

**AFRICAN ECONOMIC RESEARCH CONSORTIUM (AERC)
COLLABORATIVE MASTERS DEGREE PROGRAMME (CMAP)
IN ECONOMICS FOR SUB-SAHARAN AFRICA
JOINT FACILITY FOR ELECTIVES**



LECTURE SERIES IN ENVIRONMENTAL ECONOMICS

(Revised July 2020)



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Our mailing address is:

African Economic Research Consortium (AERC)
3rd Floor-Middle East Bank Towers Building, Jakaya Kikwete Road
P. O. Box 62882
00200 Nairobi
Kenya



OBJECTIVES

Overall, the course seeks to demonstrate how economic techniques covered in the core courses in microeconomics, macroeconomics and quantitative methods are applied to environmental and natural resource policy and research, with special reference to Sub-Saharan Africa. It also seeks to explain the role of environmental economics in the development process in general, and in the integrated management of environmental resources in particular. The specific objectives of the course are to:

- (a) Expose students to the theories and models of Environmental Economics;
- (b) Enable students to understand and appreciate linkages between the environment and economics;
- (c) Help students apply the environmental models to practical situations with specific reference to Sub-Saharan Africa;
- (d) Acquaint students with the dynamics of global environment and the implications for development in Sub-Saharan Africa.

PREREQUISITES

The pre-requisites for this elective are the core courses. Students should note that topics covered in the core courses that are of particular importance to environmental economics include:

<i>Microeconomics:</i>	Choice under uncertainty; Inter-temporal choice; Game theory; Welfare economics, Market failure including Externalities, Public Goods and Information Asymmetry.
<i>Macroeconomics:</i>	National Income Accounting, Growth theory, Stabilization policy.
<i>Quantitative Methods:</i>	Difference and differential equations, Dynamic optimization.

COURSE ASSESSMENT

The final course mark in each part will comprise of the following: Continuous assessment 40%; final examination 60%.

Group Work/Class Presentations (by students)	10 marks
Class Test	15 marks
Term paper/Literature Review	15 marks
<u>Final examination</u>	<u>60 marks</u>
Total	100 marks

COURSE OUTLINE AND READING LIST

The reading material comprises core text books, supplementary texts, journal articles and other general readings. These are selected to meet the international standards required at the master's level, and give the student a chance to understand the concepts involved and how they may be applied. The general reading list is intended to provide a resource for students including alternative perspectives to the arguments in the main texts.



SEMESTER I: ENVIRONMENTAL ECONOMICS I

LECTURE 1: BASIC ISSUES IN ENVIRONMENTAL ECONOMICS (15 Hours)

1.1. Nature and Evolution of Environmental Economics

- 1.1.1. Definition and classification of environmental and natural resources
- 1.1.2. Evolution of environmental economics
- 1.1.3. Paradigms and basic concepts related to the interaction between environmental processes and economic management.
- 1.1.4. Efficiency, Optimality, Sustainability. Ethics, and Discounting

1.2. Economic Development and the Environment

- 1.2.1 Sustainable Development: Definitions, Basic Concepts and Operationalization; Weak Sustainability
- 1.2.2. Factors responsible for Environmental Degradation: Economic activities, Institutional failures (Markets, Government and public policy), the IPAT Identity (population, economic growth and poverty, technology)
- 1.2.3. IPAT Identity and Determinants of Environmental Degradation: Demographic transition, Environmental Kuznets' Curves, Empirical evidences and trends.
- 1.2.4. Green Growth

Required Readings

Barbier E.B. (1997) Introduction to the Environmental Kuznets Curve, *Environment and Development Economics* 2(4): 369-382.

Perman, R., Ma Y., McGilvray J. and Common M. (2012). **Natural Resource and Environmental Economics**, 4th edition. Edinburgh, Longman.

Pearce D. and R. Turner (2004). **Economics of Natural Resources and the Environment**. Harvester Wheatsheaf. London.

Jonathan M. Harris and Brian Roach (2017), **Environmental and Natural Resource Economics** 4th Edition, Routledge.

Tietenberg, T. & Lewis, L. (2012). **Environmental & Natural Resource Economics** 9th Edition, The Pearson Series in Economics

Sandmo, Agnar, (2015). The Early History of Environmental Economics, *Review of Environmental Economics and Policy*, volume 9, issue 1, winter 2015, pp. 43–63.

Solow, R. (1992). An almost practical step towards sustainability, *Resources for the Future*, Washington DC.



Supplementary

1. Abalu, G. and R. Hassan. (1998). Agricultural productivity and natural resource use in southern Africa, *Food Policy*, Vol 23, No. 6: 477-490
2. Arrow K., Boling B., Costanza R., Dasgupta P., Holling C. S., Jansson B. -O., Levin S., Maler K.-G., Perrings C. and Pimentel D. (1995). Economic growth, carrying capacity and the environment. *Science* 268, 28 April: 520-521.
3. Arrow K.J. and Fisher A.C. (1974). Environmental preservation, uncertainty, and irreversibility. *Quarterly Journal of Economics*, 88: 312-319.
4. Barbier E.B.ed (1993). *Economics and Ecology: New Frontiers and Sustainable Development*. London, Chapman and Hall.
5. Barbier, E.B. (1988). *Sustainable agriculture and the resource poor: policy issues and options*. LEEC Paper 88-02.
6. Barrett S. (1992). Economic Growth and Environmental Preservation. *Journal of Environmental Economics and Management* 23: 289-300.
7. Boesen, J and M. Rukuni (2000). *Land Tenure and sustainable development in Africa*, in D. Turnham (eds), *African Perspectives: Practices and Policies Supporting Sustainable Development*, Scandinavian Seminar College, Denmark.
8. Bojo, Jan Maler, Karl-Goran and Unemo, Lena (1990). *Environment and Development: An Economic Approach*. Dordrecht, Netherlands: Kluwer.
9. Bormann F.R. (1992). *Ecology, Economics, Ethics*. New Haven, Yale University Press.
10. Boulding, KE. 1966. *The economics of the coming spaceship earth*, in H. Jarret (ed.), *Environmental quality in a growing economy*. Johns Hopkins Press, Baltimore.
11. Brandon K.E. and Brandon C. (1992). Introduction: Linking environment to development: problems and possibilities. *World Development* 20(4): 477-479.
12. Bromley D.W. (1991). *Environment and Economy*. Oxford, Blackwell.
13. Brown, Lester et al. (1992). *State of the World 1992: A Worldwatch Institute Report on Progress towards a Sustainable society*. New York, Norton.
14. Colb Y. Michael E. (1990). *Environmental management in Development: Evaluation of Paradigms*. Washington, World Bank.
15. Commander S. Ed. (1989). *Structural Adjustment and Agriculture: Theory and Practice in Africa and Latin America*. London, ODI.
16. Common, M. and Perrings, C. (1992). Towards an Ecological Economics of Sustainability. *Ecological Economics* 6: 7-34.
17. Costanza R. (ed.) (1991). *Ecological Economics: The Science and Management of Sustainability*. Chapters 2 &3: 22-46
18. Krishnan, R.; Harris, J. and R. Goodein (eds.). *A Survey of Ecological Economics*, Island Press, Washington.
19. Conway G.R. and Barbier E.B. (1990). *Sustainable Agriculture for Development*. London, Earthscan.



20. Conway, G. and E.B. Barbier. (1988). After the Green Revolution: sustainable and equitable agricultural development. *Futures* 20: 6.
21. Darmstadter J. (1992). *Reconciling Global Development and the Environment*. Washington D.C., Resources for the Future.
22. Dasgupta P. and Mäler K.G. (1991). *The Environment and Emerging Development Issues*, in Proceedings of the World Bank Annual Conference on Development Economics 1990. Washington DC, World Bank: 101-131.
23. Dasgupta P. and Mäler K.G. (1993). *Poverty, Institutions, and the Environmental Resource Base*. In Behrman J. and Srinivasan T.N. eds. Handbook of Development Economics vol. 3. Amsterdam, North-Holland.
24. Davis E.J. and Schirmer I.A. eds (1987). *Sustainability Issues in Agricultural Development: Proceedings of the Seventh Agriculture Sector Symposium*. Washington D.C., World Bank.
25. Feder G. and Noronha R. (1987). Land rights systems and agricultural development in Sub-Saharan Africa. *World Bank Research Observer*, 2, 2.
26. Goodland, R., Daly, H. El Serafy, S. (1991). *Environmentally Sustainable Economic Development - Building on Brudtland*. Environment Working Paper No. 46, The World Bank.
27. Goudie, Andrew (1990). *The Human Impact on the Natural Environment*, 3rd Ed. Cambridge, MA HITT Press.
28. Gregersen H. S. Draper and Elz D., eds. (1989). People and trees: the role of social forestry in sustainable development. Washington, D.C., World Bank.
29. Holling C.S. (1986). *The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change*. In W.C. Clark and R.E. Munn, eds. Sustainable Development of the Biosphere. Cambridge, Cambridge University Press.
30. IIED/IUCN (1994). *Strategies for National Sustainable Development*. London, Earthscan.
31. IUCN, UNEP, WWF (1991). *Caring for the Earth: A Strategy for Sustainable Living*. Gland, Switzerland.
32. Jacobs M. (1991). *The Green Economy - Environment, Sustainable Development and the Politics of the Future*. London, Phito Press.
33. Jamal V. (1983). *Nomads and farmers, incomes and poverty in rural Somalia*. In Ghai D. and Radwan S. eds. Agrarian Policies and Rural Poverty in Africa. Geneva, ILO: 281-311.
34. Krishnan, R., Harris, J. and R. Goodein (eds.). *A Survey of Ecological Economics*, Island Press, Washington.
35. Mäler K.G. (1974). *Environmental Economics - A Theoretical Inquiry*. Baltimore, Johns Hopkins Press.
36. Markandya, A. (1991). *Technology, Environment and Employment: A Survey*, World Employment Programme Working Paper. Geneva, ILO.



37. Mikesell, Raymond F. (1992). *Economic Development and the Environment - A Comparison of Sustainable Development with Conventional Development Economics*. London, Mansel Publishing Ltd.
38. Myers N. (1992). Population-Environment Linkages: Discontinuities Ahead. *Ambio* 21: 116-118.
39. Nugent J. and Gillaspay T. (1983). Old age pension and fertility in rural areas of less developed countries: some evidence from Mexico. *Economic Development and Cultural Change*, 31.
40. Osuntogun Adeniyi (1993). *Agriculture, Rural Sector and Environmental Sustainability in Africa*. (Published proceeding of the Regional Conference at International Centre for Economic Growth (ICEG). San Francisco, California, USA.
41. Osuntogun, Adeniyi and Adewuyi, Alfred eds (1994). *Population and the Nigeria Environment. Foundation for Environmental Development and Education in Nigeria (FEDEN)* Lagos, Nigeria. *Sustainable Environmental Management: Principles and Practice*. Belhaven Press. London: 118-142.
42. Pearce D.W., Barbier E.B. Markandya, A. (1990). *Sustainable Development: Economics and Environment in the Third World*. Earthscan, London
43. Pearce, D. and G. Atkinson. (1993). Capital theory and the measurement of sustainable development: An indicator of weak sustainability. *Ecological Economics* (8):103 - 108.
44. Pearce, D., K. Hamilton and G. Atkinson. (1996). Measuring sustainable development: Progress on indicators. *Environment and Development Economics* 1(1996): 85 - 101.
45. Perez-Garcia J. and Lippke B.R. (1993). *The timber trade and tropical forests: modelling the impacts of supply constraints, trade constraints and trade liberalization*. LEEC Discussion Paper DP, 93-03. London, IIED.
46. Perrings C. (1989). An optimal path to extinction? Poverty and resource degradation in the open agrarian economy. *Journal of development Economics* 30: 1-24.
47. Perrings C. (1989). *Debt and Resource Degradation in Low Income Countries: The Adjustment Problem and the Perverse Effects of Poverty in Sub-Saharan Africa*, in H. Singer and S. Sharma, editors, *Economic Development and World Debt*. London, Macmillan.
48. Perrings C. (1991). Ecological Sustainability and Environmental Control. *Structural Change and Economic Dynamics* 2: 275-295.
49. Perrings C., Mäler K.G., Folke C., Holling C.S. and Jansson B.O. (eds) (1994). *Biological Diversity: Economic and Ecological Issues*. New York, Cambridge University Press, forthcoming.
50. Pezzey J. (1989). *Economic analysis of sustainable growth and sustainable development*. World Bank Environment Department Working Paper No 15. Washington DC, World Bank.
51. Porter, M. and C. van der Linde (1995). Toward a new conception of the environmental competitiveness relationship. *Journal of Economic perspective*, No. (:97-118



52. Repetto R. and Homes J. (1983). The role of population in resource depletion in developing countries, *Population and Development Review* 9: 609-632.
53. RuttaVernon W. ed., (1991). *Sustainable Agriculture and the Environment: Perspectives on Growth and Constraints*. Boulder, Colorado: Westview.
54. Sagoff, Mark (1988). *Some Problems with Environmental Economics, Environmental Ethics*, 10: 55-74.
55. Schramm G. and Warford J.J. eds. (1989). *Environmental Management and Economic Development*. Baltimore, Johns Hopkins University Press.
56. Swaney, James A. (1987). Elements of a New Institutional Environment Economics, *Journal of Economic Issues*, 21: 1739-1775.
57. Tolba, M.K. El-Kholy O. A. et al (1992). *The World Environment 1972-1992: Two Decades of Challenge*. UNEP Nairobi, Kenya.
58. Turner R.K. (1993). *Sustainable Environmental Economics and Management: principles and practice*. London, Belhaven Press.
59. United Nations (1991). *Population, Resources and the Environment: The Critical Challenges*. New York, United Nations
60. World Bank (1992). *World Development Report: Environment and Development*. New York, Oxford University Press.
61. World Bank (1994). *Economy-Wide Policies and the Environment - Emerging Lessons from Experience*. Washington DC, The World Bank.
62. World Commission on Environment and Development (1987). *Our Common Future*. Oxford, Oxford University Press.
63. World Conservation Monitoring Center (1992). *Global Biodiversity: Status of the Earth's Living Resources*. London, Chapman and Hall.
64. World Resources Institute (1992). *World Resources 1992-3*. Washington DC, WRI.
65. WWF (1993). *Sustainable Use of Natural Resources: Concepts, Issues, and Criteria*, A WWF International Position Paper.
66. Young M.D. (1992). *Sustainable Investment and Resource Use*. New York, UNESCO



LECTURE 2: WELFARE ECONOMICS, MARKET FAILURE AND THE ENVIRONMENT (18 Hours)

2.1. Review of welfare economics and market outcomes

2.2. Public goods

2.2.1 Definition and characteristics of public goods and its distinction from private goods

2.2.2 Efficient Provision of Public Goods

2.2.3 Problems of managing the commons

2.2.4. Focus: Management of Common Property in Africa

2.3. Environmental Externalities

2.3.1 Definition and Classification of externalities

2.3.2 Externalities and Resource Allocation

2.3.3 Solutions to Externality Problems

2.4. The second-best problem, Imperfect information, and Government failure

2.4.1 The Second-best Problem

2.4.2. The Role of Imperfect Information

2.4.3 Government failure

Required Readings

Cornes, R. and Sandler, T. (1986). **The Theory of Externalities, Public Goods and Club Goods**. Cambridge, Cambridge University Press, Chapters 3 and 4.

Mueller, Dennis C. (2003) **Public choice III**, Cambridge, Cambridge University Press.

Perman, R., Ma Y., McGilvray J. and Common M. (2012). **Natural Resource and Environmental Economics**, 4th edition. Edinburgh, Longman.

Jonathan M. Harris and Brian Roach (2017), **Environmental and Natural Resource Economics 4th Edition**, Routledge.

Tietenberg, T. & Lewis, L. (2012). **Environmental & Natural Resource Economics** 9th Edition, The Pearson Series in Economics

Supplementary

1. Anderson S. and Francois P. (1997) Environmental cleanliness as a public good: welfare and policy implications of nonconvex preferences, *Journal of Environmental Economics and Management* 34(3): 256-274.



2. Baumol W. and Bradford D. (1972). Detrimental externalities and non-convexity of the production set. *Economica* 39: 160-176.
3. Daly H. E. and Cobb J. B. (1989). *For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future*. Boston: Beacon.
4. Hardin G. (1968). The Tragedy of the Commons. *Science*, 162: 1243-1248.
5. Mäler K.G. (1985). *Welfare Economics and the Environment*. In Kneese A.V. and Sweeney J.L. eds. *Handbook of Natural Resource and Energy Economics*. Amsterdam, North Holland, I: 3-60.
6. Smith V. K. (1988). *Environmental Resources and Applied Welfare Economics*. Washington DC, Resources for the Future.
7. Smith V.K. (1991). *Household production functions and environmental benefit estimation*, in J.B. Braden and C.D. Kolstad, eds, *Measuring The Demand for Environmental Quality*. Amsterdam, North Holland
8. Wibe S. and Jones T. (1992). *Forests: Market and Intervention Failures*. London, Earthscan.

LECTURE 3: THE ECONOMICS OF NATURAL RESOURCE EXTRACTION AND MANAGEMENT (27 Hours)

3.1. Optimal Extraction of Non-Renewable Resources: The Basic Model

- 3.1.1 Categorization of nonrenewable resources
- 3.1.2 Optimal extraction of non-renewable resources with constant extraction costs
- 3.1.3 Dynamic efficiency, intertemporal fairness, and Hartwick rule
- 3.1.4. The Empirical Evidence

3.2. Optimal Extraction of Non-Renewable Resources: Extensions to the Basic Model

- 3.2.1. The N-period constant-cost case
- 3.2.2. Some comparative statics: Effect of changes in discount rate, demand, available resource stock, uncertainty.
- 3.2.3 Transition to a substitute
- 3.2.4. Optimal extraction in the case of variable (rising) marginal cost
- 3.2.5. The Effect of Recycling
- 3.2.6 Market Allocations of depletable resources: property rights, environmental cost.

3.3. Optimal Extraction of Non-Renewable Resources: Application to Sub-Saharan Africa

3.4. Optimal Extraction of Renewable Resources: The Basic Model

- 3.4.1 Introduction: Natural growth, regeneration and cyclical resources
- 3.4.2 Biological growth processes
- 3.4.3 Steady-state harvesting, Maximum Sustainable Yield, and Efficiency
- 3.4.4. Equilibria in the Renewable Resource harvesting Model



3.5. Renewable Resources: Optimal Harvesting under different Property right Regimes

- 3.5.1. Open-access Harvesting Model
- 3.5.2. The Private-property Model
- 3.5.3. Socially-Efficient Resource Harvesting
- 3.5.4. Safe Minimum Standard (SMS) of Conservation
- 3.5.5. Some Empirical Evidence

3.5 Optimal Extraction of Renewable Resources: Application to Sub-Sharan Africa

Required Readings

Boyce, William E. and Richard DiPrima. (2001) **Elementary Differential Equations**, 7th edition, John Wiley and Sons, New York. (Chapter 2.5 and 9.1)

Conrad J.M. (2010) **Natural Resource Economics**. 2e, Cambridge, Cambridge University Press

Dasgupta P. and Heal G. (1979). **Economic theory and exhaustible resources**, Cambridge, Cambridge University Press.

Fisher A.C. (1981). **Resource and Environmental Economics**. Cambridge, Cambridge University Press.

Perman, R., Ma Y., McGilvray J. and Common M. (2012). **Natural Resource and Environmental Economics**. 4th edition, Edinburgh, Longman.

Jonathan M. Harris and Brian Roach (2017), **Environmental and Natural Resource Economics 4th Edition**, Routledge.

Tietenberg, T. & Lewis, L. (2012). **Environmental & Natural Resource Economics 9th Edition**, The Pearson Series in Economics

Supplementary

1. Beller, P. and d'Ayala, P. Mei eds. (1990). Sustainable Development and Environmental Management of Small Islands. *UNESCO Man the Biosphere Series Vol. 5*. (PV).
2. Berkes F. (1989). *Common Property Resources: ecology and community-based sustainable development*. London, Belhaven Press.
3. Bojo, J. (1996). *The economics of wildlife: Case studies from Ghana, Kenya, Namibia and Zimbabwe*, AFTES Working Paper No. 19, The World Bank
4. Ciriacy-Wantrup S.V. (1952). *Resource Conservation: Economics and Policies*. Berkely, University of California Press.
5. Coria, J., Robinson, E., Smith, H.G. and Sterner, T. (2014). "Biodiversity Conservation and Ecosystem Services Provision: A Tale of Confused Objectives, Multiple Market Failures and Policy Challenges" in '*Handbook on the Economics of Ecosystem Services and Biodiversity*' by Paulo A.L.D. Nunes, Pushpam Kumar and Tom Dedeurwaerdere,
6. Dasgupta P.S. (1982). *The Control of Resources*. Cambridge Mass, Harvard University Press
7. Dixon J.A., James D.E. and Sherman P.B. (1989). *The Economics of Dryland Management*. London, Earthscan.



8. Githinji M. and Perrings C. (1993). Social and Economic Sustainability in the Use of Biotic Resources in Sub-Saharan Africa. *Ambio* 27: 110-116.
9. Hansen S. (1989). Debt for nature swaps: overview and discussion of key issues. *Ecological Economics* 1: 77-95.
10. Harrison J., Miller K. and McNeely J. (1984). *The world coverage of protected areas: Development goals and environmental needs*. In McNeely, J. A. and Miller, K. R. (eds) National Parks, Conservation and Development. Washington D.C., Smithsonian Institution Press.
11. Hartwick J.M. (1977). Inter-generational Equity and the Investing of Rents from Exhaustible Resources. *American Economic Review* 66: 972-974.
12. Hassan, R. M. (1997). Conservation and efficient allocation of water resources through demand management: The potential of emerging policy instruments. *IUCN-ROSA/LAPC Policy Brief No. 2, Volume 1 September 1997. Harare, Zimbabwe*
13. Howe, Charles Hassan, and Hertzler. (1988). Desertification from over exploitation of wood resources as a cooking fuel: A dynamic approach to pricing energy resources in Sudan. *Energy Economics* 10(2):163-168.
14. Huntley B.J. (1988). *Conserving and monitoring biotic diversity: some African examples*. In Wilson, E. O. (ed) *Biodiversity*. Washington D.C., National Academy Press: 248-260.
15. Kaimowitz D. and A. Angelsen (1998). *Economic Models of Tropical Deforestation: A Review*. Center for International Forestry Research (CIFOR), Bangor, Indonesia.
16. Kane, R. and D. Turnham (2000). *Sustainable development and community mobilization*, in D. Turnham (ed.), *African Perspectives: Practices and Policies Supporting Sustainable Development*, Scandinavian Seminar College, Denmark.
17. Kneese A.V. and Sweeney J.L. (eds) *Handbook of Natural Resource and Energy Economics I*. Amsterdam, North-Holland: 223-270.
18. Krutilla J.V. and Fisher A.C. (1985). *The Economics of Natural Environments*. Washington D.C. Resources for the Future
19. McNaughton S.J. (1985). Ecology of a grazing ecosystem: the Serengeti. *Ecological Monographs* 55: 259-294.
20. McNaughton S.J., Guess, R.W. and Seagle S.W. (1988). Large mammals and process dynamics in African ecosystems. *BioScience* 38: 791-800.
21. Miller J. (1981). Irreversible land use and the preservation of endangered species. *Journal of Environmental Economics and Management* 8: 19-26.
22. Perrings C. (1993). *The economic environment and the ecologically sustainable exploitation of renewable resources: the case of dryland range management*, in E.B. Barbier ed, *Economics and Ecology: New Frontiers in Sustainable Development*. London, Chapman and Hall.
23. Perrings C., Folke C. and Mäler K-G. (1992). The Ecology and Economics of Biodiversity Loss: The Research Agenda. *Ambio* XXI: 201-211.



24. Perrings, C. (ed.) (2000). *Biodiversity Conservation in Sub-Saharan Africa: Mending the Ark*. Cheltenham, Edward Elgar
25. Repetto R. (1989). *Wasting Assets*. Washington DC, World Resources Institute.
26. Repetto, R., Magrath, W., Wells, M., Beer, C., and Rossini, F. (1989). *Wasting Assets: Natural Resources in the National Income Accounts*. World Resources Institute, Washington, D.C.
27. Solow R. M. (1986). On the Intertemporal Allocation of Natural Resources. *Scandinavian Journal of Economics*, 88: 141-149.
28. Stuart, S. N. Adams, R. J. (1991). *Biodiversity in Sub Saharan Africa and its' Islands*. Occasional paper of the IUCN Species Survival Commission No. 6.
29. Wells M. and Brandon K.E. (1993). The principles and practice of buffer zones and local participation in biodiversity conservation. *Ambio* 22(2-3): 157-162.
30. Young, M.D. and Solbrig O.T. (1993). *The World's Savannas: economic driving forces, ecological constraints and policy options for sustainable land use*. Parthenon.

SEMESTER II: ENVIRONMENTAL ECONOMICS II

LECTURE 4: ENVIRONMENTAL POLICY INSTRUMENTS

(15 Hours)

4.1. Framing the Environmental Problem: Pollution

- 4.1. 1. What level of pollution is desirable?
- 4.1.2. Categories of Pollutants and the efficient level of pollution
- 4.1.3. The Efficient Allocation of Pollution: Fund Pollutants
- 4.1.4. The Efficient Allocation of Pollution: Stock Pollutants

4. 2. Policy Instruments

- 4.2.1. Command-and Control Instruments: Regulation of technology, regulation of performance
- 4.2.2, Economic Instruments: Price-based instruments, Property rights-based instruments, Legal, voluntary and information-based instruments.
- 4.2.3 Direct provision of public goods.

4.3 Selection and Evaluation of Policy Instruments

- 4.3.1 Choosing an effective environmental policy package to address a target environmental problem: Understanding the nature and extent of the problem and determining baseline conditions; Making Policy Choices
- 4.3.2 Evaluation of Environmental Policies: Evaluation criteria, Cost-effectiveness, cost-effective policies for uniformly-mixed and non-uniformly mixed fund pollutants, Applications to overharvesting of renewable resources



4.4 Applications to Africa

Required readings:

Baumol W.J. and Oates, W.E. (1988). *The Theory of Environmental Policy*. Cambridge, Cambridge University Press, Chapter 14.

Hanley N., Shogren J.F. and White B. (2006) *Environmental Economics in Theory and Practice*, London, Macmillan.

Perman R., Ma Y., McGilvray J. and Common M. (2012). *Natural Resource and Environmental Economics*, 4th Edition, Edinburgh, Longman.

Sterner, T. and J. Coria (2012). *Policy Instruments for Environmental and Natural Resource Management*. Resources for the Future.

Jonathan M. Harris and Brian Roach (2017), **Environmental and Natural Resource Economics** 4th Edition, Routledge.

Tietenberg, T. & Lewis, L. (2012). *Environmental & Natural Resource Economics* 9th Edition, The Pearson Series in Economics

UNEP (2009): *The Use of Economic Instruments for Environmental and Natural Resource Management* First Edition

Supplementary

1. Ashley, C. (1996). *Incentives affecting biodiversity conservation and sustainable use: The case of land use options in Namibia*, Research Discussion paper No. 13, DEA, Windhoek
2. Benford F. (1998). On the dynamics of the regulation of pollution: incentive compatible regulation of a persistent pollutant, *Journal of Environmental Economics and Management* 36(1): 1-25.
3. Brandon K.E. Wells M.P. (1992). Planning for people and parks: design dilemmas. *World Development* 20(4): 557-570.
4. Ciriacy-Wantrup S.V. (1952). *Resource Conservation: Economics and Policies*. Berkely, University of California Press.
5. Convery, F.J. (1993). *Applying Environmental Economics in Africa, With Particular Reference to National Environmental Action Planning*. Dublin, UK, Dublin University Press.
6. Coria, J and Sterner, T. (2011). "Natural resource management: Challenges and policy options", *Annual Review Resource Economics*, 3, 14.1–14.28
7. Coria, J. and Sterner. T. (2010) "Tradable Permits in Developing Countries: Evidence from Air Pollution in Chile", *The Journal of Environment and Development*, 19(2), 145–170.



8. Dasgupta P.S. (1982). *The Control of Resources*. Cambridge Mass, Harvard University Press
9. Federal Environmental Protection Agency (1991). *Achieving Sustainable Development in Nigeria*. National Report for the United Nations Conference on Environment and Development. Rio de Janeiro, Brazil, 1-12 June, 1991.
10. Hassan, and Hertzler. 1988. Desertification from over exploitation of wood resources as a cooking fuel: A dynamic approach to pricing energy resources in Sudan. *Energy*
11. Helm D. (1991). *Economic policy towards the environment*. Oxford, Blackwell
12. Horan J. Shortle J.S. and Abler D.G. (1998). Ambient taxes when polluters have multiple choices, *Journal of Environmental Economics and Management* 36(2): 186-199.
13. IIED/IUCN (1994). *Strategies for National Sustainable Development*. London, Earthscan.
14. IUCN, UNEP, WWF (1991). *Caring for the Earth: A Strategy for Sustainable Living*. Gland, Switzerland.
15. Jacobs M. (1991). *The Green Economy - Environment, Sustainable Development and the Politics of the Future*. London, Pinter Press.
16. Kane, R. and D. Turnham (2000). *Sustainable development and community mobilization*, in D. Turnham (ed.), *African Perspectives: Practices and Policies Supporting Sustainable Development*, Scandinavian Seminar College, Denmark.
17. Kiss A., ed. (1990). *Living with wildlife: wildlife resource management with local participation in Africa*. Technical Paper No. 130. Washington D.C., World Bank.
18. McGowan International and Coopers & Lybrand. Oct. (1987). *National Land Management and Livestock Project: Incentive/ Disincentives Study*. Volume 1. Final Report prepared for the Ministry of Local Government and Lands. Botswana.
19. McNeely J.A. (1988). *Economics and biological diversity: developing and using economic incentives to conserve biological resources*. IUCN, Gland, Switzerland.
20. Migot-Adholla S. Hazell P., Blare B. and Place F. (1991). *Indigenous land rights in Sub-Saharan Africa: a constraint on productivity?* *The World Bank Economic Review*, 5: 155-175.
21. Panayotou, T. (1993). *The Green Markets - The Economics of Sustainable Development*. California, International Centre for Economic Growth.
22. Panayotou T. and Ashton P.S. (1992). *Not by Timber Alone: economics and ecology for sustaining tropical forests*. Washington D.C., Island Press.
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24. Pearce D.W. and Markandya A. (1989). *Marginal opportunity cost as a planning concept in natural resource management*. In G. Schramme and J. Warford, eds, *Environmental Management and Economic Development*. Baltimore, Johns Hopkins: 39-56.
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27. Perrings C. and Pearce D.W. (1994). *Threshold effects and incentives for the conservation of biodiversity*. *Environmental and Resource Economics*, forthcoming.
28. Repetto R. (1989). *Economic incentives for sustainable production*, in G. Schramm and J.J. Warford, eds, *Environmental Management and Economic Development*. Baltimore, Johns Hopkins.
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34. Tietenberg T.H. (1992). *Innovation in Environmental Policy*. London, Edward Elgar.
35. Turnham, D. (ed.) (2000). *Annex 2: Annotated List of The Project Case Studies*, in "African Perspectives: Practices and Policies Supporting Sustainable Development, Scandinavian Seminar College, Denmark
36. UNEP (2009): *The Use of Economic Instruments for Environmental and Natural Resource Management* First Edition Warford J.J. (1989). *Environmental management and economic policy in developing countries*. In G. Schramme and J. Warford, eds, *Environmental Management and Economic Development*. Baltimore, Johns Hopkins: 7-22.
37. World Bank (1991). *Environmental Assessment Source book Vol. 1 - Policies, Procedures, and Cross-Sectoral Issues*, Washington DC.
38. World Bank, (1990). *Towards the Development of an Environmental Action Plan for Nigeria*, Washington DC
39. Young, M.D. and Solbrig O.T. (1993). *The World's Savannas: economic driving forces, ecological constraints and policy options for sustainable land use*. Parthenon.



LECTURE 5: ENVIRONMENTAL VALUATION AND ANALYSIS (18 Hours)

5.1 Value and Welfare

5.1.1 The concept of total economic value: use and non-use values.

5.1.2 Welfare economics as the basis for valuation: Consumer and producer surplus; compensating and equivalent variation; willingness to accept/pay

5.2 Environmental Valuation Techniques and Analysis

5.2.1 Revealed Preference Methods: Hedonic Pricing, Travel Cost, Production Function-Based Techniques

5.2.2 Stated Preference Methods: Contingent Valuation, Choice Experiments

5.3 Environmental Cost- Benefit Analysis

5.4 Environmental Impact Assessment: An introduction

Required readings:

Barbier E.B., Markandya A. and Pearce D.W. (1990). Environmental Sustainability and Cost-Benefit Analysis. *Environment and Planning* 22: 1269-1266.

Brown G.M. and Henry W. (1989). The Economic Value of Elephants. LEEC Working Paper 89-12, London, IIED.

Dixon, J. A. et al. (1994). *Economic Analysis of Environmental Impacts*. London, Earthscan.

Freeman A.M., Joseph A. Herriges and Catherine L. Kling (2014). *The measurement of environmental and resource values*, Washington DC, RFF.

Hanley N., Shogren J.F. and White B. (2006) *Environmental Economics in Theory and Practice*, London, Macmillan.

Johansson P.O. (1987). *The Economic Theory and Measurement of Environmental Benefits*, Cambridge, Cambridge University Press.

Perman, R., Ma Y., McGilvray J. and Common M. (2012). *Natural Resource and Environmental Economics*, 4th Edition, Edinburgh, Longman.

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1. Barde J.P. and Pearce D.W. (1991). *Valuing the Environment: Six Case Studies*. London, Earthscan.
2. Barnes, J.; Schier, C. and G. van Rooy. (1997). *Tourists' willingness to pay for wildlife viewing and wildlife conservation in Namibia*, DEA Research Discussion Paper No. 15, DEA, Windhoek
3. Behnke R.H. (1985). Measuring the benefits of subsistence versus commercial livestock production in Africa. *Agricultural Systems* 16: 109-135.
4. Bishop R.C. (1982). Option values: an exposition and extension, *Land Economics*, 58, 1-15.
5. Braden J.B. and Kolstad C.D. eds. (1991). *Measuring the Demand for Environmental Quality*. Amsterdam, North Holland.
6. Brandon K.E. Wells M.P. (1992). Planning for people and parks: design dilemmas. *World Development* 20(4): 557-570.
7. Brookshire D.S., Thayer M.A., Schultze W.D. and d'Arge R.C. (1982). Valuing public goods: a comparison of survey and hedonic approaches. *American Economic Review* 72: 165-177.
8. Broome J. (1992). *Counting the cost of global warming*. London, White Horse Press.
9. Brown G.M. and Henry W. (1989). *The Economic Value of Elephants*. LEEC Working Paper 89-12, London, IIED.
10. Daly H.E. and Townsend, K.N. eds (1992). *Valuing the Earth*. Boston, MIT Press.
11. Decker D.J. (1987). *Valuing Wildlife: Economic and Social Perspectives*. London, Westview.
12. Diamond, P. and J. Hausman (1994). Contingent valuation: Is some number better than no number. *Journal of Economic Perspectives*, 8: 45-64
13. Dixon J.A. and Hufshmidt, M. eds. (1986). *Economic Valuation Techniques for the Environment*. Baltimore, Johns Hopkins Press.
14. Dixon J.A. and Sherman P.B. (1990). *Economics of protected areas: a new look at benefits and costs*. Washington D.C, Island Press.
15. Ehrlich, P. R. and Ehrlich, A. H. (1992). The Value of Biodiversity. *Ambio* 21: 219-226.
16. Ellis G.M. and Fisher A.C. (1987). Valuing the environment as an input. *Journal of Environmental Management* 25: 149-156.
17. Falconer J. (1990). *The major significance of minor forest products: the local use and value of products in the West Africa humid forest zone*. Community Forestry Note 6. Rome, FAO.
18. Fisher A.C. and Hanemann W.M. (1986). Option values and the extinction of species. *Advances in Applied Microeconomics* 4: 169-190.



19. Folmer H. (1989). *Valuation Methods and Policy Making in Environmental Economics*. Elsevier.
20. Hanneman W. M. (1989). Information and the concept of option value, *Journal of Environmental Economics and Resource Management* 16: 23-37.
21. Hanneman W.M. (1991). Willingness to pay and willingness to accept: how much can they differ? *American Economic Review* 81(3): 635-647.
22. Hassan, RM (ed.) (forthcoming). Accounting for asset depreciation and non-market values of woody land resources: Methods and results from South Africa. *Environmental Economics Network for Eastern and Southern Africa (EENESA) Working Paper (in RANESA Web site)*.
23. Karsenty a. (2000). *Economic Instruments for Tropical Forests*. Center for International Forestry Research (CIFOR), Bangor, Indonesia.
24. Kolstad C.D. and Braden J.B. (1991). *Environmental demand theory*, in J.B. Braden and C.D. Kolstad, (eds), *Measuring the Demand for Environmental Quality*. Amsterdam, North Holland: 17-40.
25. Kopp R and Smith V.K. (1993). *Valuing natural assets: the economics of natural resource damage assessment*. Washington D.C., Resources for the Future.
26. Lugo A. E. (1988). *Estimating reductions in the diversity of tropical forest species*. In Wilson, E. O. (ed) *Biodiversity*. Washington D.C., National Academy Press: 58-70.
27. Mitchell, R.C. and Carson R.T. (1989). *Using surveys to value public goods: the contingent valuation method*. Washington D.C., Resources for the Future.
28. Nash C. and Bowers J. (1988). *Alternative approaches to the valuation of environmental resources*. In Turner R.K. ed.
29. Navrud and Mungatana (1994). Environmental valuation in developing countries: the recreation value of wildlife viewing. *Ecological Economics*, No. 11: 135-151.
30. Orians G.H. (1991). *The Preservation and Valuation of Biological Resources*. Washington, Washington University Press.
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32. Peskin H.M. and Peskin J. (1978). The valuation of non-market activities in income accounting. *Review of Income and Wealth* 24:71 91.
33. Randall A. (1991). *Total and nonuse values*, in J.B. Braden and C.D. Kolstad, eds, *Measuring the Demand for Environmental Quality*. Amsterdam, North Holland: 303-322.
34. Schultze W.D., d'Arge R.C. and Brookshire D.S. (1981). Valuing environmental commodities; some recent experiments. *Land Economics* 57: 151-172.



LECTURE 6: ENVIRONMENTAL ACCOUNTING

(12 Hours)

6.1 Environmental Accounting: Theory

6.1.1 Resource use in a competitive world

6.1.2 Consumption, income and wealth

6.1.3 Measuring national income

6.2 Environmental Accounting: Practices

6.2.1 Information on the environment: Elaboration of environmental information systems; Accounting frameworks: the satellite accounts and the modified national income accounts

6.2.2 The environment in the system of national accounts: Non-renewable resources; renewable resources; environmental capital

6.3 Applications of Green National Accounts in Africa

Required readings:

Hassan, Rashid M. (2002) Accounting for Stock and Flow Values of Woody Land Resources: Methods and Results from South Africa. Centre for Environmental Economics and Policy in Africa, University of Pretoria.

Lange, G-M (2003) "The Value of Namibia's Commercial Fisheries" DEA Research Discussion Paper.

Lange, Glenn-Marie, Hassan Rashid and Kirk Hamilton (2003) Environmental Accounting in Action: Case Studies from Southern Africa. Edward Elgar.

Mäler, K.-G (1991), "National Accounts and Environmental Resources" *Environmental and Resource Economics*, 1:1-15.

Perman, R., Ma Y., McGilvray J. and Common M. (2012). Natural Resource and Environmental Economics, 4th Edition, Edinburgh, Longman.

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Solow, R. (1992). An almost practical step towards sustainability, *Resources for the Future*, Washington DC.

Turner R.K. (1993). Sustainable Environmental Economics and Management: principles and practice. London, Belhaven Press.



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UN and FAO (2004) "Handbook of National Accounting: Integrated Environmental and Economic Accounting for Fisheries". A Final Draft.

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2. Asheim, G. 1997. Adjusting Green NNP to Measure Sustainability: *Scandinavian, journal of Economics*, 99(3), 355-370.
3. Blignaut, J. and R. Hassan (2000). *A natural resource accounting analysis of the contribution of mineral resources to sustainable development in South Africa*, (Draft) University of Pretoria
4. Blignaut, J.; Hassan, R. and G. M. Lange. (2000). *Natural resource accounts for minerals: A southern Africa country comparison*, EDE 2nd International Conference, Stockholm
5. Daly H. (1989). *Towards a measure of sustainable social net product*. In Ahmad, Y.J., S. El Serafy and E. Lutz (eds). *Environmental accounting for sustainable development*. The World Bank, Washington, D.C.
6. Daly H. and Goodland R. (1994). An ecological-economic assessment of deregulation of international commerce under GATT. *Ecological Economics* 9: 73-92.
7. El Serafy S. (1989). *The proper calculation of income from depletable natural resources*. In Ahmad, El Serafy, Y.J., S. and E. Lutz (eds). *Environmental accounting for sustainable development*. Washington, D.C., World Bank.
8. Environment and Development Economics (EDE) Journal (2000). The Special Issue on Environmental Accounting. EDE.
9. Friend A. M. and Rapport D. J. (1991). Evolution of Macro-Information Systems for Sustainable Development. *Ecological Economics* 3: 59-76.
10. Hamilton, K. (1994). Green adjustments to GDP. *Resources Policy* 20(3): 155 - 168.
11. Hamilton, K. and E. Lutz. (1996). Green national accounts: Policy uses and empirical experience. *Environmental Economics* Series Paper No. 039. The World Bank, Washington D. C.
12. Hamilton, K. and M. Clemens, (1998), Genuine Savings Rates in Developing Countries, *World Bank Economic Review*.
13. Harrison A. (1989). *A possible conceptual approach to introducing natural capital into the SNA*. In
14. Hartwick J. (1992). Deforestation and national accounting, *Environmental and Resource Economics* 2: 513-521.



15. Hartwick J.M. (1990). Natural resources, national accounting and economic depreciation. *Journal of Public Economics* 43: 291-304.
16. Hartwick, J. 1994. National Wealth and Net National Product. *Scandinavian Journal of Economics*, 96(2), 253-56.
17. Hassan, R. (2000). *Improved measure of the contribution of cultivated forests to national income and wealth in SA*. EDE Special Issue on Environmental Accounting.
18. Lange and Hassan. (1999). *Natural Resource Accounting as a tool for sustainable macroeconomic policy: Applications in Southern Africa*. NETCAP Policy Brief, IUCN-ROSA, Harare, Zimbabwe.
19. Lange, G. and D. Motinga. (1997). *The contribution of resource rents to sustainable economic development in Namibia*, Research Discussion Paper No. 19, DEA, Windhoek
20. Lange, G.M. (1997). *An approach to sustainable water management using natural resource accounts: The use of water, the economic value of water and implications for policy*. Research Discussion Paper No. 18, Directorate of Environmental Affairs, Windhoek, Namibia.
21. Lutz E. (ed.). *Toward improved accounting for the environment*. An UNSATA-World Bank Symposium. The World Bank, Washington D. C.
22. Lutz E. and El Sarafy S. (1989). *Environmental and resource accounting: an overview*. Environment Department Working Paper No. 6. Washington D.C., The World Bank.
23. Mabugu, R.; Milne, G. and B. Cambell. (1998). *Incorporating fuelwood production and consumption into the national accounts of Zimbabwe*, Draft
24. Mabugu, R.; Milne, G. and B. Cambell. (1998). *Incorporating fuelwood production and consumption into the national accounts of Zimbabwe*, Draft
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26. NRA Programme. (1999). *The contribution of minerals to sustainable development in Botswana*, Botswana NRA Programme, Gaborone
27. Perrings C., Gilbert A.J. Pearce D.W. and Harrison A. (1989). *Natural resource accounts for Botswana: environmental accounting for a natural resource-based economy*. LEEC Paper 89-11. London, IIED.
28. Peskin H. M. and Lutz E. (1990). *A Survey of Resource and Environmental Accounting in Industrialized Countries*. Environmental Working Paper 37. Washington D.C., World Bank.
29. Peskin H.M. (1981). National income accounts and the environment. *Natural Resources Journal* 21:511-537.
30. Repetto R. (1988). *Resources and economic accounts*. Paris, OECD Environment Committee, Group on the State of the Environment.
31. Resource Accounting Network for Eastern and Southern Africa (RANESA) Web Site at: WWW.RANESA.CO.ZA



32. Theys J. (1984). *Environmental accounting and its use in development policy: proposals based on the French experience*. Nairobi, United Nations Environment Programme.
33. Theys J. (1989). *Environmental accounting and its use in development policy*. In Ahmad, Y.J., S. El
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35. United Nations Environment Programme (1991). *The World Environmental Data Report*, 3rd ed. Prepared for UNEP by the GEM Monitoring and Assessment Research centre, London UK in co-operation with the World Resources Institute, Washington DC, and the UK Department of the Environment. London Basil Blackwell, Oxford.

LECTURE 7: INTERNATIONAL ENVIRONMENTAL MANAGEMENT (15 Hours)

- 7.1 International Environmental Externalities**
- 7.2 Economics of Climate Change**
- 7.3 World trade and the environment**
- 7,4 International Environmental Conventions**
- 7,5 Applications to Africa**

Required readings:

Perman, R., Ma Y., McGilvray J. and Common M. (2012). *Natural Resource and Environmental Economics*, 4th Edition, Edinburgh, Longman.

Jonathan M. Harris and Brian Roach (2017), **Environmental and Natural Resource Economics** 4th Edition, Routledge.

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Dasgupta, P. K.-G Maler and A. Vercelli (2000) *The Economics of Transnational Commons*, Clarendon Press: Oxford.

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World Bank (2010) *World Development Report*, Washington, DC.



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1. Barbier E., Burgess J., Swanson T. and Pearce D. ((1990). *Elephants, Economics and Ivory*. London, Earthscan.
2. Barbier E.B. and Rauscher M. (1994). Trade, Tropical Deforestation and Policy Interventions. *Environmental and Resource Economics* 3: 35-50.
3. Barbier E.B., Bockstael N., Burgess (1993). *The Timber Trade and Tropical Deforestation in Indonesia*. J.C. and Strand I. LEEC Discussion Paper DP 93-101. London, IIED.
4. Barbier E.B., Burgess J.C. and Markandya A (1991). The Economics of Tropical Deforestation. *Ambio* 20: 55-58.
5. Barbier E.B., Burgess J.C., Aylward B.A., Bishop J.T. and Bann C. (1993). *The Economic Linkages between the Trade in Tropical Timber and the Sustainable Management of Tropical Forests*. Final Report, ITTO Activity PCM (XI)/4. International Tropical Timber Organization, Yokohoma
6. Barrett S. (1990) The Problem of Global Environmental Protection, *Oxford Review of Economic Policy* 6: 68-79.
7. Barrett S. (1994). *The Biodiversity Supergame*. *Environmental and Resource Economics*, forthcoming.
8. Blaikie, P. and Brookfield, H. eds (1987). *The degradation of common property resources*. Chapter 101 Land Degradation and Society, Methuen, New York. (RP).
9. Broome J. (1992). *Counting the cost of global warming*. London, White Horse Press.
10. Burgess J.C. (1992). *The Impact of Wildlife Trade on Endangered Species*. LEEC Discussion Paper, 92 -102. London, IIED.
11. Clark C.W. (1980). *Restricted Access to Common Property Fishery Resources: a Game-Theoretic Analysis*, in P.T. Liu, ed, *Dynamic Optimization and Mathematical Economics*. New York, Plenum: 117-132.
12. Farrell J. and Maskin E. (1989). Renegotiation in Repeated Games, *Games and Economic Behavior* 1: 327-360.
13. Githinji M. and Perrings C. (1993). Social and Economic Sustainability in the Use of Biotic Resources in Sub-Saharan Africa. *Ambio* 27: 110-116.
14. Hardin G. (1968). The Tragedy of the Commons. *Science*, 162: 1243-1248.
15. Hassan (1997). Trade liberalization and the environment: The case of agriculture in South Africa. *Agrekon*, Vol 36, No 4 (December 1997):407-429.
16. Hassan, R. (1997). Trade liberalization and the environment: the case of Agriculture in South Africa, *Agrekon*, Vol 36, No. 4: 407-429
17. Mäler K.G. (1990) International environmental problems, *Oxford Review of Economic Policy* 6: 80-108.
18. Ostrom E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, Cambridge University Press.



19. Segerson K. and Miceli T.J. (1998) Voluntary Environmental Agreements: good news or bad news for environmental protection, *Journal of Environmental Economics and Management* 36(2): 109-130.
20. Steininger K. (1994). Reconciling trade and the environment: Towards a comparative advantage for long term policy goals. *Ecological Economics* 9: 23-42.
21. Sterner, T., Barbier, E.B., Bateman, I., van den Bijgaart, I., Crépin, A.S., Edenhofer, O., Fischer, C., Habla, W., Hassler, J., Johansson-Stenman, O., Lange, A., Polasky S., Rockström, J., Smith, H.G., Steffen, W., Wagner G., Wilen. J.E., Alpízar, F., Azar C., Carless, D., Chávez, C., Coria, J., Engström, G., Jagers, S.C., Köhlin, G., Löfgren, Å., Pleijel, H. and Robinson, A. (2019). Policy design for the Anthropocene, *Nature Sustainability* 2(1), 14-21 Jan 10th. DOI: [10.1038/s41893-018-0194-x](https://doi.org/10.1038/s41893-018-0194-x).
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23. United Nations Conference on Environment and Development (1993). *Agenda 21: Rio Declaration and Forest Principles*. New York, United Nations.
24. Wade R. (1987). *The Management of Common Property Resources: Finding a Cooperative Solution*. World Bank Research Observer 2: 219-235.
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26. Young M.D. (1994). Ecologically-accelerated trade liberalization: a set of disciplines for environment and trade agreements. *Ecological Economics* 9: 43-52.