

Science[Prev](#) | [Table of Contents](#) | [Next](#)

www.sciencemag.org
Published Online October 27 2005
Science 25 November 2005:
Vol. 310 no. 5752 pp. 1333–1337
DOI: 10.1126/science.1115233

• REPORT

Ecosystem Service Supply and Vulnerability to Global Change in Europe

Dagmar Schröter^{1,2*}, Wolfgang Cramer¹, Rik Leemans³, I. Colin Prentice⁴, Miguel B. Araújo^{5,6}, Nigel W. Arnell⁷, Alberte Bondeau¹, Harald Bugmann⁸, Timothy R. Carter⁹, Carlos A. Gracia¹⁰, Anne C. de la Vega-Leinert¹, Markus Erhard¹¹, Frank Ewert³, Margaret Glendining¹², Joanna I. House⁴, Susanna Kankaanpää⁹, Richard J. T. Klein¹, Sandra Lavorel^{13,14}, Marcus Lindner¹⁵, Marc J. Metzger³, Jeannette Meyer¹⁵, Timothy D. Mitchell¹⁶, Isabelle Reginster¹⁷, Mark Rounsevell¹⁷, Santi Sabaté¹⁰, Stephen Sitch¹, Ben Smith¹⁸, Jo Smith¹⁹, Pete Smith¹⁹, Martin T. Sykes¹⁸, Kirsten Thonicke⁴, Wilfried Thuiller²⁰, Gill Tuck¹², Sönke Zaehle¹, Bärbel Zierl⁸

[\[+\]](#) Author Affiliations

- ¹ Potsdam Institute for Climate Impact Research, 14473 Potsdam, Germany.
² Center for International Development, Harvard University, Cambridge, MA 02138, USA.
³ Department of Environmental Sciences, Wageningen University, 6700 AA Wageningen, Netherlands.
⁴ Department of Earth Sciences, University of Bristol, BS8 1RJ Bristol, UK.
⁵ School of Geography and Environment, University of Oxford, OX1 3TB Oxford, UK.
⁶ Museo Nacional de Ciencias Naturales, 28006 Madrid, Spain.
⁷ Tyndall Centre for Climate Change Research, School of Geography, University of Southampton, Southampton SO17 1BJ, UK.
⁸ Department of Environmental Sciences, Eidgenössische Technische Hochschule, 8092 Zürich, Switzerland.
⁹ Finnish Environment Institute, 00251 Helsinki, Finland.
¹⁰ Center for Ecological Research and Forestry Applications, University of Barcelona, 08193 Barcelona, Spain.
¹¹ Institute for Meteorology and Climate Research, Forschungszentrum Karlsruhe, 82467 Garmisch-Partenkirchen, Germany.
¹² Agriculture and the Environment Division, Rothamsted Research, AL5 2JQ Harpenden, UK.
¹³ Laboratoire d'Ecologie Alpine, CNRS, Université Joseph Fourier, 38041 Grenoble, France.
¹⁴ Centre d'Ecologie Fonctionnelle et Evolutive, CNRS, Montpellier, France.
¹⁵ European Forest Institute, 80100 Joensuu, Finland.
¹⁶ Tyndall Centre for Climate Change Research, University of East Anglia, NR4 7TJ Norwich, UK.
¹⁷ Département de Géographie, Université Catholique de Louvain, 1348 Louvain-la-Neuve, Belgium.
¹⁸ Department of Physical Geography and Ecosystems Analysis, Lund University, 22362 Lund, Sweden.
¹⁹ School of Biological Sciences, University of Aberdeen, AB24 3UU Aberdeen, UK.
²⁰ Kirstenbosch Research Center, South African National Biodiversity Institute, 7735 Cape Town, South Africa.

[\[+\]](#)* To whom correspondence should be addressed. E-mail: dagmar.schroeter@gmail.com

ABSTRACT

Global change will alter the supply of ecosystem services that are vital for human well-being. To investigate ecosystem service supply during the 21st century, we used a range of ecosystem models and scenarios of climate and land-use change to conduct a Europe-wide assessment. Large changes in climate and land use typically resulted in large changes in ecosystem service supply. Some of these trends may be positive (for example, increases in forest area and productivity) or offer opportunities (for example, “surplus land” for agricultural extensification and bioenergy production). However, many changes increase vulnerability as a result of a decreasing supply of ecosystem services (for example, declining soil fertility, declining water availability, increasing risk of forest fires), especially in the Mediterranean and mountain regions.

Received for publication 24 May 2005.
Accepted for publication 18 October 2005.

[Read the Full Text](#)

THIS ARTICLE HAS BEEN CITED BY OTHER ARTICLES:

A pan-European summer teleconnection mode recorded by a new temperature reconstruction from the northeastern Mediterranean (AD 1768–2008)

The Holocene 1 August 2012: 887–898.

[Abstract](#) [Full Text \(PDF\)](#)

Systems approaches in global change and biogeochemistry research

Phil Trans R Soc B 19 January 2012: 311–321.

[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)

Knowledge production and learning for sustainable forest management on the ground: Pan-European landscapes as a time machine

Forestry 1 December 2011: 581–596.

[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)

Exploring ecosystem service issues across diverse knowledge domains using Bayesian Belief Networks

Progress in Physical Geography 1 October 2011: 681–699.

[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)

Global growth and stability of agricultural yield decrease with pollinator dependence

Proc. Natl. Acad. Sci. USA 5 April 2011: 5909–5914.

[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)

Physical and economic consequences of climate change in Europe

Proc. Natl. Acad. Sci. USA 15 February 2011: 2678–2683.

[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)

The aesthetics of water and land: a promising concept for managing scarce water resources under climate change

Phil Trans R Soc A 28 November 2010: 5323–5337.

[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)

Tolerance adaptation and precipitation changes complicate latitudinal patterns of climate change impacts

Proc. Natl. Acad. Sci. USA 13 July 2010: 12581–12586.

[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)

Do biotic interactions modulate ecosystem functioning along stress gradients? Insights from semi-arid plant and biological soil crust communities

Phil Trans R Soc B 12 July 2010: 2057–2070.

[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)

Climate change, biotic interactions and ecosystem services

Phil Trans R Soc B 12 July 2010: 2013–2018.

[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)

Warming alters the metabolic balance of ecosystems

Phil Trans R Soc B 12 July 2010: 2117–2126.

[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)

Climate change impacts and vulnerability of the southern populations of *Pinus nigra* subsp. *salzmannii*

Tree Physiol 1 July 2010: 795–806.

[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)

Climate change and invasion by intracontinental range-expanding exotic plants: the role of biotic interactions

Ann Bot 1 June 2010: 843–848.

[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)

Interdisciplinary research for managing ecosystem services

Proc. Natl. Acad. Sci. USA 3 February 2009: 1301–1302.

[Full Text](#) [Full Text \(PDF\)](#)**From the Cover: Science for managing ecosystem services: Beyond the Millennium Ecosystem Assessment***Proc. Natl. Acad. Sci. USA* 3 February 2009: 1305–1312.[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)**Functional Proteomics of *Arabidopsis thaliana* Guard Cells Uncovers New Stomatal Signaling Pathways***Plant Cell* 1 December 2008: 3210–3226.[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)**Incorporating the effects of changes in vegetation functioning and CO₂ on water availability in plant habitat models***Biol Lett* 23 October 2008: 556–559.[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)**Long-term resistance to simulated climate change in an infertile grassland***Proc. Natl. Acad. Sci. USA* 22 July 2008: 10028–10032.[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)**Ecosystem Services Special Feature: Global mapping of ecosystem services and conservation priorities***Proc. Natl. Acad. Sci. USA* 15 July 2008: 9495–9500.[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)**Land Change Science Special Feature: The emergence of land change science for global environmental change and sustainability***Proc. Natl. Acad. Sci. USA* 26 December 2007: 20666–20671.[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)**The Macroecological Contribution to Global Change Solutions***Science* 15 June 2007: 1581–1584.[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)**Global Desertification: Building a Science for Dryland Development***Science* 11 May 2007: 847–851.[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)**Rapid and Recent Changes in Fungal Fruiting Patterns***Science* 6 April 2007: 71.[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)**A climate-change risk analysis for world ecosystems***Proc. Natl. Acad. Sci. USA* 29 August 2006: 13116–13120.[Abstract](#) [Full Text](#) [Full Text \(PDF\)](#)