

Plant-induced changes in soil structure: Processes and feedbacks

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Key words: plants, roots, soil structure, soil porosity, soil aggregation

Abstract. Soil structure influences the growth and activity of organisms living in soil. In return, microbes, fauna, and plants affect structure. The objective of this paper is to review the role of plants in modifying soil structure. Vegetation affects structural form and stability at different scales and through various direct and indirect mechanisms. By penetrating the soil, roots form macropores which favour fluid transport. They also create zones of failure which contribute to fragment the soil and form aggregates. This phenomenon is enhanced by the wetting and drying cycles associated with plant growth. Drying also causes shrinkage and strengthening of the soil. Anchorage of roots and the exudation of cementing material stabilizes soil structure. Finally, as a source of C, roots and plant residues provide a food source to the microflora and fauna which contribute to structure formation and stabilization. In return, plant-induced changes in structure will affect plant growth mostly by modifying the root physical environment, and the water and nutrient cycles.

Introduction

Most soil chemical, biological and physical reactions and processes occur at the interface between the solid, liquid, and gas phases. It is the spatial arrangement of these three phases that defines soil structure. Structure is central to soil functioning as it controls water, gas and nutrient fluxes and storage, and therefore influences the activity and growth of living organisms. In return, microbes, fauna, and plants will affect structure in complex ways. The objective of this paper is to review the role of plants in modifying soil structure. Examples will show that vegetation affects soil structure at different scales and through a wide variety of mechanisms involving root activity, such as root penetration, water extraction, anchorage and exudation of compounds in the rhizosphere. Also, the whole plant, dead or alive, can be an important source of carbon, providing microbes and fauna with a substrate for the production of stabilizing material as well as providing physical protection of the soil surface against structure-altering processes like rainfall or compaction.

Plant Induced Soil Changes Processes And Feedbacks

Gaurav Sablok



Plant Induced Soil Changes Processes And Feedbacks:

Plant-induced soil changes: Processes and feedbacks N. van Breemen,1998-08-31 This book by soil scientists and ecologists reviews how and why plants influence soils Topics include effects on mineral weathering soil structure and soil organic matter and nutrient dynamics case studies of soil plant interactions in specific biomes and of secondary chemicals influencing nutrient cycling the rhizosphere and potential evolutionary consequences of plant induced soil changes This is the first volume that specifically highlights the effects of plants on soils and their feedbacks to plants By contrast other texts on soil plant relationships emphasize effects of soil fertility on plants following the strongly agronomic character of most research in this area The aspects discussed in this volume are crucial for understanding terrestrial ecosystems biogeochemistry and soil genesis The book is directed to terrestrial ecologists foresters soil scientists environmental scientists and biogeochemists and to students following specialist courses in these fields

Plant-induced soil changes: Processes and feedbacks Nico van Breemen,2013-03-09 This book by soil scientists and ecologists reviews how and why plants influence soils Topics include effects on mineral weathering soil structure and soil organic matter and nutrient dynamics case studies of soil plant interactions in specific biomes and of secondary chemicals influencing nutrient cycling the rhizosphere and potential evolutionary consequences of plant induced soil changes This is the first volume that specifically highlights the effects of plants on soils and their feedbacks to plants By contrast other texts on soil plant relationships emphasize effects of soil fertility on plants following the strongly agronomic character of most research in this area The aspects discussed in this volume are crucial for understanding terrestrial ecosystems biogeochemistry and soil genesis The book is directed to terrestrial ecologists foresters soil scientists environmental scientists and biogeochemists and to students following specialist courses in these fields

Ecosystem Consequences of Soil Warming Jacqueline E. Mohan,2019-04-13 Ecosystem Consequences of Soil Warming Microbes Vegetation Fauna and Soil Biogeochemistry focuses on biotic and biogeochemical responses to warmer soils including plant and microbial evolution It covers various field settings such as arctic tundra alpine meadows temperate tropical and subalpine forests drylands and grassland ecosystems Information integrates multiple natural science disciplines providing a holistic integrative approach that will help readers understand and forecast future planetwide responses to soil warming Students and educators will find this book informative for understanding biotic and biogeochemical responses to changing climatic conditions Scientists from a wide range of disciplines including soil scientists ecologists geneticists as well as molecular evolutionary and conservation biologists will find this book a valuable resource in understanding and planning for warmer climate conditions

Origin, Conservation, and Restoration of the Threatened European Grassland Ecosystem in the Anthropocene Grégory Mahy,Thierry Dutoit,Kathrin Kiehl,Armin Bischoff ,Péter Török,2024-11-07 Natural and Semi Natural Grassland Ecosystems NSG represent high value biodiversity hotspots for biodiversity of the European continent as well as an invaluable cultural heritage forged

through millennia of human nature interactions While pristine natural European grasslands result mainly from constrained specific climatic and soil conditions semi natural grasslands largely result from the activities of humans and their livestock e g grazing mowing burning during millennia of low intensity land use European NSG their biodiversity and the cultural heritage they represent are highly threatened since the beginning of the 20th century in a context of multifactorial global change including environmental dimensions climate change habitat fragmentation pollution biological invasions and land use changes with the accelerating of socio economic evolution of agricultural practices intensification or abandonment and urbanization *Hydrogeology, Chemical Weathering, and Soil Formation* Allen Hunt,Markus Egli,Boris

Faybishenko,2021-04-06 Explores soil as a nexus for water chemicals and biologically coupled nutrient cycling Soil is a narrow but critically important zone on Earth s surface It is the interface for water and carbon recycling from above and part of the cycling of sediment and rock from below Hydrogeology Chemical Weathering and Soil Formation places chemical weathering and soil formation in its geological climatological biological and hydrological perspective Volume highlights include The evolution of soils over 3 25 billion years Basic processes contributing to soil formation How chemical weathering and soil formation relate to water and energy fluxes The role of pedogenesis in geomorphology Relationships between climate soils and biota Soils aeolian deposits and crusts as geologic dating tools Impacts of land use change on soils The American Geophysical Union promotes discovery in Earth and space science for the benefit of humanity Its publications disseminate scientific knowledge and provide resources for researchers students and professionals Find out more about this book from this Q A with the Editors [Water-Soil-Vegetation Nexus and Climate Change](#) Xixi Wang,2024-01-10

Water Soil Vegetation Nexus and Climate Change presents a broad overview of the research needs and approaches regarding water soil vegetation nexus and climate change It includes chapters discussing water budget and factors that affect hydrologic processes such as precipitation runoff infiltration evapotranspiration soil water and groundwater in addition to a focus on consumptive e g domestic and irrigation and non consumptive e g eco environmental water uses and water shortage Throughout Water Soil Vegetation Nexus and Climate Change chapters specifically deal with the fundamental principles and also case studies applications and decision support tools that can be usable for developing practical management measures in sustaining our eco environment and society by maintaining an optimal water soil vegetation equilibrium Written with water resources students and professors in mind this book will provide the reader with further knowledge on the water soil vegetation nexus and its connection to climate change Includes both principles and applications providing the reader with options for both application types as needed Emphasizes the nexuses rather than individual processes allowing the reader to understand the whole picture Presents case studies and decision support tools that can be used for developing practical management measures in changing climate **Global Change and Forest Soils** ,2019-11-23

Global Change and Forest Soils Cultivating Stewardship of a Finite Natural Resource Volume 36 provides a state of the science summary and synthesis

of global forest soils that identifies concerns issues and opportunities for soil adaptation and mitigation as external pressures from global changes arise Where how and why some soils are resilient to global change while others are at risk is explored as are upcoming train wrecks and success stories across boreal temperate and tropical forests Each chapter offers multiple sections written by leading soil scientists who comment on wildfires climate change and forest harvesting effects while also introducing examples of current global issues Readers will find this book to be an integrated up to date assessment on global forest soils Presents sections on boreal temperate and tropical soils for a diverse audience Serves as an important reference source for anyone interested in both a big picture assessment of global soil issues and an in depth examination of specific environmental topics Provides a unique synthesis of forest soils and their collective ability to respond to global change Offers chapters written by leading soil scientists Prepares readers to meet the daily challenges of drafting multi resource environmental science and policy documents

South Brazilian Grasslands Gerhard Ernst Overbeck, Valério De Patta Pillar, Sandra Cristina Müller, Glayson Ariel Bencke, 2023-12-15 This volume explores the South Brazilian grasslands a unique complex of ecosystems in Brazil Despite high biodiversity and many important ecosystem services their biodiversity and conservation are neglected both nationally and globally This book provides a state of the art synthesis of knowledge on the biodiversity and its drivers in South Brazilian grasslands and associated ecosystems Further the book discusses conservation challenges and options as well as management strategies that help to maintain the region s uniqueness The chapters present information on biodiversity and ecological features of the region and put this information into the context of historical and current human land uses allowing for links to global discussions of conservation and sustainable development Altogether the book contains 20 chapters organized in four sections The book is directed at researchers students and professionals working with biodiversity and sustainable development in southern Brazil as well as to the international scientific and conservation community interested in grasslands and associated ecosystems particularly in tropical and subtropical regions

The Next Step: Disentangling the Role of Plant-Soil Feedbacks in Plant Performance and Species Coexistence Under Natural Conditions Johannes Heinze, Martijn Bezemer, Jasmin Joshi, 2020-09-17 This eBook is a collection of articles from a Frontiers Research Topic Frontiers Research Topics are very popular trademarks of the Frontiers Journals Series they are collections of at least ten articles all centered on a particular subject With their unique mix of varied contributions from Original Research to Review Articles Frontiers Research Topics unify the most influential researchers the latest key findings and historical advances in a hot research area Find out more on how to host your own Frontiers Research Topic or contribute to one as an author by contacting the Frontiers Editorial Office frontiersin.org/about/contact

Ecosystems of California Harold Mooney, Erika Zavaleta, 2016-01-19 This long anticipated reference and sourcebook for California s remarkable ecological abundance provides an integrated assessment of each major ecosystem type its distribution structure function and management A comprehensive synthesis of our knowledge about this biologically diverse state Ecosystems of California

covers the state from oceans to mountaintops using multiple lenses past and present flora and fauna aquatic and terrestrial natural and managed Each chapter evaluates natural processes for a specific ecosystem describes drivers of change and discusses how that ecosystem may be altered in the future This book also explores the drivers of California s ecological patterns and the history of the state s various ecosystems outlining how the challenges of climate change and invasive species and opportunities for regulation and stewardship could potentially affect the state s ecosystems The text explicitly incorporates both human impacts and conservation and restoration efforts and shows how ecosystems support human well being Edited by two esteemed ecosystem ecologists and with overviews by leading experts on each ecosystem this definitive work will be indispensable for natural resource management and conservation professionals as well as for undergraduate or graduate students of California s environment and curious naturalists

Plant Metallomics and Functional Omics

Gaurav Sablok, 2019-07-04 Major portion of the planet earth is covered by seas and oceans representing 96.5% of the planet s water playing a detrimental role in sustaining the plant including crop diversity and productivity for human consumption Water resources contain both soluble and transition metals which are easily absorbed by plants through roots as a first point of contact and subsequently play important physiological and biological functions in plants Transition metals such as copper Cu iron Fe manganese Mn and zinc Zn contribute to the plant productivity by playing key functional roles in the photosynthesis In addition to their major role in regulating the plant productivity they also play an important role by acting as homeostatic regulators in uni parentally inherited chloroplasts and maintains the flow of the electron transfer It is worthwhile to mention that they play a critical role as transporters which acts as electron balancing units for managing the electrostatic potential across the membranes In contrast some metals such as Cd As play a significant role in inducing the stress mechanism and influencing either directly or indirectly Haber Weiss reactions either through the production of the reactive oxygen species ROS or through the membrane damage thus leading to leakage of membrane transporters However besides playing a detrimental role as transporters in plant system excessive accumulation of these metals due to the increasing contamination in the marginal soil and water are posing important threats to the plant system Realizing the toxic effects of the metals several physiological evidences have been laid for the credence of the metal toxicity and their concurrent effect on plant productivity Increasing effects of the metals as toxicants can have three adverse effects on the populations population can move persist via local adaptation or phenotypic plasticity or die Next generation sequencing studies have revolutionized our abilities to detect the changes in expression profiles across an array of genes which can in turn help to develop early markers of metal induced stress Plant Metallomics and Functional Omics A System Wide Perspective focuses on the applications of the system wide understanding of the biological and functional interplay occurring at the juncture of the metalloid induced stress and toxicity The main goal of this book is to familiarize the readers with the most up to date information on metal induced physiological changes in plant species

Soil Conditions and Plant Growth

Peter J. Gregory, Stephen Nortcliff, 2013-03-04 Building on the extremely successful and popular Russell's Soil Conditions and Plant Growth Wiley Blackwell is pleased to publish this completely revised and updated edition of the soil science classic Covering all aspects of the interactions between plant and soil Peter Gregory and Stephen Nortcliff along with their team of internationally known and respected authors provide essential reading for all students and professionals studying and working in agriculture and soil science Subject areas covered range from crop science and genetics soil fertility and organic matter nitrogen and phosphorus cycles and their management properties and management of plant nutrients water and the soil physical environment and its management plants and change processes in soils management of the soil plant system and new challenges including food energy and water security in a changing environment Providing a very timely account on how better to understand and manage the many interactions that occur between soils and plants Soil Conditions and Plant Growth is sure to become the book of choice as a recommended text for students and as an invaluable reference for those working or entering into the industry An essential purchase for all universities and research establishments where agricultural soil and environmental sciences are studied and taught

Agricultural Crop Improvement Azamal Husen, 2025-01-03 Larger amounts of nutritious food are required to feed the growing world population which is a great challenge due to water shortages and reduced crop plant yield To overcome this issue there must be improvement in crop plant production systems Agricultural Crop Improvement Plant and Soil Relationships addresses key issues of crop plant yield and production with molecular and physiological interventions to evolve future strategies that will overcome these challenges faced by the agricultural sector Features Investigates modern and traditional agricultural techniques including nanomaterials nanosensors genetic engineering molecular breeding nutrient and plant hormone interactions microbiome engineering soil enzymes biostimulants and intercropping Explores how technologies and scientific advancements from biotechnology information technology and environmental science are revolutionizing sustainable farming practices Agricultural Crop Improvement Plant and Soil Relationships is a valuable source of information for researchers and extension workers involved in sustainable crop plants improvement and practices and a useful resource for students and scientists working on aspects of agriculture botany plant science crop physiology crop biotechnology and microbiology

Terrestrial Biospheric Carbon Fluxes Quantification of Sinks and Sources of CO₂ Joe Wisniewski, R. Neil Sampson, 2012-12-06 Towards the Balance and Management of the Carbon Budget of the Biosphere The current state of misunderstanding of the global C cycle and our failure to resolve an issue that has been debated for 100 years Jones and Henderson Sellers 1990 speaks loudly about the limitations of modern science when faced with the complexity of the biosphere Efforts to understand and balance the global C budget have gone through several phases First was a holistic view of the C budget as part of efforts to understand the geochemistry of the Earth e.g. Clarke 1908 Next came a period of data collection and synthesis which focused on the diversity of sectors of the biosphere This phase culminated in the early 1970s with the realization that humans were greatly impacting

the global C cycle as measured at the Mauna Loa Observatory Keeling et al 1973 New syntheses of the global C budget emerged at this time Woodwell and Pacan 1973 Bolin et al 1979 The next phase was one of controversy and intense focus on particular sectors of the biosphere The controversy rested on discrepancies about the role of the terrestrial biota in the global C cycle and the failure to account for sufficient C sinks to absorb all the C emitted by land use change in the tropics Woodwell et al 1978 1983 Houghton et al 1983

Soil Hydrology in a Changing Climate Humberto Blanco, Sandeep Kumar, Stephen H. Anderson, 2022-12-01 A changing climate is causing challenges for soil and water management in many parts of the world Current soil management practices need to be redesigned to effectively address present and future fluctuating climates Soil Hydrology in a Changing Climate explores how soil management practices impact soil hydrological characteristics and how we can improve our understanding of soil and water management under changing conditions Soil hydrology includes water infiltration and soil water storage which are critical for agricultural plant and animal production With our future climate predicted to include hotter drier conditions increases in evapotranspiration as well as fewer more intense storms improved soil management and soil hydrology are critical to ensuring our agriculture production can meet human demand This comprehensive book is a valuable resource for land managers soil conservationists researchers and others who wish to understand how different management practices affect soil and water dynamics and how these practices can be adjusted to enhance agricultural sustainability and environmental quality

The British National Bibliography Arthur James Wells, 1999

Seed and Soil Dynamics in Shrubland Ecosystems Ann L. Hild, 2004

Environmental Adaptations and Stress Tolerance of Plants in the Era of Climate Change Parvaiz Ahmad, M.N.V. Prasad, 2011-12-02 Climate change is a complex phenomenon with a wide range of impacts on the environment Biotic and abiotic stress are a result of climate change Abiotic stress is caused by primary and secondary stresses which are an impediment to plant productivity Prolonged exposure to these stresses results in altered metabolism and damage to biomolecules Plants evolve defense mechanisms to withstand these stresses e g synthesis of osmolytes osmoprotectants and antioxidants Stress responsive genes and gene products including expressed proteins are implicated in conferring tolerance to the plant This volume will provide the reader with a wide spectrum of information including vital references It also provides information as to how phytoconstituents hormones and plant associated microbes help the plants to tolerate the stress This volume also highlights the use of plant resources for ameliorating soil contaminants such as heavy metals Dr Parvaiz is Assistant professor in Botany at A S College Srinagar Jammu and Kashmir India He has completed his post graduation in Botany in 2000 from Jamia Hamdard New Delhi India After his Ph D from the Indian Institute of Technology IIT Delhi India in 2007 he joined the International Centre for Genetic Engineering and Biotechnology New Delhi He has published more than 20 research papers in peer reviewed journals and 4 book chapters He has also edited a volume which is in press with Studium Press Pvt India Ltd New Delhi India Dr Parvaiz is actively engaged in studying the molecular and physio biochemical responses of different

plants mulberry pea Indian mustard under environmental stress Prof M N V Prasad is a Professor in the Department of Plant Sciences at the University of Hyderabad India He received B Sc 1973 and M Sc 1975 degrees from Andhra University India and the Ph D degree 1979 in botany from the University of Lucknow India Prasad had published 216 articles in peer reviewed journals and 82 book chapters and conference proceedings in the broad area of environmental botany and heavy metal stress in plants He is the author co author editor or co editor for eight books He is the recipient of Pitamber Pant national Environment Fellowship of 2007 awarded by the Ministry of Environment and Forests Government of India

Annual Plant Reviews, Phosphorus Metabolism in Plants William Plaxton, Hans Lambers, 2015-03-25 The development of phosphorus P efficient crop varieties is urgently needed to reduce agriculture's current over reliance on expensive environmentally destructive non renewable and inefficient P containing fertilizers The sustainable management of P in agriculture necessitates an exploitation of P adaptive traits that will enhance the P acquisition and P use efficiency of crop plants Action in this area is crucial to ensure sufficient food production for the world's ever expanding population and the overall economic success of agriculture in the 21st century This informative and up to date volume presents pivotal research directions that will facilitate the development of effective strategies for bioengineering P efficient crop species The 14 chapters reflect the expertise of an international team of leading authorities in the field who review information from current literature develop novel hypotheses and outline key areas for future research By evaluating aspects of vascular plant and green algal P uptake and metabolism this book provides insights as to how plants sense acquire recycle scavenge and use P particularly under the naturally occurring condition of soluble inorganic phosphate deficiency that characterises the vast majority of unfertilised soils worldwide The reader is provided with a full appreciation of the diverse information concerning plant P starvation responses as well as the crucial role that plant microbe interactions play in plant P acquisition *Annual Plant Reviews Volume 48 Phosphorus Metabolism in Plants* is an important resource for plant geneticists biochemists and physiologists as well as horticultural and environmental research workers advanced students of plant science and university lecturers in related disciplines It is an essential addition to the shelves of university and research institute libraries and agricultural and ecological institutions teaching and researching plant science

Quantifying and Modeling Soil Structure Dynamics
Sally Logsdon, Markus Berli, Rainer Horn, 2020-01-22 Quantifying and Modeling Soil Structure Dynamics emphasizes a systems approach to how soil structure changes in response to inputs and to the environment Soil structure is a dynamic complex system affected by tillage wheel traffic roots soil life shrink swell and freeze thaw In turn soil structure affects root growth and function soil fauna solute transport water infiltration gas exchange thermal and electrical conductivities traffic bearing capacity and more Ignoring soil structure or viewing it as static can lead to poor predictions and management Readers will especially appreciate the description of soil structure influence on endpoints such as environmental contamination and efficient water use and how models should be adjusted to include dynamic soil structure components for

accurate outputs

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Table of Contents Plant Induced Soil Changes Processes And Feedbacks

1. Understanding the eBook Plant Induced Soil Changes Processes And Feedbacks
 - The Rise of Digital Reading Plant Induced Soil Changes Processes And Feedbacks
 - Advantages of eBooks Over Traditional Books
2. Identifying Plant Induced Soil Changes Processes And Feedbacks
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Plant Induced Soil Changes Processes And Feedbacks
 - User-Friendly Interface
4. Exploring eBook Recommendations from Plant Induced Soil Changes Processes And Feedbacks
 - Personalized Recommendations
 - Plant Induced Soil Changes Processes And Feedbacks User Reviews and Ratings
 - Plant Induced Soil Changes Processes And Feedbacks and Bestseller Lists
5. Accessing Plant Induced Soil Changes Processes And Feedbacks Free and Paid eBooks
 - Plant Induced Soil Changes Processes And Feedbacks Public Domain eBooks
 - Plant Induced Soil Changes Processes And Feedbacks eBook Subscription Services
 - Plant Induced Soil Changes Processes And Feedbacks Budget-Friendly Options
6. Navigating Plant Induced Soil Changes Processes And Feedbacks eBook Formats

- ePub, PDF, MOBI, and More
- Plant Induced Soil Changes Processes And Feedbacks Compatibility with Devices
- Plant Induced Soil Changes Processes And Feedbacks Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Plant Induced Soil Changes Processes And Feedbacks
 - Highlighting and Note-Taking Plant Induced Soil Changes Processes And Feedbacks
 - Interactive Elements Plant Induced Soil Changes Processes And Feedbacks
- 8. Staying Engaged with Plant Induced Soil Changes Processes And Feedbacks
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Plant Induced Soil Changes Processes And Feedbacks
- 9. Balancing eBooks and Physical Books Plant Induced Soil Changes Processes And Feedbacks
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Plant Induced Soil Changes Processes And Feedbacks
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Plant Induced Soil Changes Processes And Feedbacks
 - Setting Reading Goals Plant Induced Soil Changes Processes And Feedbacks
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Plant Induced Soil Changes Processes And Feedbacks
 - Fact-Checking eBook Content of Plant Induced Soil Changes Processes And Feedbacks
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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