as fungi that can complete their whole life cycle in water, i.e., those that can only grow and sporulate in a marine or estuarine environment (Pasqualetti, Giovannini, Barghini, Gorrasi, & Fenice, 2020). Facultative marine fungi can grow and sporulate in the sea but originated in the freshwater or terrestrial environment (Aparicio-Cuevas et al., 2019). The word "mycoloop" is used in this chapter to refer to both obligate and facultative marine fungi, as well as their interactions with other aquatic lives. The most common marine fungi are *Ascomycetes*, *Basidiomycetes*, and *Chytridiomycetes* (Gozari et al., 2021). The *Oomycetes* and *Labyrinthulomycetes*, traditionally known as pseudofungi or fungal-like creatures, were initially classed as fungi but have recently been reclassified under the new *Straminipila* Kingdom (Klinter, Bulone, & Arvestad, 2019). Nonetheless, marine mycologists and mycoplankton ecologists continue to study them. Some marine fungi may also be found in freshwater and terrestrial environments (Kodsueb et al., 2016). *Savoryella lignicola* and *Lignincola leavis*, for example, have been discovered in both marine and freshwater environments. So far, 467 obligate or facultative higher marine fungi from 244 genera have been described using cultivation-based methods, with the majority of them derived from marine substrata (Patricia, Jaime, & Meritxell, 2019). They are classified into three groups: *Ascomycota* (97%), *Basidiomycota* (2%), and anamorphic fungi (1%). The *Halosphaeriales* are the biggest order of marine *Ascomycetes*, with 45 genera and 119 species. There are an estimated 1.5 million fungal species, but only 70,000 (less than

CHAPTER 4

Spatio-temporal patterns of bacterial diversity along environmental gradients and bacterial attachment to organic aggregates

Suhaib A. Bandh[1], Sana Shafi[1], Nowsheen Shameem[1], Rubiya Dar[2], Azra N. Kamili[2], Bashir A. Ganai[2]

[1]P.G. Department of Environmental Science, Sri Pratap College Campus, Cluster University, Srinagar, India; [2]Center of Research for Development (CORD)/P.G. Department of Environmental Science, University of Kashmir, Srinagar, India

Introduction

Microbial diversity, a key component in understanding the functioning of aquatic systems, provides potentially descriptive information about the degree of contamination and trophic status. Anthropogenic activities such as agriculture, horticulture, use of pesticides, and pollution due to many other activities are believed to have significant impacts on the microbial communities (Kirk, 1994). Characterization of microbial communities is therefore important to determine the type of microorganisms, associated with specific water bodies and habitat types as well as to gain an insight into the ecological roles of these microbes. The microbial diversity in ecosystems responds to any and every change in environmental parameters and is hence considered as an indicator of change in these systems. The bacterial community composition (BCC) in lakes shows a great deal of variation within and between the sampling stations depending on the environmental features based on various intrinsic and extrinsic influences. Consequently, the BCC in lakes differs significantly between and within the microhabitats. So the variation of bacterial counts with the variation in seasons is a direct consequence of the high level of nutrients in the drainage water which affects the survival and growth of aquatic bacteria (Hader, Kumar, Smith, & Dobler, 1998). The higher bacterial counts are also a result of their positive

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CHAPTER 3

Impact of environmental changes and human activities on bacterial diversity of lakes

M.M.M. Islam[1], Sana Shafi[2], Suhaib A. Bandh[2], Nowsheen Shameem[2]
[1]Ministry of Planning, Sher-e-Bangla Nagar, Dhaka, Bangladesh; [2]P.G. Department of Environmental Science, Sri Pratap College Campus, Cluster University, Srinagar, India

Introduction

The history of the discipline of *limnology* connects back to Lake Geneva, the best known and one of the beautiful lakes in the world, since the 17th century. Lakes, the vital habitats provide essential resources for aquatic life and human beings. They not only provide us with a number of benefits but also strengthen our economy and influence our wellbeing. Lakes are an important source of drinking water besides being used for irrigational and industrial purpose and are a common place for recreational activities and swimming. They minimize the impact of floods and droughts by storing excess water. In addition, they also work to replenish groundwater, and preserve the biodiversity. They are important ecosystems that sustain a healthy balance of aquatic life, provide us with scenic beauty, and support our socioeconomic needs (Khatri & Tyagi, 2015). As freshwater around the world continues to dwindle because of the increased use and pollution, certainly lakes are viewed as potential water reservoirs of convenience for human use. These lentic ecosystems are important habitats for most microorganisms which form the foundation of their ecology. Microorganisms especially bacteria are present in all regions of these lentic ecosystems. They are natural and vital members of all aquatic communities and play important roles in maintaining varied ecosystem functions (Joshi, Pande, & Joshi, 2016).

Every aquatic ecosystem is a unique natural feature, and the study of each system in detail is necessary for case-by-case assessment of ecological health and threats, and development of proposals for realistic remedial measures for these systems in particular (Hakanson, 2004). Lake ecosystems undergo rapid environmental changes, often leading to deteriorations in

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CHAPTER 2

Bacterial diversity of the rock-water interface in freshwater ecosystem

Rubiya Dar[1], Suhaib A. Bandh[2], Sana Shafi[2], Nowsheen Shameem[2]
[1]Center of Research for Development (CORD)/P.G. Department of Environmental Science, University of Kashmir, Srinagar, India; [2]P.G. Department of Environmental Science, Sri Pratap College Campus, Cluster University, Srinagar, India

Introduction

An interface is the limit between two phases in a heterogeneous system. Solid-fluid (rock-water) interfaces are imperative in microbial ecology, as they impact microbial life in different ways (Marshall, 1976). Microorganisms attach within minutes to most lifeless solid substrates submerged in water (Bitton & Marshall, 1980), where they develop to form biofilms (Characklis & Marshall, 1990). In water bodies, complex combinations of microorganisms named biofilms are formed at the rock-water interface, and most microorganisms on the earth live in such aggregations (Costerton, Cheng, & Geesey, 1987). Biofilms which cover almost every rock-water interface on earth are called as epilithic river biofilms. They are complex matrix-enclosed communities, also described as microbial landscapes (Battin et al., 2007). Within these microbial landscapes the prokaryotic and eukaryotic microorganisms are closely associated. Bacteria, mainly belonging to Beta-proteobacteria (Araya, Tani, Takagi, Yamaguchi, & Nasu, 2003; Manz, Wendt-Potthoff, Neu, Szewzyk, & Lawrence, 1999) and diatoms embedded in these microbial landscapes (Battin, Kaplan, Newbold, Cheng, & Hansen, 2003; Besemer et al., 2007) play a fundamental role in their substrate colonization by producing extracellular polymeric substances (EPS) (Stolz, 2000). These pioneering microorganisms facilitate the establishment of the next arrivals, including autotrophic and heterotrophic microorganisms (Roeselers, Van Loosdrecht, & Muyzer, 2007) such as bacteria belonging to Alpha-proteobacteria and Bacteroidetes, Cyanobacteria, Microalgae (Barranguet et al., 2005; Brasell, Heath, Ryan, & Wood, 2015; Roeselers et al., 2007), and other microorganisms like archaea, fungi, protozoa, small metazoans, and

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Title:

Microbes: Key agents in a Sustainable Environment and the Cycling of Nutrients

Authors:

Sana Shafi,[1] Rouf Ahmad Bhat,[2*] Suhaib A. Bandh,[1] Nowsheem Shameem[1] and Humeera Nisa[3]

Authors' affiliations:

[1] Department of Environmental Science, Government Sri Pratap College Campus, Cluster University Srinagar, J & K, India 190 001
[2] Division of Environmental Sciences, Sher-e-Kashmir University of Agricultural Sciences and Technology, Shalimar, Kashmir-190025
[3] Centre of Research for Development/Department of Environmental Science, University of Kashmir, Srinagar, J & K, India 190 006

***Corresponding author's email address:**
rufi.bhat@gmail.com

CHAPTER EIGHT

MICROBES

SANA SHAFI,[1] ROUF AHMAD BHAT,[2] SUHAIB A. BANDH,[1], NOWSHEEM SHAMEEM,[1] AND HUMEERA NISA[3]

Abstract

Microbes, being diverse and ubiquitous, play a significant role in a diverse ecosystem. They not only make nutrients available to the plants through cycling but also detoxify the harmful pollutants, thereby carrying out important functions of the biosphere. In a polluted environment, microbes serve as scavengers for the detoxification of toxic substances, which can be achieved either *in-situ* where enzyme systems within microbial metabolism are used for the degradation of xenobiotics or *ex situ* where toxic materials from environmental polluted sites are subjected to consortium microbes at specified places. Increasing pollution has increased interest in sustainable and eco-friendly strategies for the removal of toxic substances such as phytoremediation, phytostabilisation, phytoextraction, phytovolatilization, and rhizoremediation. Thus, the expanding potential of bioremediation has become a key attraction for environmental protection.

Keywords: Microbes, Bioremediation, Environmental quality, Detoxification, Biogeochemical cycling

Introduction

Environmental quality is largely degraded by the industrialization and unsustainable extraction of natural resources thereby resulting in large amounts of toxic waste dispersed worldwide. These various contaminants emitted from different industries including the discharge of solid and

Climate Change and Its Impact on Plant–Microbe Interaction

S. S. KHANDARE[1]* and M. G. INGALE[2]

[1]*Department of Microbiology, Bajaj College of Science, Wardha, India*

[2]*Department of Microbiology, Bajaj College of Science, Wardha, India*

**Corresponding author. E-mail: ksuhas21@gmail.com*

ABSTRACT

The major challenge of the current century is global warming and climate change. If the policy is not changed, combustion of fossil fuels would lead to an increase in the concentration of carbon dioxide (CO_2) in the atmosphere and result in climate warming that may increase the temperature by 1.30°C by the end of the current century. Global warming is a severe issue that leads to swings in the average temperature of the world and causes significant shifts in weather and climate. Greenhouse gases (GHGs) concentrations increased in the atmosphere that exerts a warming effect like increased temperature and drought on positive plant–microbe interactions. As microorganisms are a significant component of carbon and nitrogen cycles, they play an essential role in the discharge and removal of GHGs and hold great significance, which in turn are responsible for global warming. Climate change is disturbing the propagation of species and associations between organisms. Microbes live in combination with many other species. Some are beneficial, some pathogenic, and some of which have little or no effect in complex communities. Natural communities are made of organisms that have varying attributes, dispersal capacity. Therefore, it is doubtful that they will all react to climatic change in the same manner. This presently causes it conceivable to test whether some general patterns occur and whether various nathers

Climate Change and Its Influence on Microbial Diversity, Communities, and Processes

IRTEZA QAYOOM[1], HAIKA MOHI-UD-DIN[1], AQSA KHURSHEED[1], AASHIA ALTAF[1], and SUHAIB A. BANDH[2]*

[1]*Sri Pratap College, Cluster University Srinagar, India*

[2]*Government Degree College, DH Pora Kulgam, Jammu and Kashmir, India*

**Corresponding author. E-mail: qirteza@gmail.com*

ABSTRACT

Climate change has been occurring throughout the Earth's geological past. However, the cause of alarming concern in the present age is the rapid and unprecedented rate of climate changes taking place primarily because of the anthropogenic activities. Although the effect of climate change on higher life forms and ecosystems have been well documented, it remains undervalued for the lower life forms i.e., microbes, despite their unequivocal role in the biosphere through the support they provide to the higher life forms. Microbes play a key part in determining the atmospheric concentrations of greenhouse gases and have likely responded to the climate change. Climate change exerts abiotic stress on environmental microbiomes that can lead to the shifts in the geographical range of microbial species, affect their distribution, biodiversity and abundance. This chapter highlights the impact of climate change on microbial diversity, communities and processes across different habitats.

Management of Natural Resources

5

Abstract

The natural resources include any and every such material that can be transformed in a way that the material becomes extra suitable, valuable, and useful to man or it is anything obtained from nature to meet our needs and wants. Nature is a regular source of a variety of substances required to meet our basic needs in our day-to-day life. Even the prehistoric man who lived a hunter-gatherer type of life procured each and everything for his survival from nature which has been kind enough to him since that time. Although natural resources like land, air, water, forests, wildlife, minerals, metals, energy, and various other resources existed over the earth's surface even during prehistoric times, man had neither the tools nor the technology to use them. But with time he learnt the process of cultivation of land, growth of crops, operation of wind and water mills and many other techniques and technologies that are required to harness these resources to the fullest of their potential. However, the expanding human population alongside of its technological development and scientific progress started utilizing the natural resources at a much faster rate and a larger scale. This continuous increase in human population caused an expanding demand for these resources thus creating a situation when the non-renewable natural resources may come to an end after sometime. In order to have maximum production we have actually started taking loans from the resources meant for future that cannot be paid back. As a result we would be using all those resources which are in fact the property of the future generations which is a matter of great concern. So there must be some sort of balance between the population growth and their utilization by adopting appropriate management strategies of these natural resources for making the planet sustainable.

Keywords

Natural resources · Land resources · Energy · Wildlife · Forests

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Environmental Acts and Legislation

4

Abstract

Although, the environment has been the mother of all resources it has been at the receiving when it comes to its interaction with man. Man for his own benefits and by his own acts has almost changed its entire outlook. Pursuing the anthropocentric philosophy of life man has further created an imbalance in its natural equilibrium which brought him to a point where he started thinking about the natural balance and his own role in disturbing the same. Thus, man started redefining the constitutional book of his life by bringing in a series of acts and legislations like fundamental duties, state policies, national and state laws, common and statutory law remedies for either reverting the damage done or at least protecting whatever was left undisturbed for his own sake and for the sake of his future generation. These legislative provisions have doubtlessly played a role and are continuing to do so for the protection of environment.

Keywords

Environmental acts · Directive principles · Law remedies · Statutory law remedies · National laws

Environmental concern in India is as old as the Indian civilization and traditionally this concern was mostly aimed at conservation of forests, wildlife, and other natural resources. But after independence the issues of main concern shifted to sanitation, public health, and hygienic disposal of community wastes as these issues resulted in many outbreaks of deadly communicable diseases (Iyer 1984). However, now the concern has broadened to include sustainable development. The period from independence to 1972 was a period of continuous deterioration and degradation due to two reasons:

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Environmental Education and Environmental Impact Assessment

3

Abstract

Environmental education is not a separate branch of science but a lifelong interdisciplinary field of study and a way of implementing the goals of environmental protection. It helps us to inculcate the necessary awareness, skills, attitudes, knowledge, and participatory potential in people so that they adjust their day-to-day activities in such a way that they never clash with the environment. Environmental Impact Assessment helps us to analyze both the positive and negative impacts of any proposed activity and the subjective reduction of their negative impacts with the purpose of identification, examination, assessment, and evaluation of the likely and probable impacts and, thereby, helps to work out remedial action plans to minimize the adverse impacts. It is an important management tool for ensuring the justified use of natural resources during developmental process by focusing on the problems, conflicts, or natural resource constraints that could affect the viability of a project. It also examines the implications of a project that might harm people, their homeland or their livelihoods, or other nearby developments. The chapter combines the considerations of how impacts from human activities can be predicted and assessed with the utility of these tools in decision-making, how environmental, economic and social concerns can be balanced, and the potential of the tool to enhance the "spirit of the age," i.e., sustainable development.

Keywords

Environmental education · Environmental impact assessment · Decision-making · Environmental awareness

B. Mushtaq et al., *Environmental Management*,

Air Pollution and Its Abatement

2

Abstract

Air pollution, the unusual interference with the quality of atmosphere by way of addition of contaminants such as smoke, dust, smog, chemicals and vapors, unreasonably interferes with the comfortable enjoyment of life and conduct of business. Caused by many sources including both natural and man-made, air pollution results in a series of devastating impacts on man and his environment including the global environmental disasters like climate change, ozone depletion, and photochemical smog formation. Needing a proper and timely attention it requires an effective abatement strategy which controls the quality of air at surface level in residential, commercial, market, industrial, urban, and workplaces. And the effective abatement strategy includes the technical measures to control the gaseous and particulate pollutants, legislative approaches, substitution of raw materials and modification of the processes involved in the day-to-day activities of humans.

Keywords

Air pollution · Air pollution abatement · Air quality assessment · Lapse rates · Electrostatic precipitators

Recently for the first time in the cultural history, man has forced one of the most horrible changes (pollution) into his environment which sometimes in part was pure, virgin, undisturbed, uncontaminated, and quite hospitable. This change, a result of various human activities has brought about an undesirable change in the physical, chemical, and biological characteristics of our environment, harmful to human life, other species, living conditions and their cultural assets. It has further altered the different major and minor components of environment including air, water, and soil.

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Management of Water Resources

1

Abstract

Water resources which are potentially useful to humans and the rest of the world, are not only important for the existence of life on earth but also for ensuring sustainable development of the world, as their effective and sustainable management is effectively linked to various sectors of our economy including the industrial, agricultural, power, fisheries, recreational and environmental, transportation, domestic and household sectors. The resources and the services provided by them have benefited both people and their economies for many centuries, yet in many countries people lack the basic drinking water and sanitation needs. Therefore, management of water resources has become a critically important issue for their future use, for their protection from overexploitation and pollution and for the prevention of disputes over water bodies. It is the proper planning, development, and management of water resources both in terms of quality and quantity across all water uses which include the infrastructure, policies, protocols, incentives, information, and institutions for its proper guidance and support.

Keywords

Water resources · Water resource management · Watershed management · Rainwater harvesting · Water resource distribution

Water being the most valuable and renewable natural resource is in a great trouble these days because the demand of this resource is inclining continuously while its supply is declining. Like air, it is an essential constituent of the life-support system as all living beings depend on water for their existence. Due to increased industrialization, modernization, urbanization, and other such phenomena the demand for water has increased manifold in the cities which has further increased due to the increased

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