

# Carbon dioxide sequestration in terrestrial ecosystems

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**ABSTRACT:** The terrestrial biosphere plays a prominent role in the global carbon (C) cycle. Although a net source of C, some terrestrial ecosystems are currently accumulating C and it appears feasible to manage existing terrestrial (forest, agroecosystem, desert) ecosystems to maintain or increase C storage. Forest ecosystems can be managed to sequester and store globally significant amounts of C. Agroecosystems and arid lands could be managed to conserve existing terrestrial C but CO<sub>2</sub> sequestration rates by vegetation in these systems is relatively low. Biomass from forest agroecosystems has the potential to be used as an energy source and trees could be used to conserve energy in urban environments. Some ecosystem management practices that result in C sequestration and conservation provide ancillary benefits.

## INTRODUCTION

Anthropogenic activities, including combustion of fossil fuels and land-use change, contribute carbon dioxide (CO<sub>2</sub>) emissions to the global carbon (C) cycle. Current annual CO<sub>2</sub> emissions are estimated at  $7.5 \pm 1.5$  petagrams (Pg =  $g \times 10^{15}$ ) as C (Sundquist 1993). The atmospheric CO<sub>2</sub> reservoir is increasing by  $3.4 \pm 0.2$  Pg annually (Tans et al. 1990). Atmospheric CO<sub>2</sub> concentrations are approximately 360 ppm. The world's oceans are believed to be a net sink of  $2.0 \pm 0.8$  Pg C annually, leaving the terrestrial biosphere as a sink up to 4 Pg C annually (Tans et al. 1990, Sundquist 1993). Terrestrial ecosystems of the northern hemisphere have been identified as a potential C sink (Tans et al. 1990, Kauppi et al. 1992, Sedjo 1992), although some tropical forests are also accumulating significant amounts of C (Brown et al. 1992). The precise role of the terrestrial biosphere in the global C cycle remains uncertain.

Carbon dioxide is among the most important anthropogenic greenhouse gases (Houghton et al. 1990, Sundquist 1993). Potential actions to mitigate fossil fuel emissions include increased energy conservation and efficiency, employment of renewable energy systems

and use of alternative fuels (NAS 1991). Other greenhouse gas mitigation options include sequestration of CO<sub>2</sub> in biologic 'sinks' such as plant biomass. For example, C can be sequestered in trees and durable forest products, in agronomic crops, in halophytes (salt-tolerant plants), as organic matter in soil, and in marine plants such as microalgae for decades or centuries. Alternatively, biomass from terrestrial systems can be used as an energy source and offset fossil fuel CO<sub>2</sub> emissions.

Given the scientific uncertainty regarding global climate change and C cycling the purpose of this report is to: (1) review current information describing the role of the terrestrial biosphere in the global C cycle, and (2) consider the potential role of sequestering or conserving C in forest and agroecosystems to mitigate the accumulation of greenhouse gases in the atmosphere.

## FORESTS

Globally, boreal, temperate and tropical forest systems contain approximately 1200 Pg C and cycle 70 to 90 Pg C annually (Kauppi et al. 1992, Sedjo 1992).

# Carbon Dioxide And Terrestrial Ecosystems

**Geeske Joel**



## **Carbon Dioxide And Terrestrial Ecosystems:**

**Carbon Dioxide and Terrestrial Ecosystems** George W. Koch, Jacques Roy, 1995-12-21 The importance of carbon dioxide extends from cellular to global levels of organization and potential ecological deterioration may be the result of increased CO<sub>2</sub> in our atmosphere Recently the research emphasis shifted from studies of photosynthesis pathways and plant growth to ground breaking studies of carbon dioxide balances in ecosystems regions and even the entire globe Carbon Dioxide and Terrestrial Ecosystems addresses these new areas of research Economically important woody ecosystems are emphasized because they have substantial influence on global carbon dioxide balances Herbaceous ecosystems e.g. grasslands prairies wetlands and crop ecosystems are also covered The interactions among organisms communities and ecosystems are modeled and the book closes with an important synthesis of this growing nexus of research Carbon Dioxide and Terrestrial Ecosystems is a compilation of detailed scientific studies that reveal how ecosystems generally and particular plants specifically respond to changed levels of carbon dioxide Contributions from an international team of experts Empirical examination of the actual effects of carbon dioxide Variety of terrestrial habitats investigated Specific plants and whole ecosystems offered as studies

**Global Change and Terrestrial Ecosystems** Brian Harrison Walker, Will Steffen, 1996-11-13 This major new book presents a collection of essays by leading authorities who address the current state of knowledge The chapters bring together the early results of an international scientific research program designed to address what will happen to our ability to produce food and fiber and what effects there will be on biological diversity under rapid environmental change This book addresses how these changes to terrestrial ecosystems will feed back to further environmental change International in scope this state of the art assessment will interest policymakers students and scientists interested in global change climate change and biodiversity Special features include descriptions of a dynamic global vegetation model developing generic crop models and a special section on the emerging discipline of global ecology

*Impacts of rising atmospheric carbon dioxide on model terrestrial ecosystems* T H. Jones, L J. Thompson, J H. Lawton, T M. Bezemer, R D. Bardgett, T M. Blackburn, K D. Bruce, P F. Cannon, G S. Hall, S E (Susan) Hartley, Gill Howson, C G. Jones, C. Kampichler, E. Kandeler, D A. Ritchie, 1998 *Carbon Dioxide, Populations, and Communities* Fakhri A. Bazzaz, 1996-07-17 In past decades and in association with a continuing global industrial development the global atmospheric concentration of carbon dioxide has been rising Among the many predictions made concerning this disturbing trend is global warming sufficient to melt polar ice caps thereby dramatically altering existing shorelines This book will help fill an obvious gap in the carbon dioxide debate by substituting data for speculation Includes contributions from leading authorities around the world Serves as a companion to Carbon Dioxide and Terrestrial Ecosystems The first book of its kind to explore evolutionary responses of both populations and communities to elevated carbon dioxide [Terrestrial Ecosystems in a Changing World](#) Josep G. Canadell, Diane E. Pataki, Louis F. Pitelka, 2007-01-10 Over 100 authors present 25 contributions on the impacts of

global change on terrestrial ecosystems including key processes of the earth system such as the CO<sub>2</sub> fertilization effect shifts in disturbances and biome distribution the saturation of the terrestrial carbon sink and changes in functional biodiversity ecosystem services such the production of wheat pest control and carbon storage in croplands and sensitive regions in the world threaten by rapid changes in climate and land use such as high latitudes ecosystems tropical forest in Southeast Asia and ecosystems dominated by Monsoon climate The book also explores new research developments on spatial thresholds and nonlinearities the key role of urban development in global biogeochemical processes and the integration of natural and social sciences to address complex problems of the human environment system

**Water and Carbon Dynamics, Ecosystem Stability of Forest and Grassland in Response to Climate Change** Xiaoming Kang, Shoujia Sun, Fenghui Yuan, Xianjin Zhu, Xiaojuan Tong, Hui Huang, 2024-04-15 Forest and grassland ecosystems are the most important carbon sinks in terrestrial ecosystems They can maintain or enhance carbon stocks and sinks in biomass and play vital roles in mitigating climate change China is taking action to achieve its carbon peak and carbon neutral targets Climate change particularly the increase in the frequency severity and extent of drought will affect the stability of the forest and grassland How forests and grassland mitigate and adapt to climate change is still a challenge Exploring the response of the forest and grassland to extreme climate events contributes to improving vegetation quality and enhancing the ability to respond to climate change

**Characterizing Carbon-dioxide Fluxes from Oceans and Terrestrial Ecosystems** Nir Yitzhak Krakauer, 2006

**Spatial Patterns and Mechanisms for Terrestrial Ecosystem Carbon Fluxes in the Northern Hemisphere** Zhi Chen, 2018-02-19 This book systematically illustrates the underlying mechanisms of spatial variation in ecosystem carbon fluxes It presents the regulation of climate pattern together with its impacts on ecosystem traits which yields new insights into the terrestrial carbon cycle and offers a theoretic basis for large scale carbon pattern assessment By means of integrated analysis the clear spatial pattern of carbon fluxes including gross primary production ecosystem respiration and net ecosystem production along latitudes is clarified from regions to the entire Northern Hemisphere Temperature and precipitation patterns play a vital role in carbon spatial pattern formation which strongly supports the application of the climate driven theory to the Northern Hemisphere With regard to the spatial pattern the book demonstrates the covariation between production and respiration offering new information to promote current respiration model development Moreover it reveals the high carbon uptake of subtropical forests across the East Asian monsoon region which challenges the view that only mid to high latitude terrestrial ecosystems are principal carbon sink regions and improves our understanding of carbon budgets and distribution

**Carbon Dioxide and Environmental Stress** Yiqi Luo, Harold A. Mooney, 1999-04-02 Interactions of CO<sub>2</sub> with Water Temperature Salinity UV B Ozone and Nutrients T C Hsiao and R B Jackson Interactive Effects of Water Stress and Elevated CO<sub>2</sub> on Growth Photosynthesis and Water Use Efficiency J S Amthor Increasing Atmospheric CO<sub>2</sub> Concentration Water Use and Water Stress Scaling Up from the Plant to the Landscape R M M Crawford

and D W Wolfe Temperature Cellular to Whole Plant and Population Responses S D Smith D N Jordan and E P Hamerlynck Effects of Elevated CO<sub>2</sub> and Temperature Stress on Ecosystem Processes R E Munns G R Cramer and M C Ball Interactions Between Rising CO<sub>2</sub> Soil Salinity and Plant Growth J Rozema A H Teramura and M M Caldwell Atmospheric CO<sub>2</sub> Enrichment and Enhanced Solar Ultraviolet B Radiation Gene to Ecosystem Responses A Polle and E J Pell The Role of Carbon Dioxide in Modifying the Plant Response to Ozone H H Rogers G B Runion S A Prior and H A Torbert Response of Plants

**The Global Carbon Cycle** Martin Heimann, 2013-06-29 This book is the outcome of a NAAIL Advanced Study Institute on the contemporary global carbon cycle held in Cortina, Italy September 8-20, 1991. The motivation for this ASI originated from recent controversial findings regarding the relative roles of the ocean and the land biota in the current global balance of atmospheric carbon dioxide. Consequently the purpose of this institute was to review among leading experts in the field the multitude of known constraints on the present day global carbon cycle as identified by the fields of meteorology, physical and biological oceanography, geology and terrestrial biosphere sciences. At the same time the form of an Advanced Study Institute was chosen thus providing the opportunity to convey the information in tutorial form across disciplines and to young researchers entering the field. The first three sections of this book contain the lectures held in Cortina. The first section reviews the atmospheric large scale global constraints on the present day carbon cycle including the emissions of carbon dioxide from fossil fuel use and it provides a brief look into the past. The second section discusses the role of the terrestrial biosphere and the third the role of the ocean in the contemporary global carbon cycle.

**Global Climate and Ecosystem Change** Gordon J. MacDonald, Luigi Sertorio, 2013-11-21 Humankind's ever expanding activities have caused environmental changes that reach beyond localities and regions to become global in scope. Disturbances to the atmosphere, oceans and land produce changes in the living parts of the planet while at the same time alterations in the biosphere modify the atmosphere, oceans and land. Understanding this complex web of interactions poses unprecedented intellectual challenges. The atmospheric concentrations of natural trace gases, carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O) and lower atmosphere ozone (O<sub>3</sub>) have increased since the beginning of the industrial revolution. Industrial gases such as the chlorofluorocarbons (CFCs) which are not part of the natural global ecosystem are increasing at much greater rates than are the naturally occurring trace gases. All these gases absorb and emit infrared radiation and thus have the potential for altering global climate. The major terrestrial biomes are also changing. Although world attention has focused on deforestation, particularly in tropical areas, the development of agriculture, the diversion of water resources and urbanization have all modified terrestrial ecosystems in both obvious and subtle ways. The terrestrial biosphere, by taking up atmospheric carbon dioxide, acts as a primary determinant of the overall carbon balance of the global ecosystem. Although the ways in which the biosphere absorbs carbon are as yet poorly understood, the destruction and regrowth of forests certainly alter this process.

**Responses of Grassland Ecosystems to Elevated CO<sub>2</sub>** Geeske Joel, 2000 *Quantifying Spatially and Temporally Explicit CO<sub>2</sub>*

*Fertilization Effects on Global Terrestrial Ecosystem Carbon Dynamics*, 2016      *Effects of Whole-ecosystem Atmospheric Carbon Dioxide Concentration Manipulation on Abundance and Species Diversity of Arthropods in a Post-fire Chaparral Community*, 2001 This study examined the in situ effects of elevated CO<sub>2</sub> on arthropod abundance in a chaparral community using a series of controlled CO<sub>2</sub> ambient Light controlled Temperature CO<sub>2</sub> LT null balance chambers and a Free Atmosphere Carbon dioxide Enrichment FACE ring Abundance of most arthropod groups including parasitic wasps Hymenoptera decreased with elevated CO<sub>2</sub> resulting in reduced total arthropod abundance However abundance of moths Lepidoptera primarily Geometridae and Microlepidoptera appeared to increase The relationship of springtail Collembola and predatory arachnid abundance vs CO<sub>2</sub> concentration was curvilinear with abundance peaking near 450 550 ppmv and lowest at 750 ppmv While other studies have shown that plant biomass typically increases with elevated CO<sub>2</sub> concentrations our results suggest that arthropod biomass may decrease Arthropod species diversity was also measured using the modified Coleman s rarefaction function to estimate species richness In contrast to decreasing abundance diversity of arthropods appeared to increase with elevated CO<sub>2</sub> although the relationship was not significant A separate study examined the effect of elevated CO<sub>2</sub> and host plant density on psyllids collected from lilac shrubs Psyllid densities increased on lilac shrubs under elevated atmospheric CO<sub>2</sub> and there was evidence of an interaction between shrub density and CO<sub>2</sub> effects Results of this study suggests that ecosystem function is likely to be affected by CO<sub>2</sub> mediated alteration of arthropod services such as nutrient cycling and energy flow to higher trophic levels      *Effect of Rising Atmospheric Carbon Dioxide on the Growth of Vegetation and Accumulation of Carbon in Terrestrial Ecosystems* Bert G. Drake,      **Direct Effects of Increasing Carbon Dioxide on Vegetation** Boyd R. Strain, Jennifer D. Cure, 1985      *The Role of Terrestrial Ecosystems in Global Change*, 1994      **Atmospheric Carbon Dioxide and the Global Carbon Cycle** John R. Trabalka, 1986      *Carbon Dioxide and Climate (Jan 70 - Aug 89)*, 1989      *Atmospheric Carbon Dioxide and the Global Carbon Cycle* John R. Trabalka, 1985

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