Towards a new green revolution:

Nature pays, but who pays for nature?

Prof. dr. ir. Erwin H. Bulte

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Introduction

Back in the 19th century, Thomas Carlyle was the first to refer to economics as the "Dismal Science". He found economics "dismal" for a number of reasons, and he particularly disliked the gloomy population theory of Thomas Malthus. Many years later the merits of Malthus' theories are still subject of debate, but the idea that economists are somehow more prone to 'dismay' than representatives from other sciences must be wrong. I regularly participate in interdisciplinary events and find that economists tend to be amongst the more optimistic and, indeed, cheerful of the congregation.

Why are we such an optimistic bunch? The main reason, I believe, is that we have tools and models to predict how humans will respond to changing circumstances. We don't extrapolate current trends and throw our arms up in despair when confronted with evidence that things are going badly. Instead, we build models to try to understand how societies will adapt to new realities – through new policies, new technologies, or new institutions – and base our worldview on this response. Today I would like to talk about the emerging social response to one of the major challenges that we now face. A response that I will refer to as a new *green revolution*.

Before considering tomorrow's revolution it is a good idea to first step back and consider a quote from one of the Founding Fathers of modern economics, David Ricardo. His words, written almost 200 years ago, are an important prelude to what I will be discussing later.

> "*The labour of Nature is paid, not because she does much but because she does little. In proportion, as she becomes niggardly in her gifts, she exacts a greater price for her work. Where she is magnificently beneficent, she always works gratis*." (Ricardo, 1817)

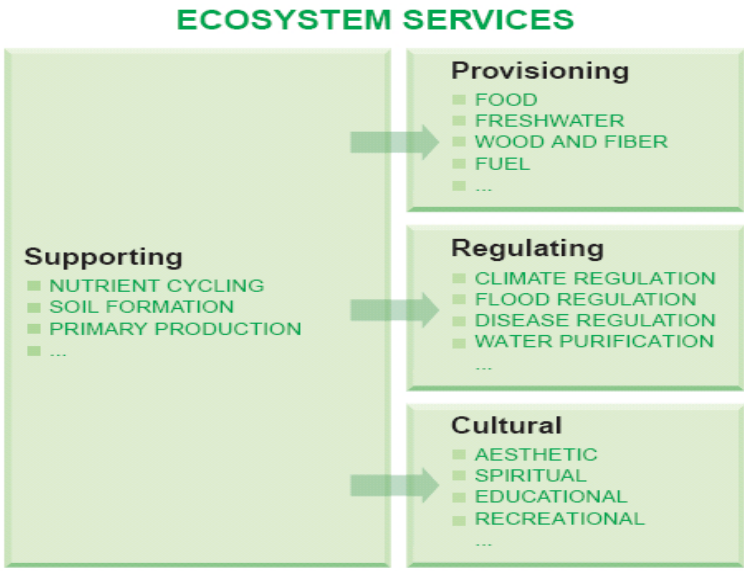
While the language is perhaps slightly outdated, the message is clear enough. When there is a lot of nature – or in economics speak: when nature is not scarce – the value of a particular "unit" of nature will be modest or even negligible. When there is an abundant supply of fresh and high quality water in rivers and lakes, why pay money for water in a Belgian or French bottle? Or why care much if one particular lake becomes a little polluted? Nature's abundance has been the relevant state of affairs for most of human history: we have been surrounded and overwhelmed by nature – we tried to fight and resist and subdue it, not cherish it. Under such circumstances, having access to another unit of nature is virtually without value, and certainly no rational man would incur great costs or suffer inconveniences to protect it. But it is becoming clear that this situation is changing.

I will be talking about the nature of this change, focusing on developments in tropical regions (but most of what I will be talking about is equally true for countries in temperate zones). In the past, tropical countries have seen two waves of conservation efforts: the traditional 'command-and-control' approach that emphasizes protected areas (bordered by fences or otherwise), which was followed by an indirect approach called 'integrated conservation and development projects' (ICDP). ICDPs try to reconcile community development and conservation by promoting sustainable resource use or promotion of alternative sources of livelihood (which explains why ICDPs is occasionally referred to as 'conservation by distraction'). Both approaches have yielded some positive effects, but it is becoming increasingly clear that a third wave is needed to make further progress on the conservation and development front (Ferraro and Kiss 2002).

Although I am comfortable talking about economics and nature conservation, I usually find myself in an awkward position when doing so. Some of my economic colleagues view my work as suspiciously 'applied,' whereas others (mainly non-economists) regard it as hopelessly theoretical and even esoteric. I am afraid there is not much I can do about that – I will likely spend my career balancing the suspicious and the hopeless. Both groups of 'critics' will find some ammunition in this talk – it is a lofty economic theory approach to getting dirty hands.

The millennium assessment

Earlier this year the so-called millennium assessment (MA in short) reminded us of the many effects of humans on the planet. The MA was an enormous effort of more than 1300 scientists from 95 different countries to document the state of the planet's ecosystems and species. The MA distinguishes between four inter-related categories of ecosystem services – flows of benefits from natural systems for human societies. They hang together as follows:



What has happened to ecosystems and the flow of services they generate, and what may we expect for the future? In the report's own words:

- *"Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber and fuel;*
- *The changes that have been made to ecosystems have contributed to substantial net gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of the degradation of many ecosystem services, increased risks of nonlinear changes, and the exacerbation of poverty for some groups of people;*
- *The degradation of ecosystem services could grow significantly worse during the first half of this century and is a barrier to achieving the Millennium Development Goals*
- *The challenge of reversing the degradation of ecosystems while meeting increasing demands for their services can be partially met under some scenarios that the MA has considered but these involve significant changes in policies, institutions and practices, that are not currently under way."*

In short, this is not a pretty story. While the editors have tried to paint a balanced picture – avoiding a doom and gloom story that would turn off most of the audience – the message that emerges from the pages of the report is clear enough. Natural systems are degrading at a rapid pace, and reduced flows of ecosystem services (especially regulatory and cultural services) will quite likely an adverse effect on welfare of future generations.

Nature pays!

Let us now consider the MA evidence in an economic framework. The World Bank has compiled the following data, documenting how income and net capital stocks – assets – have developed in various parts of the world over the past 30 years.

Country	Growth rate Wealth per capita (1970-2000)	Growth rate GDP per capita (1970-2000)
Bangladesh	-0.6	1.9
India	-0.4	3.0
Nepal	-0.4	1.9
Pakistan	-0.6	2.2
China	4.6	7.8
Africa	-2.7	-0.01

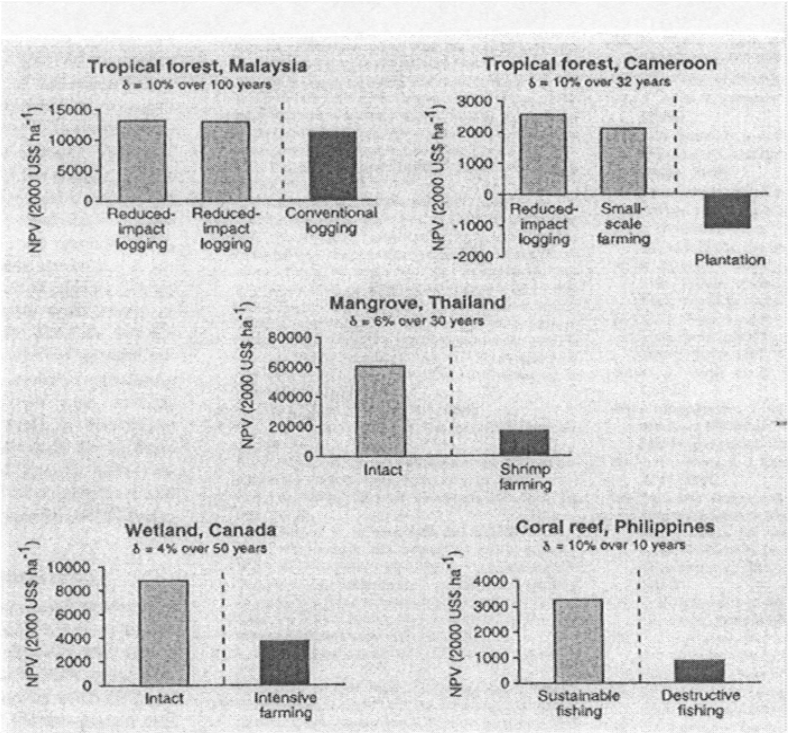
Capital comes in different forms, and economists often distinguish between man-made capital, human capital and natural capital. Ecosystems are capital assets too. As evident from the MA classification, ecosystems provide a host of services: they maintain a genetic library, preserve and regenerate soils, fix nitrogen and carbon, recycle nutrients, control floods, filter pollutants, pollinate crops, operate the hydrological cycles, etc. Degradation of ecosystems is much like the depreciation of physical capital (roads, buildings, machinery) but with two big differences: damages are frequently irreversible, or systems take a very long time to recover, and ecological processes tend to be non-linear, so that ecosystems can collapse abruptly, without much prior warning (Dasgupta 2005).

From the Table is evident that aggregate *capital stocks* may be falling, even if *income* is growing. This is true for all Asian countries in the Table but China (Africa is worse off, with both income and capital stocks falling). If we look at national income as a proxy for welfare we might think that increases in income means countries are moving up. This is a mistake. Income growth financed by capital depletion (selling the family silver) will be a temporary phenomenon. Capital stocks are a measure of true wealth, and it is the basic source from which future income is derived. Raising incomes by depleting capital stocks implies setting the stage for a 'boom' and 'bust' pattern. That is, unless income is not consumed but carefully invested in productive assets like physical infrastructure or education (Hartwick

1977). The Table suggests this is not happening – at least not at a sufficiently large rate. Therefore one may predict that current incomes in many developing countries, appallingly low as they might be, will not be sustained in the future. The depletion of natural capital, as identified in the MA (and confirmed by the World Bank data), is likely to adversely affect incomes in the future. This is bad for many reasons, not in the least place because poverty is an important driver of civil war in developing countries (Miguel *et al*. 2004).

At this point it is appropriate to present another piece of the puzzle. Sceptical economists could argue that the conversion of natural capital is a desirable and inevitable phase in the process of economic development. This, I feel, may be too simple a view on the process of economic growth in general, and on the potential contribution of natural systems to development in particular. A recent overview paper compares the profitability of various forms of land use, some of which leaves natural habitats more or less intact – think of reduced-impact logging or sustainable fishing – while others convert natural systems into something completely different (plantation cropping, intensive farming, etc.). The results are provided in the Figure (taken from Balmford *et al*. 2001).

The table shows that investing in nature pays: sustainable management of ecosystems yields a more valuable flow of benefits than going for short-term gains. Or, perhaps more appropriately, the Figure suggests that investing in nature *may* pay. While some environmentalists are quick to generalize the results from such case studies and present them as fundamental truths, I am convinced that there are also many examples where nature is *not* the economically preferred form of land use. Some further destruction of mature will inevitably happen in the future (see also Bulte *et al*. 2002 for a study of land use in Costa Rica).



Nevertheless, here is how I interpret the results. Sometimes nature is hacked down even if it would have been better if we had just left it in place. There are cases – maybe many cases – where leaving nature in place does more good for mankind than subduing it. Why, then, do we hack it down? Standard economic theory provides two reasons for this. First, people destroy nature because governments sometimes subsidize such activities. A lot has been written about *policy failure* and I do not intend to contribute to that litany now. But estimates of the amount of money involved in so-called "perverse subsidies" – subsidies that are bad for the economy and bad for nature – add up to impressive numbers. The total amount involved, in both developed in developing countries, may be as high as $2 trillion per year (Myers and Kent, 2001).

Second, and more to the point for the story that follows, we hack down nature because many of the services and benefits provided by nature are "free" – in the sense that they are not

marketed – an obvious case of *market failure*. So even if nature is valuable, it does not command a flow of money and therefore it tends to be ignored. The values captured in the Table include some (but not all!) of the ecosystem services identified in the Millennium Assessment – think of carbon storage, flood control, and so on. Environmental economists have developed tools and tricks to attach euro-values to these services, but that is not the same as money-in-the-bank. The point is that even if the *social returns* to conservation and sustainable management are high, from the perspective of a *private* individual it may be better to ignore some benefits (accruing to others) and focus on the small subset of tradable benefits only.

Where do we stand?

Summing up, it appears as if I have painted a rather bleak picture. (i) Essential ecosystem services are under threat, and (ii) especially the poorest among the poor are unable to build up alternative stocks of assets to compensate for the loss in their natural capital. And (iii) while nature may be a competitive form of land use, (iv) some of the associated benefits do not readily translate into money in the bank and are therefore best ignored by private landowners. Traditional conservation approaches are not capable to satisfactorily deal with these issues.

Yet, there is hope that we can make serious progress on two important counts – mitigating or even reversing the most dismal predictions of the MA and at the same time making progress in alleviating poverty. The Millennium Assessment suggests nature is no longer plentiful – it is getting scarce. The logical consequence, as pointed by Ricardo, is that at the margin, which is where economists spend their professional lives, nature becomes valuable. Soon this means that nature is no longer gratis but will start commanding a positive price. In other

words, nature and nature's services are increasingly becoming commodities that will be traded on markets or in market-like environments. This is the green revolution.

Markets and the environment

Economists have long argued that there should be scope for markets and market-based instruments in environmental policy. After knocking on the proverbial door for a long time, we have been reluctantly admitted in policy circles, and have started to transform the way in which decision makers think about environmental management. We now see 'markets' (real and created) working their magic in many places. We observe people trading fish quota the world over, trading the right to emit sulphur in the USA, and trading the right to emit carbon in Europe. I am not arguing that markets should replace other conservation efforts (e.g. Brunner *et al*. 2001 suggests that National Parks are at least somewhat effective in conserving tropical biodiversity), but increasingly they will be *combined* with them. This is necessary, if only because parks are only some 10% of the Earth's surface and much can be gained by careful management of the remaining 90%.

Often markets did not exist – they had to be created. Consider the example of fishing. People have been trading fish for a long time, but trading the right to go out and catch fish is more novel. How does this work? Policy makers have to put an upper limit (or "cap") on the quantity of fish that may be harvested. These harvest rights are transferred to the fishermen, who are then allowed to trade among each other to determine where the value of the rights is highest. Through trade, firms themselves decide who will do the harvesting, this is not done by relatively uninformed regulators. Trading harvest quota implies maximum flexibility in choosing the distributional implications of management, and also provides incentives to improve technologies. The economic approach to regulation has proven efficient and

effective, and Brown (1999) argues that no country has ever abandoned a system of tradable quota after implementing it. It is perhaps no surprise that policy makers and international organizations increasingly turn to economists for more advice. Economic incentives and market-based approaches are the name of the game nowadays in environmental management. An added advantage of this development, perhaps, is that it contributes to making conservation palatable to a broad audience. According to a recent survey in the US almost half of the public equates "environmentalists" with narrow-minded "extremists" (Shellenberger and Nordhaus 2004). Correcting such views through proposing practical and efficient regulation seems very important.

Paying for ecosystem services

What may be the next step in the economic approach to conservation? I believe there is reason to be optimistic about the potential of a new tool in the toolkit, and that is *paying for ecosystem services* – PES for short. Remember the words of Ricardo: when scarcity starts to kick in, nature should stop providing these services gratis. Someone has to start paying for it. Who might that be, you may wonder? Well, ultimately the person paying will be the person demanding the service. In many cases, therefore, it will be you.

I think I know what some of you are thinking now: "paying for ecosystem services like air purification and flood control is just an esoteric idea – it will not fly in reality." But this cynical view has already been proven wrong. It *is* happening in reality, and it is happening in many places around the globe. A recent survey indicated that there are hundreds of payments schemes in developing countries that have elements in common with a pure PES scheme.

What are the defining elements of a pure PES scheme? Wunder (2005) defines a payment for an ecosystem service as (i) a *voluntary* transaction where (ii) a *well-defined* ecosystem service (ES) is (iii) being bought by a (minimum one) ES buyer from (iv) a (minimum one) ES supplier, (v) if and only if the provider secures ES provision. The transaction should be voluntary and the payment should be conditional on the service being delivered – this is no handout to the poor and needy but payment for a real service. Note, however, that paying for an ecosystem service is not necessarily the same as trading nature on a market. Markets may play a role, as will become clear, but because many of the ecosystem services come in the form of a public good we cannot rely on markets alone. Governments and intergovernmental organizations are essential to the package.

It is useful to work towards some form of PES classification system. We can usefully distinguish between cases where the ecosystem service benefits a small group of agents versus the case where it benefits a large and presumably more diverse group of agents. If the number of people increases, for example because we are considering regulatory services that impact everybody, the ecosystem services more closely starts to resemble a public good. Another useful distinction is between cases where service "suppliers" and "demanders" are geographically located close together, and those cases where they are not. The following Table provides a few examples, highlighting the broad variety of possible cases.

	Local feedback	**International feedback**
Few demanders	*CASE I*: Plantations and pollination services	*CASE II*: The Panama Canal and regulatory services
Many demanders (~ public good)	*CASE III*: Local watershed management	*CASE IV*: Elephant conservation and non-use values

Case I is relatively straightforward. To grow agricultural crops farmers typically depend on insects for pollination. Insects provide this service free of charge, and a recent case study on Costa Rica's coffee plantations estimated that the value of this service may be considerable – some $60.000 per farm. Coffee plots closer to the forest produce yields that are 20% higher because these fields benefit from more visiting insects. No doubt farmers are willing to pay their forest-owning neighbour a certain amount of money to attenuate any incentives that neighbour might have to convert his forest plot into, say, a parking lot. Some would call this a bribe – others call it a fair payment for a valuable ecosystem service. The consequences of losing pollinators can be far-reaching as is evident from the case of certain Chinese apple orchards where chemical inputs have all but eradicated a local bee species, so that females and children now have to pollinate the flowers manually.

Case II, or the case of concentrated demand and international feedback may also be relatively easy to address. A few months ago I participated in a UNEP meeting where John Forgach was also present. He is a banker who recognized the potential to make money off PES deals. But of course not off any PES deal. Forgach carefully selected a big one that afterwards featured prominently in an *Economist* cover story. The story has all the characteristics of a modern classic in the making. Here it is.

Much of the forests in the watershed of the Panama canal had been cleared and several bad things started to happen. After deforestation more sediments and nutrients flowed into the canal. Sediments cause clogging and nutrients trigger the growth of weeds – both processes necessitate regular and costly interventions like dredging. In addition, while the tree vegetation released water in a fairly regular and steady flow, the same is not true for the grassy vegetation that replaced it – the water may come in waves. Forgach reasoned that

dealing with these problems is just like dealing with other infrastructure projects, and he recognized that reforesting the watershed was the cheapest way to ensure the future availability of a useful canal. The emergence of a 'guild' of brokers in the ecosystem services trade (a group who sees this as a new business opportunity) will be extremely important for the future elaboration and fruition of the concept.

But who should pay for such a project? The Panama Canal is different from the pollination example in that the economic stakes are enormous. Several large companies from different countries, like Wal-Mart, that depend on the canal to move their produce were quite willing to invest in it. The idea is that companies can underwrite bonds to finance replanting of the forest – with native tree species – and that, in turn, these companies qualify for reduced insurance premiums. A market solution emerges! The interests of firms and conservationists run parallel as a profitable business deal in this case yields large environmental benefits. I suspect there are a few similar cases to be explored. Think of African savannah conservation and ecotourism, where big tourism operators are well aware of what drives their profits.

Next, turn to case III, or the case of many demanders and local feedback. In contrast to the examples above the 'many-demanders-element' implies abandoning the domain of the market (as strictly defined). If the number of service demanders is large – possibly encompassing everybody in a certain region – the service is a public good. Textbook economics is perfectly able to explain why markets don't work properly in this case. Free riding problems can be overwhelming: if nobody can be excluded from enjoying a service, then the service cannot be priced on a market and no-one will invest to make it available. This is a classic case of market failure, and when markets are the problem they are not necessarily the solution. However, market failure does not invalidate the PES idea. It only

means that, as service demanders, we need to design an institution that enables us to coordinate on what is good for us, and represent our joint interest.

There are now many examples in the field (especially from Latin America) where communities – villages, cities – are able to negotiate PES deals. Until now such deals are most common in the context of watershed projects. The most famous example, no doubt, is the Catskill Mountain case – the watershed from which New York City gets most of its drinking water (see Ashendorff *et al*. 1997). The water quality in the 1980s and early 1990s declined to the level that the government faced large costs for installing water purification plants. Experts estimated up-front investments cost of some $5 billion and recurring costs of $250 million each year. This hurt. Fortunately, an alternative plan was also available. The government could instead invest in watershed management and conservation, and pay farmers up in the watershed to limit their pollution. The costs of this effort are substantial too – some $250 million up front and recurring costs of $100 million each year – but substantially lower than the purification plants. If we consider the foregone costs on such plants as a proxy for the valuation of the regulatory services provided by the watershed, then the Catskill Mountains example is further evidence that investing in nature may pay off handsomely. There are now many such PES programs in watersheds. They are also found in developing countries, where downhill communities pay uphill communities for conservation and planting of trees. A prerequisite for success is overcoming the free rider problem, which often requires intervention by donors or governments. But these PES programs have great potential to be sustainable, and function like means to coordinate on resource use that is socially beneficial.

Cases I-III have drawn much attention because they deal with cases where feedback loops between supply and demand are relatively tight – geographically or in terms of business interests. By directly appealing to the interests of beneficiaries (and tapping into their resources), they offer scope for increasing the total amount of money available for promoting conservation.

Next we turn to the bottom right quadrant of the Table, case IV. Two examples of global ecosystem services are carbon sequestration (mitigating the adverse effects of the greenhouse effect) and cultural values associated with biodiversity conservation. When we want to reduce emissions of greenhouse gasses it does not matter whether we plant trees and fix carbon in India, or invest in new technologies in the Netherlands – a ton of carbon is a ton carbon. There is great scope for market instruments to lower the costs of reducing emissions (invest where success is cheap), but we all know that progress on the carbon front is extremely slow and fragile.

Today I prefer not to focus on carbon but on African elephants (a very similar story can be told about biodiversity conservation in general). While clearly different than the carbon story in its details, there are also many similarities. Conservation of elephants yields large benefits, but the distribution of these benefits is very unequal. Wild elephants are greatly valued by tourists and the global community at large, but it is the impoverished and remote communities of Africa (and Asia) that bear the costs and depredations associated with their conservation. And ultimately, of course, these communities are the main drivers of changes in local land use and biodiversity: if local people don't want elephants around they will eventually disappear – wildlife in many protected areas in East Africa depends on access to (food) resources found on private and communal lands.

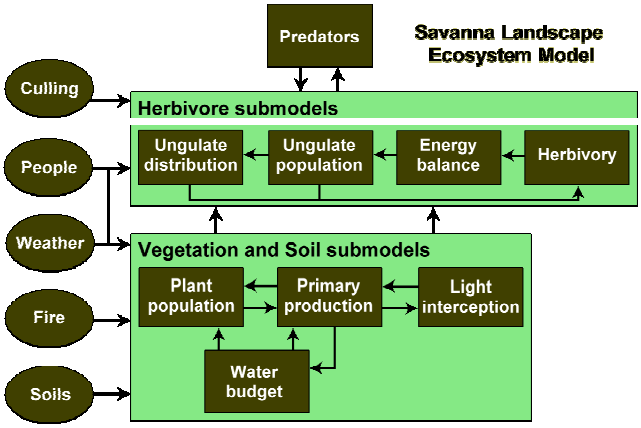
Let us consider the case of the Amboseli ecosystem, an area that is home to an extraordinary rich nature as well as to thousands of Maasai pastoralists, whose traditional livestock activities are well adapted to the variable habitat. And which are nicely compatible with wildlife conservation: elephants and other animals wander in and out of the park and you can find them grazing along the livestock of the Maasai. But things are changing.

The majority of Maasai households receive virtually no direct benefits from the eco-tourism industry. The indirect benefits, in the form of reduced school fees, irrigation infrastructure maintenance, livestock sales yards, and other related community goods, often fail to benefit those in most need. In contrast, the Maasai do receive direct benefits from renting out their land. It is no surprise, therefore, that they are increasingly renting out large areas for irrigated or rain-fed agriculture. Some of the irrigated land was fenced during the 1990s to protect it from wildlife, and increasingly those protected croplands become an obstacle to the seasonal migration of wildlife.

While cropping may be *privately* rational (the returns of cultivation dominate the private returns to wildlife management), it is an open question whether it is also *socially* beneficial – i.e. what happens when we include eco-services benefiting people outside the Amboseli system? Is it still the case that the benefits from onion growers prevail?

In collaboration with the Food and Agricultural Organisation, a biological modeller from Colorado State University, and a number of African counterparts we are now trying to look into this issue. We have a spatially explicit integrated ecosystem model (called SAVANNA) that we use to simulate the impact of implementing a PES program where we pay the Maasai

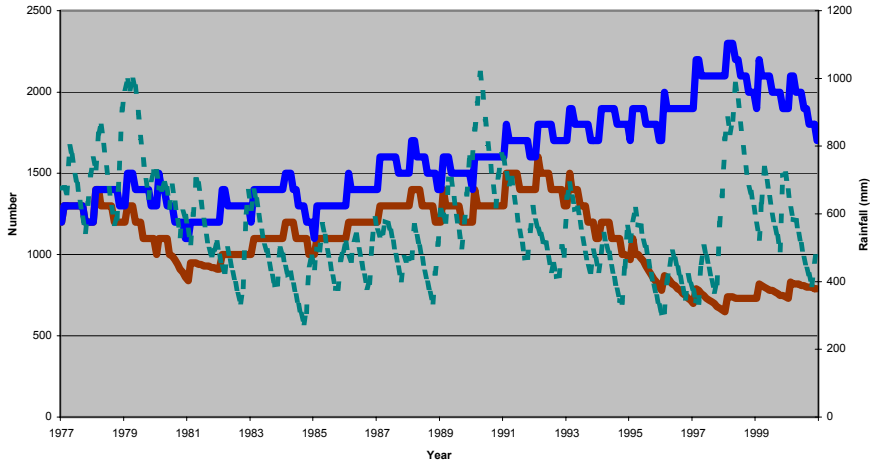
for returning the onion fields back to nature. Ideally we would pay not for grass but for elephants and other wildlife species because that is what we care about, but this would be impractical (monitoring is much harder) and possibly unfair as local levels of elephant abundance depend on many factors beyond the control of pastoralists (think of rainfall). The model distinguished between 7 plant species and 9 animal species, including cattle and goats, and we link it to a model of Maasai decision-making. The Figure contains a sketch of the building blocks of the ecological model.



We use the model to analyze the impact of paying the Maasai for making their land accessible for wildlife. The theoretical results are encouraging. The following Figure compares simulated elephant abundance in the presence and absence of (fenced in) agriculture on strategic locations in the Amboseli ecosystem. The solid upper line is elephant abundance without agriculture, the solid lower line is elephant abundance with part of the ecosystem used for cropping, and the dashed line depicts actual rainfall over the study period.

The model suggests that a PES program would make the elephant population much more resilient to drought shocks – there is no collapse in the mid 1990s. The average number of elephants supported by the Amboseli ecosystem may be some 500 elephants greater with the

PES scheme in place paying for the removal of all fences from the study area. Less ambitious options (securing corridors rather than removing all agriculture) are also feasible.



The PES program also improves the lot of the Maasai. This is clearly an advantage of PES relative to some of the command-and-control measures applied in the past which, in the case of protected areas, typically involves displacing people and denying them access to key resources. In fact, we find that poverty alleviation and elephant conservation may go hand-in-hand in Amboseli. If Maasai income goes up they are able adjust the composition of their livestock herd so that it better meets their desires. Compared to the current situation this means more cattle and fewer goats. Since goats and elephants compete for food (and cattle and elephants do not, or at least not to the same extent), such a shift is good news for elephant lovers.

The annual costs of an ambitious PES program amount to about $450.000. This means that a 15% increase in the entrance fee to the park would be sufficient to pay for such a scheme. A modest bed tax would also do the trick. The essence is that the tourists are paying the Maasai for producing habitat that supports the wildlife that they came to see, and that depends on private lands for their survival at current densities.

Of course it would be even better if not just tourists but the world community at large would pay for such projects. After all: *everybody* benefits because we all care about elephants, and we all want them conserved for our children and grand children to enjoy.

A similar story can be told about another project near Nairobi – the Kitengela project. Wildlife from Nairobi National Park traditionally moves between the park and other grazing grounds. Increasingly, fences used to delineate private fields blocked these migration routes, and as a result wildebeest and zebra numbers have been falling dramatically. A program was started by ILRI to pay farmers for removing their fences. Unlike the Amboseli case this program is up and running, so we can learn from its experiences. The results indicate that payments for removing the fences are a powerful incentive to produce nature, they are hugely important for people as an income buffer in dry years (in bad years the payments, small as they might be, effectively double household income), and surveys indicate that they help improve the attitude of people towards wildlife. Because the timing of the payments coincides with the periods when school fees are due, there is also evidence that the PES scheme facilitates education. In economics jargon: the payments facilitate the accumulation of both natural and human capital!

Another benefit of the PES system is that it oftentimes allows conservationists to deal with landowners directly (and sometimes deal with communities, if property rights are not defined at the individual level). This implies sidestepping a possibly corrupt government service.

Minor and major challenges

All of these effects are wonderful. But, alas, there are also a few challenges ahead. I have taken the liberty to list four of them. The first challenge is of a *technical* nature. In economics jargon: often we don't understand the 'production function' of ecosystem services. For example, how does forest conservation contribute to all sorts of hydrological benefits? This is a topic clouded by myths. Similarly, in the Netherlands and elsewhere in Europe we greatly about the conservation of meadow birds, and in the recent past we have forked over serious amounts of money to farmers to promote nature conservation in agricultural landscapes. Klein and Sutherland (2003) cite an estimate of €24.3 billion as expenditures on such schemes up to 2003, for 15 EU member countries. But research by Klein *et al*. (2001) suggests that the effects of such efforts are minimal. If we don't know how to "produce" lapwings and godwits, PES does not work and simply amounts to subsidizing farmers (perhaps a popular thing to do for politicians).

Similarly, it has been proposed to transfer an amount of €70-100 million to cockle fishers as compensation for denying them access to the Waddenzee. But the link between fishing and cockles is ill understood, and it is possible that other factors such as a disturbed nutrient balance are equally important in determining cockle stocks and, indirectly, bird abundance. We just don't know, and more work needs to be done to get the science right. Some of the research should be of an interdisciplinary nature, combining explorations into technical relationships and economic valuation work. I find it shocking that there is very little systematic research into evaluating the effectiveness of agri-environment schemes (see Klein and Sutherland 2003). One of the consequences is that there is very limited opportunity to improve our understanding of what works and what does not. This is unfortunate because there are also success stories to tell (e.g. black grouse, stone curlew and corn crake in the

U.K.). More careful evaluation would enable researchers to identify what contributes to success for specific species.

A second challenge, also of a technical nature (but rooted in economics), is slippage or leakage. This captures the idea that successful PES schemes may lead to their own demise because they trigger behavioural changes. For example, paying money to the Maasai for not growing crops may induce them to hold more livestock, eroding the conservation gain from securing new habitat. Similarly, higher prices of food crops may induce other farmers to convert new areas of habitat into agricultural fields. These are issues that are amenable to (economic) modelling, and that should be carefully considered before implementing PES schemes. However, given the current levels at which PES is being practiced strong general equilibrium effects are unlikely to emerge. In a similar vein, 'moral hazard' and 'averse selection' are also technical issues that require tackling by careful (economic) project design.

Third, it is not always obvious who will pay for the ecosystem services. This is no problem for the cases with "few demanders" where the market may work, but markets fail in the presence of public goods. When talking about services within a nation's borders it is obvious that the government can play an important role – think of the Catskill Mountains case, and about the conservation of meadow birds in the Netherlands. Using tax dollars to pay for public goods is an excellent solution, and the government purchases the ecosystem service from the supplier on behalf of society at large. But when we move to the international level matters are not so easy. Currently we lack a good institution to broker deals between suppliers of ecosystem services and the rest of the world. There are NGOs who play that role for specific projects. And, there is the Global Environmental Facility (GEF), funded by all countries, that is exactly designed to deal with global conservation issues. But I believe this

approach has serious shortcomings, and that one of the major challenges for the future will be to develop alternative institutions (or modify GEF). GEF regulations imply that projects can only be funded for a period of 5 years – after that they should be able to support their own. This is fine for watershed management projects or other efforts that yield tangible benefits for a well-defined group of users, but unsatisfactory for schemes that yield flows of global non-use values. Who will pay after 5 years? Because of the public good nature of the benefit there is a continued need for channelling public funds to private parties. In the absence of sustained compensation the benefits will stop flowing as well. I am of the opinion that rich countries have under-funded GEF to a degree invoking Scrooge rather than Soros, and it appears as if matters will only become worse when GEF4 with its new sets of rules replaces the current GEF3 round. One interpretation is that the "rich North" prefers to free ride on conservation efforts in the "poor South" – an outcome that would be both inefficient and unfair. In the context of carbon storage, the Nobel prize winning economist Joseph Stiglitz recently argued that developing countries are subsidizing industrial countries to the tune of $30 billion.

The GEF also fails to promote efficiency because of its piece-meal project-based focus. Instead, ecosystem services should be produced in areas where such production is cheap. I suspect that much can be gained by an auction-like mechanism to rank projects in terms of the costs associated with service provision.

Payments for the selected projects may be based on contributions of countries (some percentage of GNP) but there are other mechanisms. One example would be a small sub-charge on air tickets as recently proposed by the French government. According to one estimate I have seen, Europe alone can generate a sum of €10 billion per year by a modest €5

surcharge on economy tickets combined with a €25 surcharge on business class tickets. In the African context this buys a lot of nature. Balmford *et al*. (2001) suggest an annual outlay of $25 billion would support a "globally effective network" of nature. Depending on your perspective, the required amounts are large or not (personally, I would not dare to belittle an annual outlay of no less than 5% of the US defense budget...). In any event, a small tax on flying in Europe will bring us halfway. While establishing a link between paying for biodiversity conservation and airfare seems perhaps far-fetched and even opportunistic, it is defendable. Most of the global nonuse values of conservation accrue to the rich people, and these are the people who would be paying the tax. While 'second-best,' a case can be made that such a tax measure reaches the right audience. As a side-benefit, the taxation of flying implies attacking two global problems simultaneously: in addition to funding conservation efforts it would contribute to lowering carbon emissions and thus help mitigate the greenhouse effect.

There are other possibilities, but they will take me even further away from firm ground to stand on. For example, it is my understanding that taxing international capital flows – an elusive topic with unforeseen dimensions for a 'micro person' like me – is, after the Asian crisis in the late 1990s, no longer viewed as heresy in economics. Perhaps this may be considered a source of revenues. Regardless, I propose pioneering with such funding mechanisms, start small, and learn from our experiences.

The fourth challenge concerns the relation between poverty alleviation and provision of ecosystem services. As a reminder: some 1.2 billion people are living on less than a dollar a day, and recently the FAO announced that some 16.000 children are dying of 'hunger' every day. There is also evidence that the poor tend to be found in rural areas, and especially in

marginal areas like steep slopes of the upper watershed (Heath and Binswanger 1996), exactly the areas that should be tackled from a PES perspective. Further, White and Martin (2002) indicate that indigenous groups and impoverished rural communities own or manage at least 22% of tropical forests. While Wunder (2004) rightly warns against "over-burdening" PES projects with anti-poverty objectives, it is clearly feasible that conservation and improving the lot of the poorest *can* be mutually reinforcing. This happened in the cases of Amboseli and Kitengale discussed above.

Regarding PES and poverty we can distinguish between two questions: (i) do payments improve the lot of poor households (participating in the scheme or otherwise), and (ii) to what extent is PES compatible with an economically viable development trajectory for the economy as a whole? I don't believe any work has been done to address the issue of PES and the national economy. Probably this is because PES efforts are currently too small to have any significant impact at the aggregate level (but this could change). One might speculate that demand for ecosystem services, and hence their value, increases over time because of ongoing population growth and income growth. A condition for this to happen is that payments are based on *willingness to pay* for such services, as opposed to their opportunity costs. On the other hand, the production of nature likely yields very little in terms of spillover benefits from which other sectors in the economy benefit. Matsuyama (1992) developed a model of economic growth of a two-sector economy – the manufacturing sector with increasing returns to scale at the sector level, and the agricultural sector subject to constant returns to scale. If we consider 'production of ecosystem services' on a par with agriculture, PES could have the adverse and unintended effect of 'locking' economies into economically suboptimal development paths.

Next, return to the first question of the link between PES and household income. Pagiola *et al*. (2005) explore the issues and evidence of this link. While it is too early to draw firm conclusions, we may glean some insights from recent experiences. First off, a pre-condition for beneficial effects is that the PES program actually reaches the poor: they should (i) be in the "right place," (ii) want to participate (e.g. it should 'fit' into the farm practice), and (iii) be able to participate (e.g. they should be able to make the necessary investments, have sufficiently secure tenure, etc.). It is quite easy to design programs that fail on either of these conditions, so that PES does not help in fighting poverty.

Providers	Potential impact	Extent of impact depends on	Comments
Participants			
Land owners with secure tenure	Income from PES (+)	• Amount of payment (+) • Opportunity cost (−)	
Land owners with insecure tenure	Income from PES (+)	• Amount of payment (+) • Opportunity cost (−) • Ability to participate (+)	Efforts by politically powerful groups to seize more land? (−)
Tenants	Income from PES (+)	• Amount of payment (+) • Opportunity cost (−) • Division of benefits with landlord	Change in landlord's willingness to rent? (−)
Downstream service users	Pay for PES (−)	• Amount of payment (−) • Consequences of lack of PES program (+)	
	Receive services (+)		
Nonparticipants affected by PES			
Farm workers	Change in labor demand (+/−)	• Relative labor needs for PES-promoted practices compared to current practices (+/−) • Other employment opportunities (+/−)	
People dependent on NTFP collection	Change in availability and access to nontimber products (+/−)	• Nature of current and PES-promoted practices (+/−) • Local context	

[a] Hypothesized impacts: (+) positive impact: poverty reduction, or increased welfare of the poor; (−) negative impact: poverty increase, or reduced welfare of the poor; (+/−) uncertain impact: depends on case-specific circumstances.

Next, *if* PES reaches the poor we may infer that it will make them better off – participation in a PES deal is voluntary so participants should gain. The proper net measure of benefits for the eco-service seller is payment received minus opportunity cost. Since payments are often based on opportunity cost the net benefits may be small (although the stabilizing effect of

payments on household income is welcome). Of course there may also be positive non-income effects, ranging from the continued supply of eco-services, which benefit the demander, to the potential impact of PES deals on the formation of social capital.

But there exist other effects. Pagiola *et al*. (2005) argue that, in case of imperfect tenure security, PES schemes may induce wealthy and powerful households to "muscle out" poor households. In addition, the effect on non-participating poor and landless is ambiguous, depending on whether labour demand goes up or down. In theory PES could also raise the price of food crops because of its limiting effect on agricultural production. This would erode the purchasing power of households depending on such crops. This means that we are facing some tough tradeoffs when balancing conservation versus poverty objectives. An overview of the various effects is provided in the Table above, and it leads Pagiola and co-authors to conclude that

> "*PES programs are not a magic bullet for poverty reduction, but there can be important synergies when program, design is well thought out and the conditions are favourable*".

Of course we know, after Tinbergen, that we usually need two instruments to solve two problems.

If it seems that I have bogged down in detail I offer my apologies for that. The truth, of course, is that I have simplified to a dangerous extent. Scratch the surface and the struggling begins. Nevertheless, I hope that you see merit in the idea – and acknowledge that there are

potential problems as well – of introducing market-based mechanisms such as payments for ecosystems services.

Conclusions

Let us return to Carlyle and his dismal economists. There is a lot to be concerned or dismayed about. The world population will increase from 6.5 billion to about 9 billion people in the foreseeable future, and incomes and claims to nature are rising in emerging economies like India and China. It is also fair to ask whether current consumption patterns in OECD countries are sustainable or not. Demands on natural systems that support us are likely to increase. But the point of this speech is that there is no need to lose hope.

The main idea may be summarized in a few lines. Nature pays but its conservation is costly, and there is an urgent need to find better ways to finance conservation and use the available funds. PES helps on both counts: by linking ecosystem service suppliers to demanders we may tap into new sources of money, and paying suppliers for the ecosystem services they produce is an effective and efficient means to trigger the production of these services. There are challenges ahead, but these do not appear more formidable than those of traditional conservation approaches.

An acute question for ivory tower economists, like me, is to what extent we allow such issues to invade our work. The system of rewards in Academia is designed so as to maximize research *output* – social relevance is typically distinctly less important. I am in a fortunate position in that 'curiosity-driven' research in my case leads me to work on issues that are also important to people outside the research community. But there is a trade-off: the Amboseli case is at the boundary of research and project implementation, and from a pure scientific

perspective my time might be better spent elsewhere. However, I cannot help but loving this kind of work, and the newly gained security that comes with a tenured chair implies that this component of my research portfolio will probably become more important over time.

PES is one of the prominent new tools that can usefully be combined with other approaches (command-and-control, ICDPs, etc.) to make progress on both the poverty and conservation front. The main challenge will be to develop new institutions to deal with global public goods, where the incentives to free ride are especially strong. Even if governments are slow to respond to these new opportunities, NGOs are making progress and gain valuable experience about what works and what does not (it is not the first time for governments to follow the music, rather than lead it). An initiative that is particularly noteworthy in this respect is the *Ecosystem Marketplace* organized by the Katoomba Group, which brings together suppliers and demanders and greatly enhances transparency in this emerging market.

Finally, when I talk about these issues with people I get two different sorts of feedback. Some people say "yes, but this is obvious – we have known this since Ronald Coase published his famous paper on social cost in 1960!" Other people consider PES an eye-opener and call it "revolutionary." I think both groups are right – this is an obvious revolution, waiting to happen.

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