The ecological economics of sustainability revisited

environmental change, poverty and development

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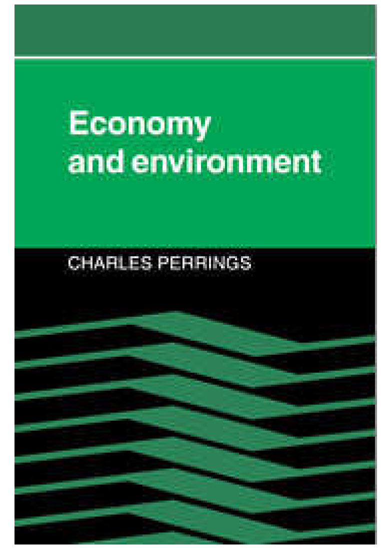
APPLYING ECOLOGICAL ECONOMICS FOR SOCIAL AND ENVIRONMENTAL SUSTAINABILITY

Questions about sustainability

- What defines an ecological economics of sustainability?
- What does it say about wealth and the value of natural capital?
- What does it say about poverty and the distribution of income and assets?



Perrings C. 1987. *Economy and Environment*, Cambridge, Cambridge University Press.

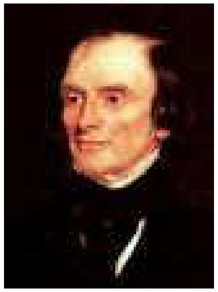
Perrings C. (ed) 2008. *Ecological Economics*, London, SAGE.

The origins of ecological economics

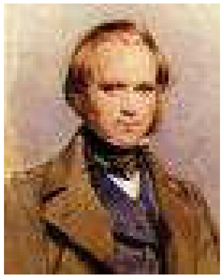
- Thomas Malthus and Charles Darwin provided fundamental insights into the co-evolution of coupled systems that, following Norgaard (1984) are at the core of ecological economics.

- Adam Smith and John Stuart Mill provided the fundamental insights into the value of nature and natural resources that underpin both the economics of the environment and conservation biology.

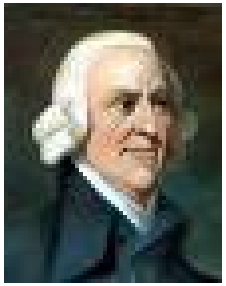
- Daly's (1973) arguments for the steady state economy appeal to John Stuart Mill's arguments for restraint on economic growth as key to preserving the natural environment.



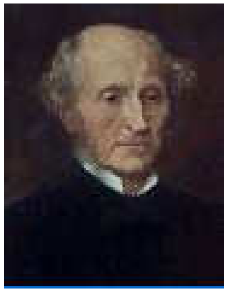
Thomas Malthus



Charles Darwin



Adam Smith

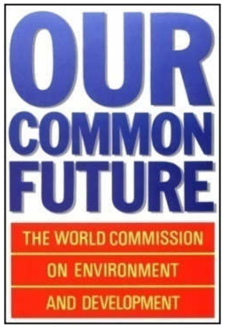


John Stuart Mill

Daly H. 1973. *Toward a Steady State Economy*, San Francisco, W.H. Freeman.

Norgaard R. 1984. Coevolutionary Development Potential, *Land Economics* 60(2): 160-173.

Scientific foundations of the Brundtland definition of sustainable development



- ‘Development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ (WCED, 1987)
  - Hotelling (1931) - the condition for the conservation of stocks of natural capital
  - Hartwick (1977) - the condition for maintaining the flow of services from the aggregate stock of assets when environmental assets are depleted or degraded
  - Holling (1973) - the condition for living systems to maintain functionality

World Commission on Environment and Development. 1987. *Our Common Future*. Oxford, Oxford University Press.

Hotelling H. 1931 The Economics of Exhaustible Resources, *Journal of Political Economy* 39(2): 137-175.

Holling C.S. 1973. Resilience and Stability of Ecological Systems, *Annual Review of Ecology and Systematics* 4: 1–24.

Hartwick J.M. 1977. Intergenerational Equity and the Investing of Rents from Exhaustible Resources, *American Economic Review* 67(5): 972-974.

Sustainability, non-declining wealth and poverty

- Sustainability requires that per capita wealth is non-declining and that critical elements of natural capital (for which there are no substitutes) are protected (Dasgupta, 2001)

- The connection between sustainability and poverty then depends on the relationship between poverty and accumulation/decumulation of assets.

- Brundtland (WCED) argued that poverty prevents both the protection of critical natural capital and the accumulation of assets:
  - ‘a world in which poverty and inequity are endemic will always be prone to ecological … crises’

Dasgupta P. 2001. *Human Well-Being and the Natural Environment*, Oxford, Oxford University Press.

Overconsumption, wealth and poverty

- Any consumption level that leads to declining assets is unsustainable. But overconsumption is usually seen as a problem of the rich, not the poor.

- Arrow et al (2004), asking when consumption is 'excessive', note:
  - sustainability does not imply a unique consumption path
  - non-declining consumption is not sufficient to avert non-declining utility
  - a sustainable consumption path is not necessarily an efficient consumption path.

- Factors that lead to excessive consumption under *either* a sustainability *or* a present value maximization criterion include the underpricing of natural resources and the institutional conditions that allow that to occur.

- Low levels of consumption may still be unsustainable.

Arrow K., P. Dasgupta, L. Goulder; G. Daily; P. Ehrlich; G. Heal; S. Levin; K.-G. Mäler; S. Schneider; D. Starrett; B. Walker. 2004. Are we consuming too much? *Journal of Economic Perspectives* 18(3): 147-172

Sustainability and ‘bequest’ assets

- van den Bergh and Nijkamp (1991) suggested an approach to implementing sustainability that has influenced many ecological economists: that each finite-horizon policy problem be posed in ways that include a constraint on the terminal value of stocks.
- Howarth (2007) argues that sustainability can be satisfied by providing future generations with a ‘structured bequest package’ of assets (after Norton and Toman, 1997).
- This includes (but is not restricted to) common pool environmental resources to which all members of both current and future generations have access rights.

van den Bergh J. C.J.M. and P. Nijkamp 1991. Operationalizing sustainable development: dynamic ecological economic models, *Ecological Economics* 4: 11-33.

Howarth R. 2007. Towards an operational sustainability criterion, *Ecological Economics* 63: 656-663.

Norton B.G., and M.A. Toman 1997. Sustainability: ecological and economic perspectives. *Land Economics* 73: 553–568.

Separating sustainability and efficiency

- Sustainability is addressed through the 'moral rules' that society sets for itself: the constraints it places on social decision-making.

- This makes it possible to separate the pursuit of efficiency from the pursuit of sustainability. For any given set of 'moral rules' it is possible to identify the set of efficient allocations that satisfy those rules.

- Pezzey (2004) distinguishes environmental and sustainability policy.
  - Environmental policies internalize the environmental externalities.
  - Sustainability policies achieve a sustainability goal: i.e. 'any departure from maximizing social welfare based on current agents' individual time preferences, i.e., aimed at improving intergenerational equity'.

Pezzey J.C.V. 2004. Sustainability Policy and Environmental Policy, *Scandinavian Journal of Economics* 106(2), 339–359.

Uncertainty and bequest assets

- In an uncertain environment, sustainability requires not constant assets, but the capacity to deliver benefits of equivalent value over the expected range of environmental conditions.
- A necessary condition for sustainability in these circumstances is that current economic activities should not result in the loss of system resilience (Perrings and Common, 1992)
- In an evolving system, this requires a continuous process of adaptation to changes in environmental conditions, and ‘a diversity of co-existing alternatives’ (Rammel and van den Bergh, 2003)

Common M. and C. Perrings 1992. Towards an ecological economics of sustainability, *Ecological Economics* 6: 7-34.
Rammel C. and J. van den Bergh 2003. Evolutionary policies for sustainable development: adaptive flexibility and risk minimising, *Ecological Economics* 47: 121– 133.

Nitrogen and natural capital

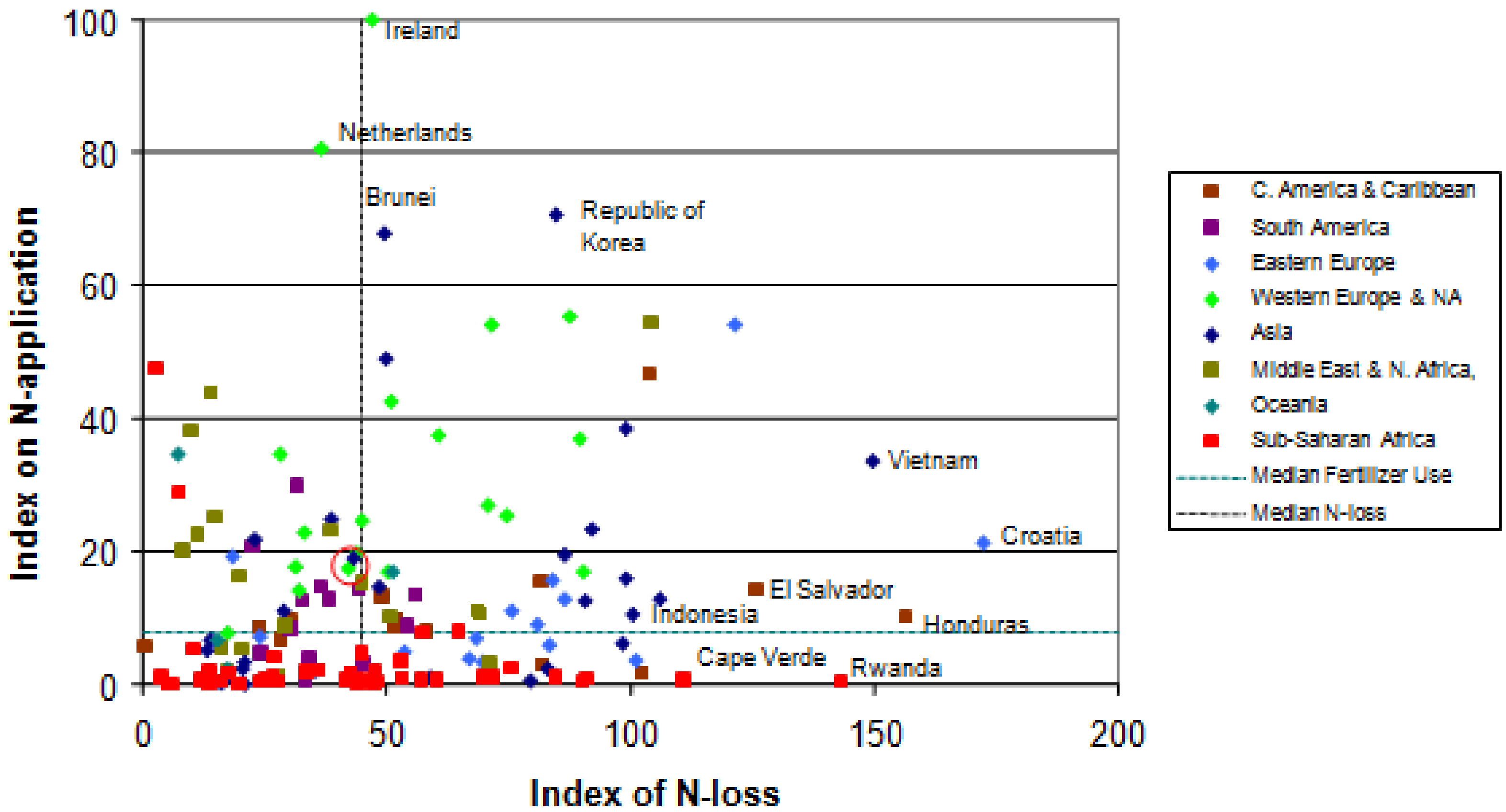
- Nitrogen is essential for all life. The N-cycle is arguably the most important of the biogeochemical cycles.
- Modification of the N-cycle is the basis for the productivity growth that underpins all human development, but we have no good measures of its contribution to the overall wealth and well-being.
- Since invention of the Haber-Bosch process that converts atmospheric dinitrogen to ammonium humans have fundamentally transformed the N-cycle (Kinzig & Socolow 1994).
- This has substantially enhanced the value of productive landscapes, and so the value of natural capital.

Kinzig, A.P. and R.H. Socolow. 1004. Human impacts on the nitrogen cycle. *Physics Today* Nov 94:24-31.

Dimensions of the N-problem

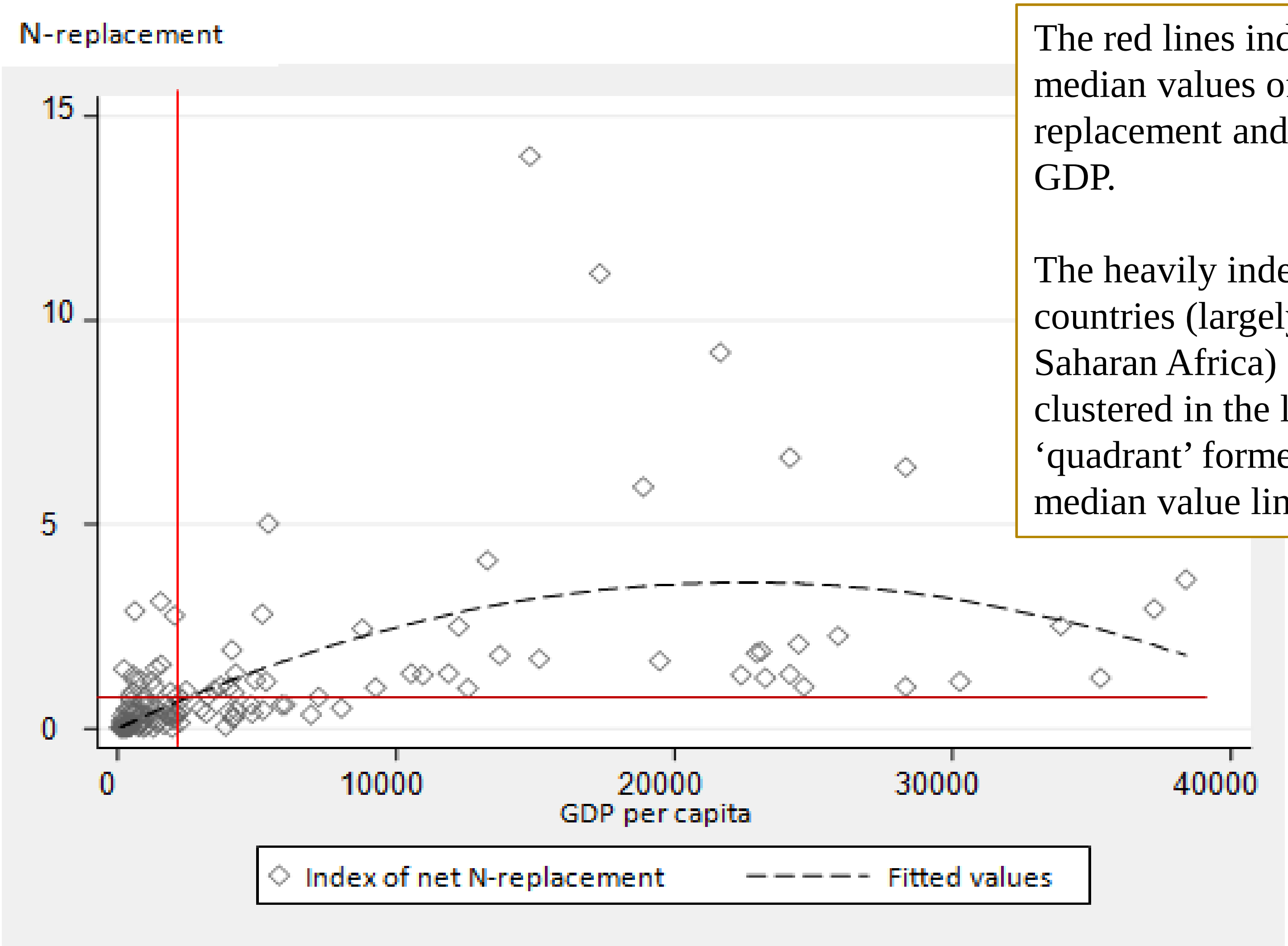
Major Problems	Form of N involved	Activities implicated	Scale of Impact
Coastal eutrophication	Nitrate	Agriculture, fossil fuel combustion, waste discharge	Regional (but of global concern due to loss of coastal biodiversity)
Global climate change	Nitrous Oxide	Agriculture	Global
Terrestrial deposition	NOx, NO3, NH3	Fossil fuel combustion, agriculture	Regional (but of global concern due to forest depletion)
Groundwater contamination	Nitrate	Agriculture	Local to Regional
Air pollution	NOx	Fossil fuel combustion	Local to Regional
Nutrient depletion	NO3, NH4, organic N	Land use & land cover change, agriculture	Local to Regional (but of global concern due to famine and food insecurity)

F1: Index of N-application relative to N-loss



Perrings C. and A.P. Kinzig 2008. Sustainable development in an N-rich, N-poor world, ecoSERVICES working paper.

F2: Net N-replacement and GDP per capita

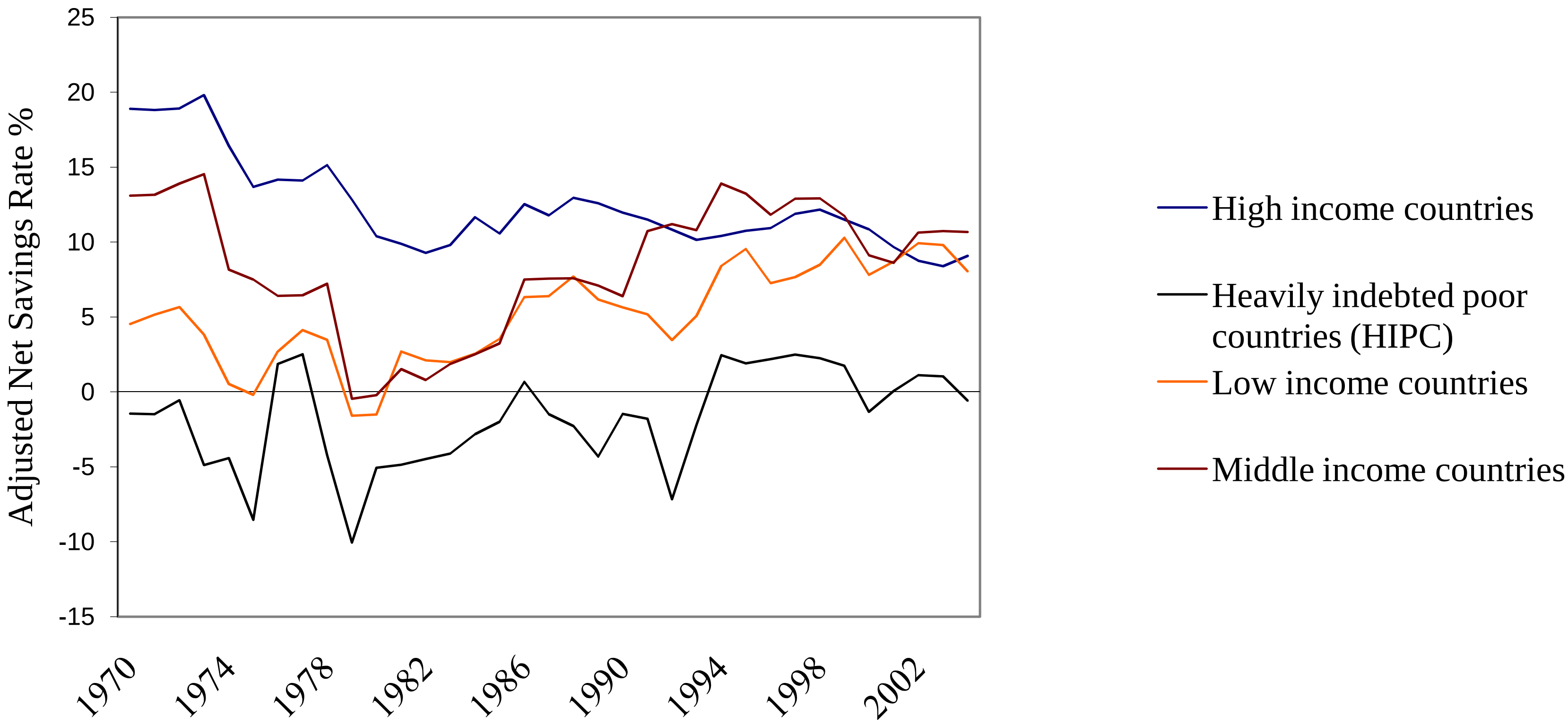


The red lines indicate median values of net N-replacement and per capita GDP.

The heavily indebted poor countries (largely in Sub-Saharan Africa) are clustered in the lower left 'quadrant' formed by the median value lines.

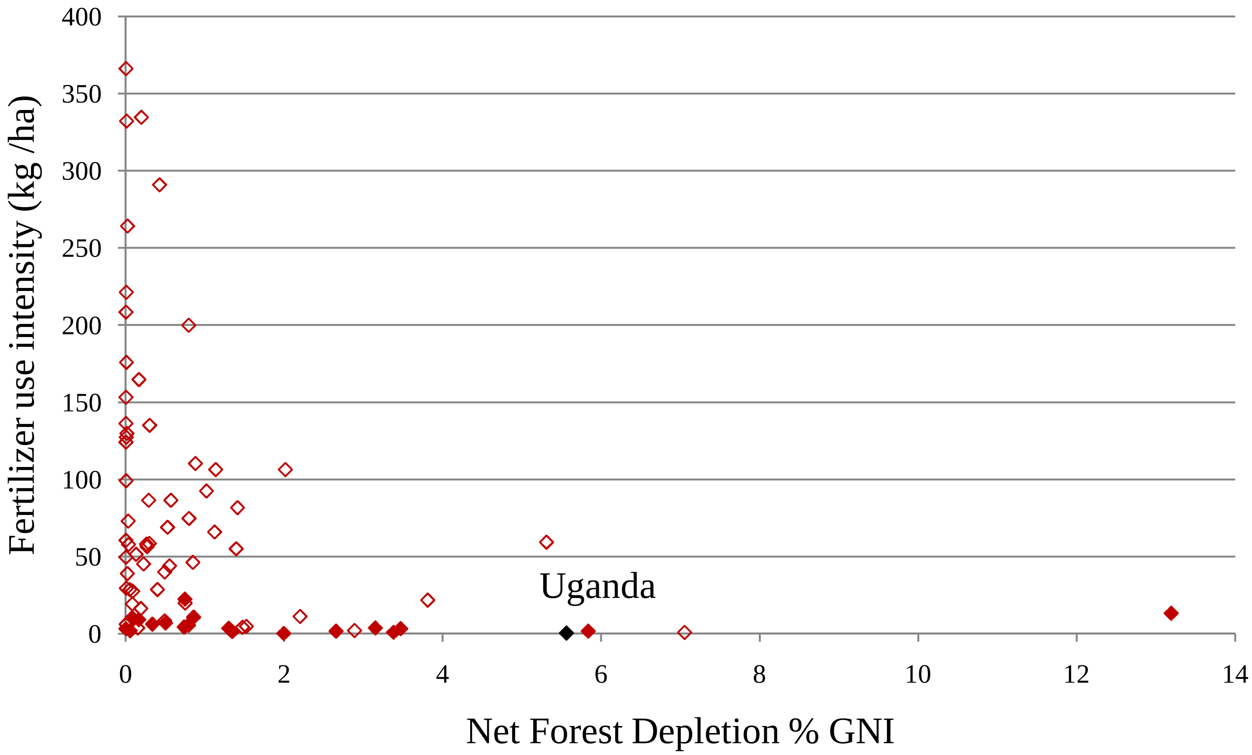
Perrings C. and A.P. Kinzig 2008. Sustainable development in an N-rich, N-poor world, ecoSERVICES working paper.

F3: Adjusted Net Savings in high, middle and low income countries and in 'heavily indebted poor countries', 1970-2003



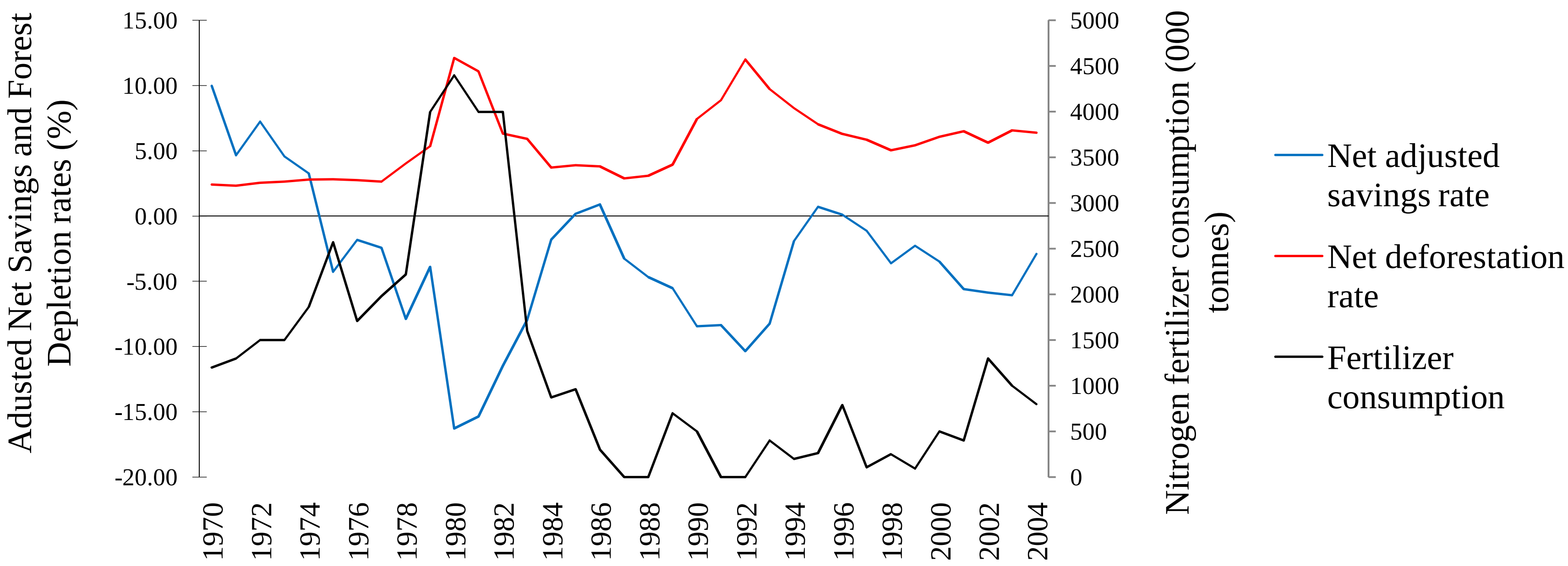
Perrings C. and A.P. Kinzig 2008. Sustainable development in an N-rich, N-poor world, ecoSERVICES working paper.
http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTDATASTA/0,,contentMDK:20502388~isCURL:Y~menuPK:2935543~pagePK:64168445~piPK:64168309~theSitePK:2875751,00.html

F4: Fertilizer use intensity and net forest depletion % GNI in HIPC and non-HIPC countries



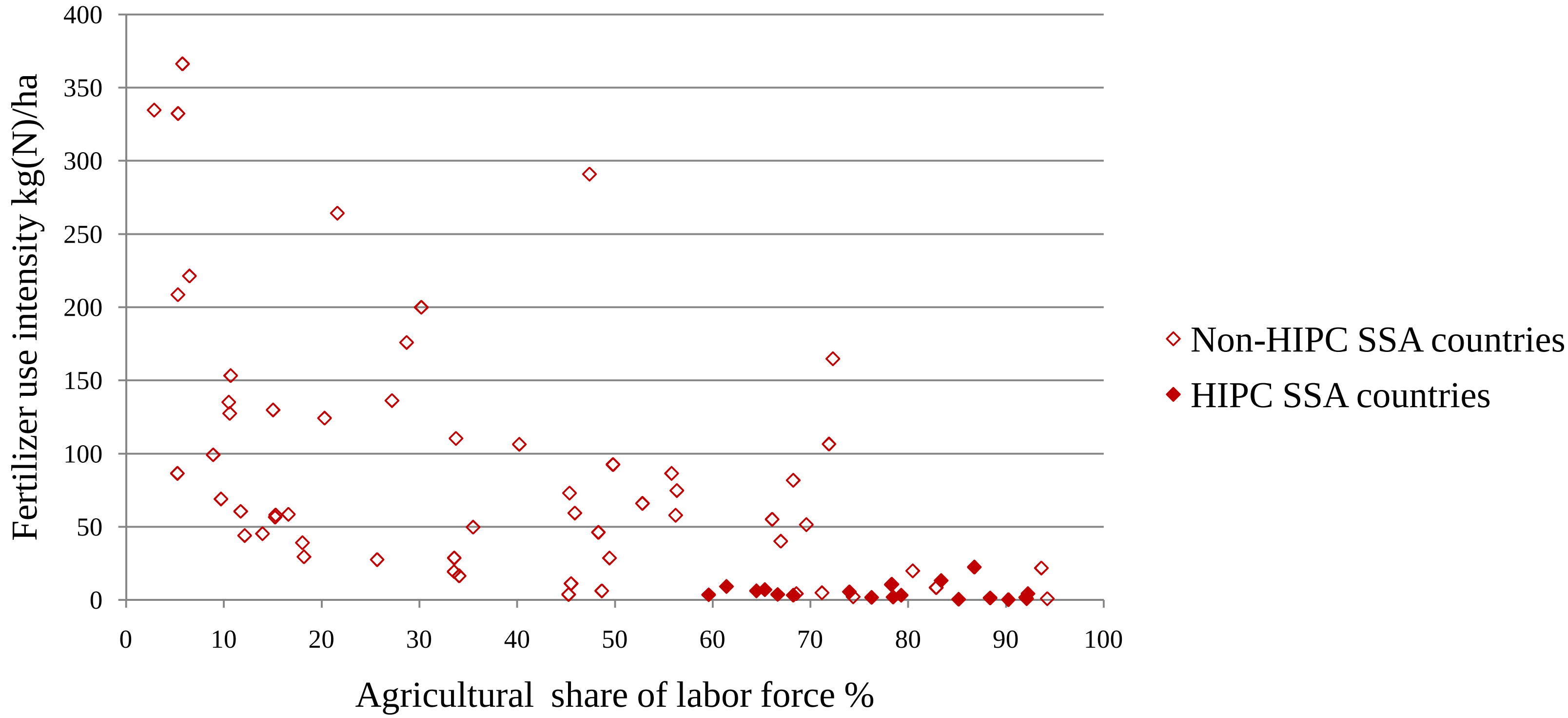
Perrings C. and A.P. Kinzig 2008. Sustainable development in an N-rich, N-poor world, ecoSERVICES working paper. Data on fertilizer use intensity from World Resources Institute, http://earthtrends.wri.org/searchable_db . Data on Net Forest Depletion % GNI from World Bank at http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTDATASTA/0,,contentMDK:20502388~isCURL:Y~menuPK:2935543~pagePK:64168445~piPK:64168309~theSitePK:2875751,00.html

F5: Uganda: Adjusted Net Savings, Net deforestation and Fertilizer Consumption



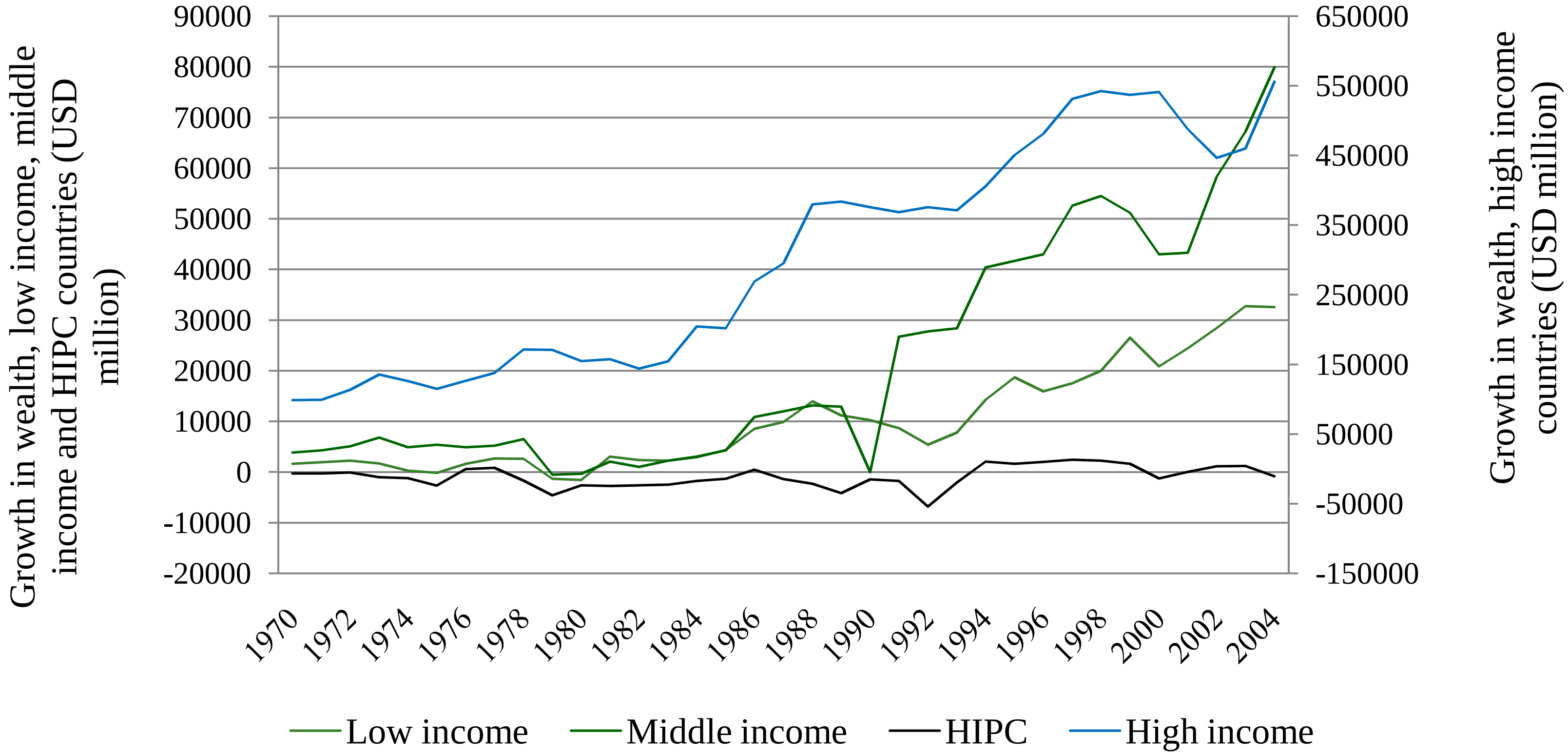
Perrings C. and A.P. Kinzig 2008. Sustainable development in an N-rich, N-poor world, ecoSERVICES working paper. Data on fertilizer use intensity from World Resources Institute, http://earthtrends.wri.org/searchable_db . Data on Net Forest Depletion % GNI from World Bank at http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTDATASTA/0,,contentMDK:20502388~isCURL:Y~menuPK:2935543~pagePK:64168445~piPK:64168309~theSitePK:2875751,00.html

F6: Fertilizer use intensity and the share of the labor force in agriculture in HIPC and non-HIPC countries



Perrings C. and A.P. Kinzig 2008. Sustainable development in an N-rich, N-poor world, ecoSERVICES working paper.
Data taken from World Resources Institute, http://earthtrends.wri.org/searchable_db

F7: Changes in national wealth by income group, 1970-2004



Perrings C. and A.P. Kinzig 2008. Sustainable development in an N-rich, N-poor world, ecoSERVICES working paper. Calculated from data at World Bank 2007 World Development Indicators Online, Washington D.C., World Bank. http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTDATASTA/0,,contentMDK:20502388~isCURL:Y~menuPK:2935543~pagePK:64168445~piPK:64168309~theSitePK:2875751,00.html

The drivers of underinvestment in nutrient stocks in sub-Saharan Africa

- Low levels of income reduce the scope for countervailing investment in substitute capital. But income levels are not the only factor behind rural investment decisions.

- The open access or weakly regulated access regimes that characterize many environmental resources in Sub-Saharan Africa have two important consequences.
  - People have an incentive to overuse the resource.
  - Insecurity of tenure is itself a disincentive to invest in the asset.

- Population pressure leads to shortening fallow periods: Drechsel et al (2001) find a significant relationship between soil nutrient depletion, reduced fallow periods, and population pressure in 36 SSA countries.

Drechsel P, L. Gyiele, D. Kunze, O. Cofie 2001. Population density, soil nutrient depletion, and economic growth in sub-Saharan Africa, *Ecological Economics* 38: 251–258.

Underinvestment in nutrient stocks and loss of resilience

- The net result of N-depletion has been a reduction in system resilience – and hence sustainability *sensu* Holling (1973).

- Important provisioning services – the production of foods, fuels, fibers, and water resources – have become increasingly sensitive to fluctuations in environmental conditions. That is, many production systems have become more 'vulnerable' to both stresses and shocks (Brooks et al, 2005).

Brooks, N. W. N. Adger, P. M. Kelly 2007. The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation, *Global Environmental Change Part A*, 15(2): 151-163.

The anatomy of unsustainability in the N-depletion problem

- The nitrogen problem illustrates four dimensions of unsustainability:
  - declining asset values that follow from the ecological consequences of uncompensated nutrient mining
  - disincentives to invest in substitute forms of capital provided by near open access, and insecure common pool tenure regimes
  - loss of wealth that affects those least able to accommodate it (the rural poor)
  - loss of system resilience, measured by increased sensitivity of output and incomes to variability in environmental conditions.

- ‘ More resilient social-ecological systems are able to absorb larger shocks without changing in fundamental ways… In general, resilience derives from things that can be restored only slowly, such as reservoirs of soil nutrients, heterogeneity of ecosystems on a landscape, or variety of genotypes and species’ (Folke et al, 2002)

Folke C. et al. 2002. *Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations*, Scientific Background Paper on Resilience for the process of WSSD on behalf of The Environmental Advisory Council to the Swedish Government, Stockholm, Environmental Advisory Council.

Ecological economics and the science of sustainability

- It is hard to distinguish between the ecological economics of sustainability and the emerging sustainability science (characterized by Kates et al (2001) as the science of 'the interactions between nature and society… the interaction of global processes with the ecological and social characteristics of particular places and sectors'.

- As Arrow et al (1995) pointed out, we are trying to understand what makes a rapidly evolving system the source of a sustainable stream of benefits. The best measure of sustainability in this case is the resilience of the coupled system – its capacity to function over the expected range of environmental conditions.

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. Grübler, B. Huntley, J. Jäger, N. S. Jodha, R. E. Kasperson, A. Mabogunje, P. Matson, H. Mooney, B. Moore III, T. O'Riordan and U. Svedin 2001. Sustainability Science, *Science* 292: 641-642.
Arrow K.J., B. Bolin, R. Costanza, P. Dasgupta, C. Folke, C. S. Holling; B.-O. Jansson, S.Levin, K.-G. Mäler, C. Perrings and D. Pimentel 1995. Economic Growth, Carrying Capacity, and the Environment, *Science* 268: 520-521.

A role for ecological economics

- The protection of the opportunities open to future generations depends on each generation passing on to the next a portfolio of assets (produced and natural capital) that allow them to adapt to changing conditions.

- In an uncertain, evolving system the value of the portfolio lies in its capacity to accommodate environmental change. While we can mitigate risks that are endogenous to the system, we can only adapt to risks that are exogenous (given the spatial and temporal scale at which it is defined).

- A major role of ecological economics in the science of sustainability is to identify the consequences of different portfolios choices (to evaluate the trade-offs involved in different social and ecological configurations), and to identify mechanisms and policies that will avoid unsustainable configurations.

Thank you

We need make no apology
For thinking about world ecology
For mere economics
Is stuff for the comics
Unless we can live with biology

How can we achieve the facility
To encourage some sustainability
When all that it means
When it comes to our genes
Is to overexpand our virility

Kenneth Boulding, 1990