

## **Curriculum Vitae Pamela A. Matson**

Richard and Rhoda Goldman Professor of Environmental Studies  
Dean Emerita, School of Earth, Energy and Environmental Sciences

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### **Academic Appointments**

Professor, Earth System Science  
Senior Fellow, Stanford Woods Institute for the Environment  
Affiliate, Precourt Institute for Energy

### **Administrative Appointments**

Faculty Director for the Sustainability, Science, and Practice Master's Program, Stanford University, 2017-Present  
Senior Fellow, Woods Institute for the Environment, 2005 – Present  
Naramore Dean of the School of Earth, Energy and Environmental Sciences, Stanford University, 2002 – 2017  
Co-director Center for Environmental Science and Policy, Stanford University, (2000-2002)  
Sant Director of the Earth Systems Program, Stanford University, (1999-2002)  
Richard and Rhoda Goldman Professor of Environmental Sciences, Stanford University, 1997 - Present  
Professor, University of California, 1993 - 1997  
Research Scientist, NASA-Ames Research Center, 1983 - 1993  
Post-doctoral Fellow, Department of Entomology, North Carolina State University, 1983

### **Honors and Awards**

Faculty Women's Forum Deborah Rhode Lifetime Achievement Award, Stanford University (2021)  
Tellus Mater Distinguished Fellow, Cambridge University (2019)  
Honorary Doctorate, McGill University (2017)  
Honorary Doctorate, Princeton University (2017)  
Fellow, California Academy of Sciences (2015)  
Doctor of Science Honorary Degree, Arizona State University (2014)

Honorary Member, British Ecological Society (2013)  
 Sustainability Science Award, Ecological Society of America (2013)  
 Top 100 Women of Influence, Silicon Valley Business Journal (2013)  
 Fellow, Ecological Society of America (2012)  
 Einstein Visiting Professor, Chinese National Academy (2011)  
 Eminent Ecologist Award, Colorado State University (2009)  
 Major contributor to Nobel Peace prize awarded to Intergovernmental Panel on Climate Change, Norwegian Nobel Committee (2007)  
 The 2005 Richard W. Lyman Award, Stanford University (2005)  
 McMurty University Fellow for Undergraduate Education (2002)  
 National Associate, National Academy of Sciences (2002)  
 Leopold Leadership Fellow, Leopold Leadership Program (1999)  
 Richard and Rhoda Goldman Professorship, Stanford University (1999)  
 School of Public and Environmental Affairs Distinguished Alumni Award, Indiana University (1998)  
 Distinguished Alumni Award, Oregon State University (1998)  
 AAAS Fellow, American Academy of Arts and Sciences (1997)  
 Distinguished Alumni Award, University of Wisconsin-Eau Claire (1996)  
 MacArthur Fellowship (1995-2000)  
 Elected Member, National Academy of Sciences (1994)  
 Exceptional Service Medal, NASA (1993)  
 Elected Member, American Academy of Arts and Sciences (1992)  
 Fellow, Ames (NASA) Associate (1992)  
 Research Paper Award, Oregon State University (1984)

## **Education**

Ph.D. in Forest Ecology, Oregon State University, 1983  
 M.S. in Environmental Science, Indiana University, 1980  
 B.S. (magna cum laude) Biology and English, University of Wisconsin - Eau Claire, 1975

## **Boards, Advisory Committees, Professional Leadership**

### ***External To Stanford:***

Chair, Gund Institute (University of Vermont) Advisory Board (2018-Present)  
 Chair, World Wildlife Fund -US Board of Trustees (2018 - Present)  
 Member, World Wildlife Fund – International Board of Directors (2018-2021)  
 Member, FutureEarth Advisory Council (2018 - 2020)  
 Member, Board of Directors, FFAR (Foundation for Food and Agriculture Research) (2014 - 2015)  
 Vice Chair, Board of Trustees, World Wildlife Fund (2012 - 2018)  
 Member, ClimateWorks Board of Trustees (2011 - 2020)  
 Member, External Advisory Board for School of Global Environmental Sustainability, Colorado State University (2010 – 2016)  
 Member, Advisory Board, National Park System (2010 - 2012)

Member, Visiting Committee for MIT's Department of Civil and Environmental Engineering, MIT (2010)

Member, Advisory Board, Climate Central, Inc. (2009 - 2012)

Member, NAS Committee on America's Climate Choices and Chair of Advancing Climate Science Subcommittee, National Academy of Science (2009 - 2012)

Member, NAS Committee on Climate, Energy and National Security, National Academy of Science (2009 - 2011)

Member, NAS Science Ambassador Program Advisory Board, National Academy of Science (2009 - 2010)

Member, NAS Certification Committee, National Academy of Science (2009)

Member, Board of Advisors, Global Institute of Sustainability, Arizona State University (2007 - Present)

Member, Advisory Board, Department of Ecology and Evolutionary Biology, Princeton University, (2007 - 2019)

Member, Editorial Board, Proceedings of the National Academy of Sciences (2006 - 2015)

Member, Board of Trustees, World Wildlife Fund (2003 - Present)

Founding Editor and Editorial Board Member, Annual Review of Environment and Resources (2002 - 2015)

External Review Committee, Life Sciences Initiative, Cornell University (2002)

Founding Co-Chair, National Academy of Sciences Roundtable on Science and Technology for Sustainability, National Academy of Sciences (2001 – 2009)

Founding Editor and Editorial Board Member Annual Review of Energy and the Environment (2001 - 2015)

Advisory Committee for Environmental Program, Luce Foundation (2001 - 2007)

Chair, Section on Ecology and Environmental Sciences, National Academy of Sciences (2001 - 2004)

President, Ecological Society of America (2001 - 2003)

Member, Board of Trustees, National Park Conservation Association (2000 - 2007)

Member, National Academy of Sciences Temporary Nominating Group on Global and Human Environmental Science, National Academy of Sciences (2000 - 2004)

Member, Coordinating Committee on the Sustainability Transition, National Academies of Science (2000 - 2002)

President Elect, Ecological Society of America (2000 - 2001)

External Review Committee, University of Utah (2000)

Co-Chair, Section 27, National Academy of Sciences (1998 - 2001)

Institute for International Studies Search Committee, Stanford University (1998 - 2001)

Lead Author, Working Group 1, Chapter 4, IPCC (Intergovernmental Panel on Climate Change) (1998 - 2001)

Liaison, Section 27, National Academy of Sciences (1998 - 2001)  
 Member, Science Advisory Committee, Organization of Tropical Studies (1998 - 2001)  
 Editorial Board, Annual Review of Energy and Environment (1998 - 2000)  
 Member, International SCOPE project on nitrogen transport and transformations, SCOPE (1998 - 2000)  
 Program Committee for the XVI International Botanical Congress, International Botanical Congress (1998 - 1999)  
 Editorial Board, Ecosystems (1997 - 2002)  
 Member and Executive Committee Member, Scientific Advisory Committee, International Geosphere-Biosphere Program (1997 - 2001)  
 Member, Advisory Committee, Natural Resource Ecology Laboratory (1996 - 2000)  
 Member, U.S. National Committee, Scientific Committee on Problems of the Environment (SCOPE) (1996 - 1999)  
 Member, Board of Trustees, Institute of Ecosystem Studies (1995 - 2004)  
 Member, Board on Sustainable Development, National Academy of Sciences (1995 - 2000)  
 Chair, Sustainable Biosphere Initiative Steering Committee, Ecological Society of America (1994 - 2000)  
 Editorial Board, Ecological Applications (1994 - 2000)  
 Member, Boreal Ecosystem-Atmosphere Exchange Study Advisory Committee, NASA (1994 - 1998)  
 Editorial Board, Global Change Biology (1994 - 1997)  
 Member, Mission to Planet Earth Advisory Committee, NASA (1994 - 1997)  
 Member, Advisory Board, Aspen Global Change Institute (1992 - 2012)

***Stanford:***

Chair, Provost's Committee on Sustainability, Stanford University (2012 - 2017)  
 Member, Advisory Council, Woods Institute for the Environment (2006 - 2017)  
 Science Director, Leopold Leadership Program, Stanford University (2004 - 2017)  
 Stanford Environmental Initiative Leader, Stanford University (2004 - 2011)  
 Ex Officio member of Stanford University Academic Senate, Stanford University (2002 - 2017)  
 Member, Executive Committee of the Emmett Interdisciplinary Program in Environment and Resources, Stanford University (2001 - 2006)  
 Sophomore Advisor, Stanford University (2001 - 2006)  
 Chair, Ad hoc Committee for an Interdisciplinary Environmental Studies Graduate Program, Stanford University (2000 - 2001)  
 Member, Provost's Task Force on University Needs, Stanford University (2000 - 2001)  
 Provost's Committee on Environment, Stanford University (1999 - 2004)

Provost's Committee to form Stanford Institute for the Environment, Stanford University (1999 - 2003)

Director, Earth Systems Program, Stanford University (1999 - 2002)

Dean of the School of Education Search Committee, Stanford University (1999 - 2000)

Acting Director, Earth Systems Program, Stanford University (1998 - 1999)

Goldman Honors Program faculty member, Stanford University (1997 - 2002)

Sexual Harassment Advisor, School of Earth Sciences, Stanford University (1997 - 2001)

## Publications

Hall, S.J., K.A. Lohse, and P.A. Matson. 2021. "Globalization of nitrogen deposition and ecosystem response: A 20-year perspective." This article belongs to Ambio's 50<sup>th</sup> Anniversary Collection, Theme: Eutrophication. *Ambio* 50: 750-752.

Hess, L.T., E.S. Hinckley, G. Robertson, and P.A. Matson. 2020. "Rainfall intensification increases nitrate leaching from tilled but not no-till cropping systems in the US Midwest." *Agriculture Ecosystems and Environment* 290 (106747): 1-10.

Anderson, C.M., R.S. DeFries, R. Litterman, P.A. Matson, D.C. Nepstad, S. Pacala, W.H. Schlesinger, M.R. Shaw, P. Smith, C. Weber, and C.B. Field. 2019. "Natural climate solutions are not enough." *Science* 363 (6430): 933-34.

Hess, L.T., E.S. Hinckley, G. Robertson, S.K. Hamilton, and P.A. Matson. 2018. "Rainfall Intensification Enhances Deep Percolation and Soil Water Content in Tilled and No-Till Cropping Systems of the US Midwest." *Vadose Zone Journal* 17 (1).

Liu, X., P. Vitousek, Y. Chang, W. Zhang, P. Matson, F. Zhang. 2016. "Evidence for a historic change occurring in China." *Environmental Science and Technology* 50: 505-506.

Clark, W. C., N.M. Dickson, and P.A. Matson. 2016. "Knowledge Systems for Sustainable Development." *Proceeding of the National Academy of Sciences of the United States of America (Articles from the Arthur M. Sackler Colloquium Linking Knowledge with Action for Sustainable Development)* 113 (17): 4570-4622

Matson, P. A., W. Clark, and K. Andersson. 2016. *Pursuing Sustainability: A Guide to the Science and Practice*. Princeton University Press.

Becker, A., P. Matson, M. Fischer, and M. Mastrandrea. 2014. "Towards seaport resilience for climate change adaptation: Stakeholder perceptions of hurricane impacts in Gulfport (MS) and Providence (RI)." *Progress in Planning*.

Vitousek, P.M., and P.A. Matson. 2014. "Agricultural Nutrient Use and Its Environmental Consequences" pp. 269-285. In *The Evolving Sphere of Food Security*, Naylor, R.L. (ed). Oxford University Press: New York, NY.

Bierbaum, R.M., and P.A. Matson. 2013. "Energy in the Context of Sustainability." *Daedalus* 142(1): 146-161.

Matson, P.A. 2013. "From Global Environmental Change to Sustainability Science: Ecosystem Studies in the Yaqui Valley, Mexico" pp. 233-242. In *Fundamentals of Ecosystem Science*, Weathers, K.C., D.L. Strayer, and G.E. Likens (eds). Academic Press: Elsevier, Inc.

DeFries, R.S., E.C. Ellis, F.S. Chapin, P.A. Matson, B.L. Turner, A. Agrawal, P.J. Crutzen, C. Field, P. Gleick, P.M. Kareiva, E. Lambin, D. Liverman, E. Ostrom, P.A. Sanchez, and J. Syvitski. 2012. "Planetary opportunities: A social contract for global change science to contribute to a sustainable future." *BioScience* 62(6): 603-606.

Matson, P.A. (ed). 2012. *Seeds of Sustainability: Lessons from the Birthplace of the Green Revolution in Agriculture*. Washington, DC: Island Press.

Chapin III, F.S., P.A. Matson, and P. Vitousek. 2011. *Principles of Terrestrial Ecosystem Ecology*. New York: Springer.

Chen, Xin-Ping, Zhen-Ling Cui, P.M. Vitousek, K.G. Cassman, P.A. Matson, Jin-Shun Bai, Quin-Feng Meng et al. 2011. "Integrated soil-crop system management for food security." *Proceedings of the National Academy of Sciences* 108(16): 6399-6404.

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Hinckley, E.S., S. Fendorf, and P.A. Matson. 2011. "Short-term fates of high sulfur inputs in Northern California vineyard soils." *Nutrient Cycling in Agroecosystems* 89(1): 135-142, doi: 10.1007/s10705-010-9383-3.

National Research Council of the National Academies Committee (Matson, co-chair). 2010. *America's Climate Choices: Advancing the Science of Climate Change*. Washington, DC: National Academy Press.

- Ahrens, T.E., D.B Lobell, J.I. Ortiz-Monasterio, Y. Li, and P.A. Matson. 2010. "Narrowing the agronomic yield gap with improved nitrogen use efficiency: a modeling approach." *Ecological Applications* 20(1): 91-100.
- K. Jacobs, L. Lebel, J. Buizer, L. Addams, P. Matson, E. McCullough, P. Garden, G. Saliba, and T. Finan. 2010. "Linking knowledge with action in the pursuit of sustainable water-resource management." *Proceedings of the National Academy of Sciences*, doi: 10.1073/pnas.0813125107.
- Vitousek, P.M., R. Naylor, T. Crews, M.B. David, L.E. Drinkwater, E. Holland, P.J. Johnes, J. Katzenberger, L.A. Martinelli, P.A. Matson, G. Nziguheba, D. Ojima, C.A. Palm, G.P. Robertson, A. Sanchez, A.R. Townsend, and F. Zhang. 2009. "Nutrient Balances in Agricultural Development." *Science* 324(5934): 1519-1520.
- Matson, P.A. 2009. "The Sustainability Transition." *Issues in Science and Technology* XXV(4): 39-42.
- Vitousek, P.M., and P.A. Matson. 2009. "Nutrient cycling and biogeochemistry." In *Princeton Guide to Ecology*, S.A. Levin (ed). Princeton University Press.
- Ahrens, T.D., J.M. Beman, J.A. Harrison, P.K. Jewett, and P.A. Matson. 2008. "A synthesis of nitrogen transformations and transfers from land to the sea in the Yaqui Valley agricultural region of northwest Mexico." *Water Resources Research* 44, W00A05, doi: 10.1029/2007WR006661.
- Daily, G.C., and P.A. Matson. 2008. "Ecosystem services: From theory to implementation." *Proceedings of the National Academy of Sciences* 105(28): 9455-9456.
- Chapin, F.S., G.M. Woodwell, J.T. Randerson, G.M. Lovett, E.B. Rastetter, D.D. Baldocchi, D.A. Clark, M.E. Harmon, D.S. Schimel, R. Valentini, C. Wirth, J.D. Aber, J.J. Cole, M.L. Goulden, J.W. Harden, M. Heimann, R.W. Howarth, P.A. Matson, A.D. McGuire, J.M. Melillo, H.A. Mooney, J.C. Neff, R.A. Houghton, M.L. Pace, M.G. Ryan, S.W. Running, O.E. Sala, W.H. Schlesinger, E.D. Schulze. 2006. "Reconciling carbon cycle terminology: A search for consensus." *Ecosystems* 9(7): 1041-1050.
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- Matson, P.A., and P.M. Vitousek. 2006. "Agricultural intensification: Will land spared from farming be land spared for nature?" *Conservation Biology* 20(3): 709-710.

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Matson, P., A. Luers, K. Seto, R. Naylor and I. Ortiz-Monasterio. 2005. "People, land use and environment in the Yaqui Valley, Sonora, Mexico." In *Population, Land Use, and Environment*, B. Entwistle and P. Stern, eds, 238-264. Washington, DC: National Research Council.

Carney, K.M., and P.A. Matson. 2005. "Plant diversity, soil microorganisms, and soil carbon cycling: does altering belowground communities matter to ecosystem functioning?" *Ecosystems* 8(8): 928-940.

Beman, J.M., K.R. Arrigo, and P.A. Matson. 2005. "Agricultural runoff fuels large phytoplankton blooms in vulnerable areas of the ocean." *Nature* 434: 211-214.

Lobell, D.B., J.I. Ortiz-Monasterio, G.P. Asner, P.A. Matson, R.L. Naylor, and W.P. Falcon. 2005. "Analysis of wheat yield and climatic trends in Mexico." *Field Crops Research* 94: 250-256.

Lohse, K.A., and P.A. Matson. 2005. "Consequences of nitrogen additions for soil processes and solution losses from wet tropical forests." *Ecological Applications* 15(5): 1629-1648.

Carney, K. M., P.A. Matson, and B.J.M. Bohannan. 2004. "Diversity, composition, and function of tropical soil nitrifiers across a plant diversity gradient and among land use types." *Ecology Letters* 7: 684-694.

Steffen, W., A. Sanderson, P.D. Tyson, J. Jäger, P.A. Matson, B. Moore III, F. Oldfield, K. Richardson, H.J. Schellnhuber, B.L. Turner, and R.J. Wasson. 2004. *Global Change and the Earth System: A Planet Under Pressure*. New York: Springer-Verlag. ISBN 3-540-40800-2.

Osher, L.J., P.A. Matson, and R. Amundson. 2003. "Effect of land use change on soil carbon in Hawaii." *Biogeochemistry* 65(2): 213-232.



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Vitousek, P., O. Chadwick, P. Matson, S. Allison, L. Derry, L. Kettley, A. Luers, E. Mecking, V. Monastera, and S. Porder. 2003. "Erosion and the rejuvenation of weathering-derived nutrient supply in an old tropical landscape." *Ecosystems* 6(8): 762-772.

Hall, S.J., and P.A. Matson. 2003. "Nutrient status of tropical rain forests influences soil N dynamics after N additions." *Ecological Monographs* 73(1): 107-129.

Turner, B.L., R.E. Kasperson, P.A. Matson, J.J. McCarthy, R.W. Corell, L. Christensen, N. Eckley, J.X. Kasperson, A. Luers, M.L. Martello, C. Polsky, A. Pulsipher, and A. Schiller. 2003. "A framework for vulnerability analysis in sustainability sciences." *Proceedings of the National Academy of Sciences* 100(14): 8074-8079.

Turner, B.L., P.A. Matson, J.J. McCarthy, R.W. Corell, L. Christensen, N. Eckley, G.K. Hovelsrud-Broad, J.X. Kasperson, R.E. Kasperson, A. Luers, M.L. Martello, S. Mathiesen, R. Naylor, C. Polsky, A. Pulsipher, A. Schiller, H. Selin, and N. Tyler. 2003. "Illustrating the coupled human-environment system for vulnerability analysis: Three case studies." *Proceedings of the National Academy of Sciences* 100(14): 8080-8085.

Harrison, J., and P. Matson. 2003. "Patterns and controls of nitrous oxide emissions from waters draining a subtropical agricultural valley." *Global Biogeochemical Cycles* 17(3): 1080-1093.

Luers, A.L., D.B. Lobell, L.S. Sklar, C.L. Addams, and P.A. Matson. 2003. "A method for quantifying vulnerability, applied to the agricultural system of the Yaqui Valley, Mexico." *Global Environmental Change* 13: 255-267.

Matson, P.A., K. Lohse, and S. Hall. 2002. "The globalization of nitrogen deposition and consequences for terrestrial ecosystems." *Ambio* 31(2): 113-119.

Chapin, F.S., P.A. Matson, and H.A. Mooney. 2002. *Principles of Ecosystem Ecology*. New York: Springer Verlag.

Tilman, D., C.G. Cassman, P.A. Matson, R. Naylor, and S. Polasky. 2002. "Agricultural sustainability and intensive production practices." *Nature* 418: 671-677.

Hall, S.J., and P.A. Matson. 2002. "Environmental variables controlling trace gas emissions from forests: Acid Precipitation and Nitrogen Deposition." In *Trace Gas Exchange in Forest Ecosystems*, H. Papen, R. Gasche, and H. Rennenberg, eds, 279-306. Fundamental and Applied Tree Physiology, Book Series, Volume 3. The Netherlands: Kluwer Academic Publishers.

Matson, P.A. 2001. "Environmental challenges for the 21st century: Interacting challenges and integrative solutions." *Environmental Law Quarterly*, University of California, Berkeley. Vol 27(4): 1179-1190.

Schuur, E.A.G., and P.A. Matson. 2001. "Aboveground net primary productivity and nutrient cycling across a mesic to wet precipitation gradient in Hawaiian montane forest." *Oecologia* 128: 431-442.

Schuur, E.A.G., O.A. Chadwick, and P.A. Matson. 2001. "Carbon cycling and soil carbon storage in mesic to wet Hawaiian montane forests." *Ecology* 82(1): 3182-3196.

Riley, W.J., I. Ortiz-Monasterio, and P.A. Matson. 2001. "Nitrogen leaching and soil nitrate, nitrite, and ammonium levels under irrigated wheat in Northern Mexico." *Nutrient Cycling in Agroecosystems* 61: 223-236.

Prather, M., D. Ehhalt, F. Dentener, R. Derwent, E. Dlugokencky, E. Holland, I. Isaksen, J. Katima, V. Kirchhoff, P. Matson, P. Midgley, and M. Want. 2001. "Atmospheric chemistry and greenhouse gases." In *Climate Change 2001: The Scientific Basis*. Houghton et al (eds) Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press.

Steffen, W., P. Tyson, J. Jager, P. Matson, B. Moore, F. Oldfield, K. Richardson, J. Schellnhuber, B. Turner, and R. Wasson. 2001. "Earth system science: An integrated approach." *Environment* 43(8): 21-27.

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Mosier, A.R., M.A. Bleken, P. Chaiwanakupt, E.C. Ellis, J.R. Freney, R.B. Howarth, P.A. Matson, K. Minami, R. Naylor, K. Weeks, and Ahao-Liang Zhu. 2001. "Policy implications of human accelerated nitrogen cycling." *Biogeochemistry* 52(3): 281-320.

Perez, T., S.E. Trumbore, S.C. Tyler, P.A. Matson, I. Ortiz-Monasterio, T. Rahn, and D.W.T. Griffith. 2001. "Identifying the agricultural imprint on the global N<sub>2</sub>O budget using stable isotopes." *Journal of Geophysical Research-Atmospheres* 106(#D9): 9869-9878.

Kates, R.W., W.C. Clark, R. Corell, J.M. Hall, C.C. Jaeger, I. Lowe, J.J. McCarthy, H.J. Schellnhuber, B. Bolin, N.M. Dickson, S. Faucheux, G.C. Gallopin, A. Grubler, B. Huntley, J. Jager, N.S. Jodha, R.E. Kasperson, A. Mabogunje, P. Matson, H. Mooney, B. Moore, T. O'Riordan, and U. Svedin. 2001. "Environment and development: Sustainability science." *Science* 292(5517): 641-642.

Panek, J., P.A. Matson, I. Ortiz-Monasterio, and P. Brooks. 2000. "Distinguishing nitrification and denitrification sources of N<sub>2</sub>O in a Mexican wheat system using N as a tracer." *Ecological Applications* 10(2): 506-514.

Riley, W.J., and P.A. Matson. 2000. "NLOSS: A mechanistic model of denitrified N<sub>2</sub>O and N<sub>2</sub> evolution from soil." *Soil Science* 165(3): 237-249.

Schuur, E.A.G., and P.A. Matson. 2000. "Land use change: Global effects of local changes." In *Earth System Science: Patterns and Processes*, W.G. Ernst (ed). Cambridge, UK: Cambridge University Press.

Harrison, J., and P. Matson. 2000. "The atmosphere as global commons." In *The Commons Revisited: An American Perspective*, J. Burger, R. Norgaard, E. Ostrom, D. Policansky, and B.D. Goldstein (eds). Washington, DC: Island Press.

Matson, P.A., and A. Goldstein. 2000. "Biogenic trace gas exchange." In *Methods in Ecosystem Science*, O. Sala, R. Jackson, H. Mooney, and R. Howarth, (eds). New York: Springer-Verlag.

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Hall, S.J., and P.A. Matson. 1999. "Nitrogen oxide emissions following nitrogen additions in tropical forests." *Nature* 400: 152-155.

Vitousek, P.M., L.O. Hedin, P.A. Matson, J.H. Fownes, and J. Neff. 1998. "Within-system element cycles, input-output budgets, and nutrient limitation." In *Successes, Limitations, and the Future of Ecosystem Ecology*, M. Pace, and P. Groffman (eds). New York: Springer.

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Matson, P. 1997. "NO<sub>x</sub> emissions from soils and its consequences for the atmosphere and biosphere." *Nutrient Cycling in Agroecosystems* 48: 1-6.

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