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The policy challenges for green economy and sustainable economic development

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Abstract

Green growth, the promotion of energy efficiency and clean energy technologies and sustainable development are frequently viewed as complementary goals by international policymakers. This paper argues that green growth will not ensure sustainable economic development as long as global ecosystem degradation and loss means that the world continues to face worsening problems of ecological scarcity — the loss of myriad benefits, or "services", as these systems are exploited for human use and activity. Overcoming this problem requires addressing further sustainability and funding challenges. The sustainability challenge is to overcome a vast array of market, policy and institutional failures that prevents recognition of the economic significance of this scarcity. The funding challenge is to bridge the shortfall between the global benefits that humankind receives from ecosystems and what we are willing to pay to maintain and conserve them. Improving economic and scientific analysis of ecological scarcity, valuing the loss in benefits, and translating the implications into policy are the key steps for addressing the sustainability challenge. Exploring and implementing a range of innovative financing mechanisms, from international payments for ecosystem services to financial and currency transactions taxes to international financing facilities are possibilities for alleviating the funding challenge.

Keywords: Currency transaction tax; ecological scarcity, financial transactions tax; green economy; international financial facility; payment for ecosystem services; sustainable development.

> "We recognize that sustainable green growth, as it is inherently a part of sustainable development, is a strategy of quality development, enabling countries to leapfrog old technologies in many sectors, including through the use of energy efficiency and clean technology. To that end, we will take steps to create, as appropriate, the enabling environments that are conducive to the development of energy efficiency and clean energy technologies, including policies and practices in our countries and beyond, including technical transfer and capacity building."
> *The G20 Seoul Summit Leaders' Declaration, 11-12 November 2010*

1. Introduction

As the above quote from the Group of 20 (G20) Leaders' Declaration at the Seoul Summit indicates, "green growth", the promotion of energy efficiency and clean energy technologies and sustainable development are frequently viewed as complementary goals by international policymakers. The implication is that the development of energy efficiency and clean energy technologies is the means by which "sustainable green growth", and ultimately sustainable development, will be attained.

The G20, which comprises the world's 20 largest and richest countries, has already made some progress in this area.[1] A unique feature of the global policy response to the 2008-9 recession is that, as part of their efforts to boost aggregate demand and growth, some governments adopted expansionary policies that also incorporated a sizable "green fiscal" component. Such measures were wide ranging, including support for: renewable energy; carbon capture and sequestration; energy efficiency; public transport and rail; and improving electrical grid transmission; as well as other public investments and incentives aimed at environmental protection. Of the US$ 3.3 trillion allocated worldwide to fiscal stimulus over 2008-09, US$ 522 billion (around 16%) was devoted to such green expenditures or tax breaks (Robins *et al*., 2009; 2010a). Almost the entire global green stimulus was by the G20.

Current views on the eventual success of these policies are mixed. It is argued that relying on green stimulus alone

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[1] The members of the G20 include 19 countries (Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, the UK and the US) plus the EU.

is not enough to instigate a global "green" recovery (Barbier, 2010; Strand and Toman, 2010). Fossil fuel subsidies and other market distortions, as well as the lack of effective environmental pricing policies, carbon markets and regulations, will diminish the impacts of G20 green stimulus investments on long-term investment and job creation in green sectors. However, despite these difficulties, HSBC Global Research forecasts that the global market for clean energy and energy efficiency investment opportunities will triple to US$ 2.2 trillion by 2020 (Robins *et al*. 2010b). The expansion will be led by low-carbon vehicles, such as plug-in hybrids and full electric vehicles, China's growing clean energy market and the need for upfront capital for the new green technologies.

Although the rapid expansion of clean energy and energy efficiency markets would be a major boost to global green growth, it still does not guarantee that the world will attain sustainable economic development. Green growth will not mean sustainable growth as long as global ecosystem degradation and loss means that the world continues to face worsening problems of ecological scarcity. The purpose of this paper is to explore the major policy challenges that need to be overcome in order to avert the worsening global ecological scarcity problem. These challenges fall into two broad areas.

First, there is the sustainability challenge. From an economic perspective, ecological scarcity has been defined as the loss of myriad benefits, or "services", as these systems are exploited for human use and activity (Barbier, 1989). Ecological scarcity arises through a fundamental tradeoff in our use of the natural environment. Economic development leads to important benefits for humankind, but the result has been profound alterations to the world's major ecosystems and the valuable benefits that they provide. The continuing loss of these benefits as global development proceeds constitutes increasing ecological scarcity. The reason for this growing scarcity is straightforward. We use our natural capital, including ecosystems, because it is valuable, but we are losing natural capital because it is free. Convincing global policymakers that economic development must take into account the worsening ecological scarcity that it causes remains the paramount sustainability challenge facing the world today.

Second, there is a funding challenge. There remains a huge gap between the global benefits that humankind receives from ecosystems and what we are willing to pay to maintain and conserve them. For example, Pearce (2007) estimates that the global benefits of ecosystem goods and services are likely to be "hundreds of billions of dollars", yet currently the world spends at most US$ 10 billion annually on ecosystem conservation. What is more, although the number of protected areas in the world continue to grow, they are seriously underfunded, both globally and especially in Africa, Latin America, North Africa, the Middle East, and Asia (James *et al*. 1999). Overcoming this funding gap is critical if we are to stop the current decline of global ecosystems and the benefits they provide. But there are a number of economic disincentives that have so far prevented successful international negotiation and agreement to halt biodiversity loss and ecosystem degradation worldwide. Financing and implementing international mechanisms to combat this global funding problem is a second critical challenge facing the world today.

The rest of this paper focuses on these two policy challenges for sustainable economic development. Overcoming them should be the main policy goal in coming decades, if international policymakers are serious about their commitment to ensuring that green growth becomes sustainable growth.

2. Sustainability challenge

Most interpretations of sustainability take as their starting point the consensus reached by the World Commission on Environment and Development (WCED). The WCED (1987) defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Economists are generally comfortable with this broad interpretation of sustainability, as it is easily translatable into economic terms: an increase in well-being today should not have as its consequences a reduction in well-being tomorrow. That is, future generations should be entitled to at least the same level of economic opportunities — and thus at least the same level of economic welfare — as currently available to present generations. Consequently, economic development today must ensure that future generations are left no worse off than present generations. Or, as some economists have succinctly put it, per capita welfare should not be declining over time (Pezzey, 1989).According to this view, it is the total stock of capital employed by the economic system, including natural capital, which determines the full range of economic opportunities, and thus well-being, available to both present and future generations (Pearce and Barbier, 2000).[2] Society must

[2] The alternative to this capital approach to sustainability is the systems approach. The systems approach is captured in the infamous "three pillar" Venn diagram, which was first proposed by Barbier (1987). The diagram depicts sustainable development as the intersection of the goals attributed to three systems: ecological, economic and social. Attempting to maximize the goals for just one system does not achieve sustainability, because the impacts on the other systems are ignored. For example, achieving greater efficiency, equity and reduced poverty in economic systems may still generate unintended environmental and social impacts that undermine ecological and social systems. Instead, sustainable development can only be achieved by balancing the tradeoffs among the various goals of the three systems. Thus, the economic system should strive for efficiency, equity and poverty reduction, but at the same time account for the impacts on biological productivity, biodiversity and ecological resilience as well as the implications for social justice, good governance and social stability. It follows that, for the systems approach, rising ecological scarcity is also a threat to attaining sustainable development.

decide how best to “use” its total capital stock today to increase current economic activities and welfare, and how much it needs to “save” or even “accumulate” for tomorrow, and ultimately, for the well-being of future generations.

However, it is not simply the aggregate stock of capital in the economy that may matter but also its composition, in particular whether present generations are “using up” one form of capital to meet the needs of today. For example, much of the interest in sustainable development has risen out of concern that current economic development may be leading to rapid accumulation of physical and human capital, but at the expense of excessive depletion and degradation of natural capital. The major concern has been that, by depleting the world’s stock of natural wealth irreversibly, the development path chosen today will have detrimental implications for the well-being of future generations.

From an economic standpoint, the critical issue of debate is not whether natural capital is being irreversibly depleted, but whether individuals today can compensate future generations for the current loss of natural capital, and if that is possible, how much compensation is required for this loss (Mäler, 1995). Economists concerned with this problem appear to be divided into two camps over the special role of natural capital in sustainable development. The main disagreement is whether natural capital has a unique or essential role in sustaining human welfare, and thus whether special “compensation rules” are required to ensure that future generations are not made worse off by natural capital depletion today. These two contrasting views are now generally referred to as weak sustainability versus strong sustainability.[3]

According to the weak sustainability view, there is essentially no inherent difference between natural and other forms of capital, and hence the same compensation rules ought to apply to both. As long as the natural capital that is being depleted is replaced with even more valuable physical and human capital, then the value of the aggregate stock — comprising human, physical and the remaining natural capital — is increasing over time.[4] Maintaining and enhancing the total stock of all capital alone is sufficient to attain sustainable development.

In contrast, proponents of the strong sustainability view argue that physical or human capital cannot substitute for all the environmental resources that comprise the natural capital stock, or all of the ecological services performed by nature. Consequently, the strong sustainability viewpoint questions whether, on the one hand, human and physical capital, and on the other, natural capital, effectively comprise a single homogeneous total capital stock. Instead, proponents of strong sustainability maintain that some forms of natural capital are essential to human welfare, particularly key ecological goods and services, unique environments and natural habitats and even irreplaceable natural resource attributes (such as biodiversity). Uncertainty over the true value to human welfare of these important assets, in particular the value that future generations may place on them if they become increasingly scarce, further limits our ability to determine whether we can adequately compensate future generations for irreversible losses in such essential natural capital today. Thus, the strong sustainability view suggests that environmental resources and ecological goods and services that are essential for human welfare and cannot be easily substituted by human and physical capital should be protected and not depleted. The only satisfactory compensation rule for protecting the welfare of future generations is to keep essential natural capital intact. That is, maintaining or increasing the value of the total capital stock over time in turn requires keeping the non-substitutable and essential components of natural capital constant over time.

The debate between weak and strong sustainability perspectives is not easy to reconcile. What economists on both sides of the debate agree on is that the type of natural capital that is especially at risk is ecosystems. As explained by Dasgupta (2008, p. 3): “Ecosystems are capital assets. Like reproducible capital assets (roads, buildings, and machinery), ecosystems depreciate if they are misused or are overused. But they differ from reproducible capital assets in three ways: (1) depreciation of natural capital is frequently irreversible (or at best the systems take a long time to recover); (2) except in a very limited sense, it isn’t possible to replace a depleted or degraded ecosystem by a new one; and (3) ecosystems can collapse abruptly, without much prior warning”. Rising ecological scarcity, therefore, is an indication that we are depleting irrevocably ecosystems too rapidly, and the consequence is that current and future economic welfare is affected.

In sum, increasing ecological scarcity is a sign that current global economic development is unsustainable. An important source of natural capital that should be kept intact is being irreversibly degraded, which is putting the current and future generations at risk.

An important indicator of the growing ecological scarcity worldwide was provided by the Millennium Ecosystem Assessment (2005), which found that over 60% of the world’s major ecosystem goods and services were degraded or used unsustainably (see Table 1). Some important benefits to humankind fall in this category, including: fresh water; capture fisheries; water purification and waste treatment; wild foods; genetic resources; bio-chemicals;

[3] For further discussion of this distinction between weak and strong sustainability see Barbier *et al*. (1994); Howarth and Norgaard (1995); Neumayer (2010); Pearce *et al*. (1989); Pearce and Barbier (2000); Toman *et al*. (1995) and Turner (1993).

[4] Note, however, that rapid population growth may imply that the value of the *per capita* aggregate capital stock is declining even if the total value stays the same. Moreover, even if the *per capita* value of the asset base were maintained, it may not imply non-declining welfare of the majority of people. These considerations also hold for the “strong sustainability” arguments discussed below.

Table 1. Global status of key ecosystem goods and services

Condition globally has been enhanced	Condition globally has been degraded	Condition globally is mixed
• Crops • Livestock • Aquaculture • Global climate regulation	• Capture fisheries • Wild foods • Wood fuel • Genetic resources • Biochemicals, natural medicines and pharmaceuticals • Fresh water • Air quality regulation • Regional and local climate regulation • Erosion regulation • Water purification and waste treatment • Pest regulation • Pollination • Natural hazard regulation • Spiritual and religious values • Aesthetic values	• Timber • Cotton, hemp, silk and other fiber crops • Water regulation • Disease regulation • Recreation and ecotourism

Notes: Enhancement is defined as either increased production of or change in the ecosystem good or service that leads to greater benefits for people. Degradation is defined as if current use exceeds sustainable levels, or a reduction in the benefits obtained from the good or service due to either some human-induced change or use exceeding its limits. Mixed status implies that the condition of the good or service globally has experienced enhancement in some regions but degradation in others.
Source: Adapted from Millennium Ecosystem Assessment (2005, Table 1).

wood fuel; pollination; spiritual, religious and aesthetic values; the regulation of regional and local climate; erosion; pests; and natural hazards.

One major difficulty is that the increasing costs associated with this rising ecological scarcity are not routinely reflected in markets. Almost all the degraded ecosystem goods or services listed in Table 1 are not marketed. Some goods, such as capture fisheries, fresh water, wild foods and wood fuel, are often commercially marketed, but due to the poor management of the biological resources and ecosystems that are the source of these goods, the market prices do not reflect unsustainable use and overexploitation. Nor have adequate policies and institutions been developed to handle the costs associated with worsening ecological scarcity globally. All too often, policy distortions and failures compound these problems by encouraging wasteful use of natural resources and environmental degradation.

Thus, the unique challenge posed by rising ecological scarcity today is to overcome a vast array of market, policy and institutional failures that prevents recognition of the economic significance of this scarcity in the first place. As argued by Pearce and Barbier (2000, p. 157): “Important environmental values are generally not reflected in markets, and despite much rhetoric to the contrary, are routinely ignored in policy decisions”.

Figure 1 highlights the policy challenge that the world faces. At the core is the vicious cycle of unsustainable growth, whereby the failure of environmental values to be reflected in markets and policy decisions leads to economic development with excessive environmental degradation. If environmental values are not reflected in market and policy actions, then any increasing ecological scarcity will also be ignored in decision-making. The result is that the vicious cycle will be reinforced, and the current pattern of economic development will continue on its unsustainable path.

Reversing this process of unsustainable development requires transforming the vicious cycle displayed in Figure 1 into a virtuous one. Three important steps are involved.

First, improvements in environmental valuation and policy analysis are required to ensure that markets and policies incorporate the full costs and benefits of environmental impacts (Pearce and Barbier, 2000; Sukhdev, 2008; TEEB, 2010). Environmental valuation and accounting for natural capital depreciation must be fully integrated into economic development policy and strategy. As argued above, the most undervalued components of natural capital are ecosystems and the myriad goods and services they provide. Valuing ecosystem goods and services is not easy, yet it is fundamental to ensuring the sustainability of global economic development efforts.

Second, the role of policy in controlling excessive environmental degradation requires implementation of effective and appropriate information, incentives, institutions, investments and infrastructure (the five *i*’s indicated in Figure 1). Better information on the state of the environment, ecosystems and biodiversity is essential for both private and public decision-making that determines the allocation of natural capital for economic development. The use of market-based instruments; the creation of markets and, where appropriate, regulatory measures; have a role to play in internalizing this information in everyday economic allocation decisions. Such instruments are also important in correcting the market and policy failures that distort the economic incentives for improved environmental

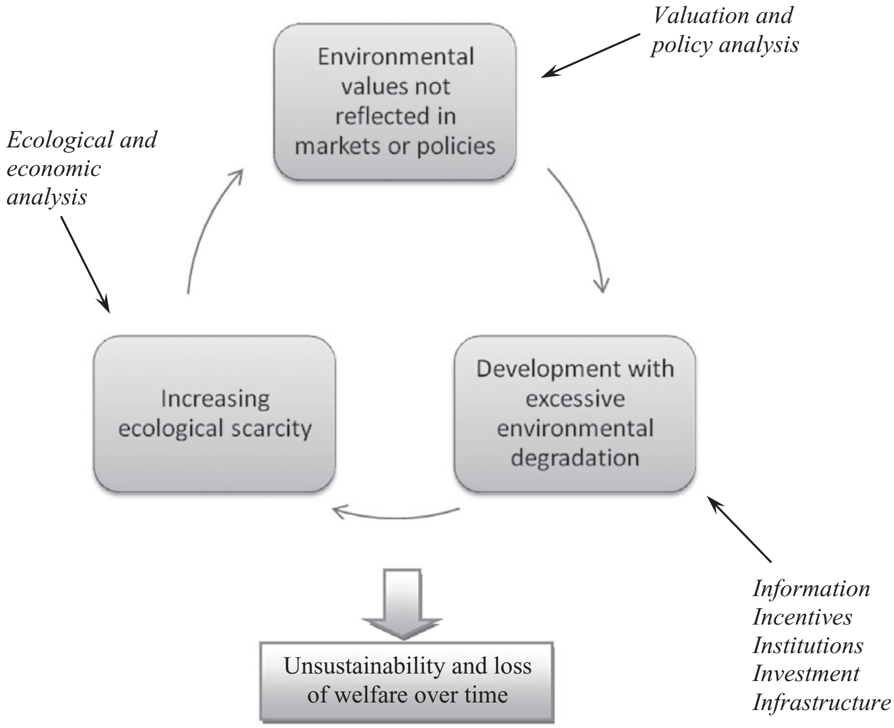

Figure 1. Reversing the vicious cycle of "unsustainable" development.
Source: Adapted from Pearce and Barbier (2000, Figure 7.1).

and ecosystems management. However, overcoming institutional distortions and encouraging more effective property rights, good governance and support for local communities, is also critical. Reducing government inefficiency, corruption and poor accountability are also important in reversing excessive environmental degradation in many countries. But there is also a positive role for government to play, in providing an appropriate and effective infrastructure through public investment, protecting critical ecosystems and biodiversity conservation, devising new incentive mechanisms such as payment for ecosystem services, and fostering the technologies and knowledge necessary for improving ecosystem restoration and ecological transitions.

Third, continuing environmental degradation and ecological landscape conversion affects the functioning, diversity and resilience of ecological systems and the goods and services they supply. The ecological scarcity of these goods and services, and their potential long-term impacts on the health and stability of ecosystems, are difficult to quantify and value. Increasing collaboration between environmental scientists, ecologists, and economists will be required to assess and monitor these impacts (Millennium Ecosystem Assessment, 2005; Polasky and Segerson, 2009). As indicated in Figure 1, such interdisciplinary ecological and economic analysis is necessary to identify and assess problems associated with increasing ecological scarcity. Further progress in reversing unsustainable development calls for more widespread interdisciplinary collaboration in order to analyse complex problems of environmental degradation, biodiversity loss and ecosystem decline.

Articulating the steps needed to overcome various market, policy and institutional failures that are contributing to ecological scarcity is relatively straightforward. Yet implementing these steps is still proving to be very difficult.

The problem may lie in the intransigence of social institutions — the mechanisms and structures for ordering economic behaviour and the means of production within society. As argued so far, one reason why today's mounting ecological scarcity problems seem so intractable is the numerous market, policy and institutional failures that prevent the recognition of the economic significance of this scarcity. But why has it proven so difficult to overcome these failures? An explanation of this intransigence may be that it is the result of what new institutional economists (NIE) view as the tendency of many important social institutions, broadly defined, to be highly invariant over long periods of time (See, for example, Dixit, 1996; 2003; Hodgson, 1998; McCann *et al*., 2005; North, 1990; 1991; Williamson, 2000). We can refer to this rigidity as institutional inertia, which is equivalent to what North (1990) referred to as institutional path dependence.

The NIE define institutions as all the mechanisms and structures for ordering the behaviour and ensuring the cooperation of individuals within society. They are the formal and informal "rules" that govern and organize social behaviour and relationships, including reinforcing the existing social order, which is a stable system of institutions and structure that characterizes society for a considerable period of time. Consequently, as societies develop, they become more complex, and their institutions are more difficult to change. Institutions help structure the means of production, and how goods and services are produced influence the development of certain institutions. This is a cumulative causative, or mutually reinforcing, process. One reason for this self-reinforcing process is that institutions and the social order become geared toward reducing the transaction costs — the costs other than the money price that are incurred in exchanging goods or services — of existing production and market relationships. For example, typical transaction costs include search and information costs, bargaining and decision costs, and policing and enforcement costs.

The role of such transaction costs in hindering the successful implementation of environmental policies has been well documented (e.g., see Gangadharan, 2000; Krutilla, 1999; Mettepenningen *et al*., 2009; Rousseau and Proost, 2005; Stavins, 1995). However, as noted by Krutilla (1999, p. 250), "transactions costs terminology has also been construed more broadly to refer to any costs associated with establishing, administrating, monitoring or enforcing a government policy or regulation". It is these broad transaction costs that are responsible for the institutional inertia, or path dependence, that is thwarting whole-scale policy change towards sustainable development.

According to Boettke *et al*. (2008, p. 332), "path dependence emphasizes the increasing returns to institutions, which 'lock in' particular institutional arrangements that have emerged in various places for unique historical reasons". Since the means of production include the endowment of natural capital, and the way in which an economy uses this endowment, it follows that the existing system of social institutions and structure — the "social order" — becomes fixed around a stable set of economic institutions, including how production is organized and all inputs are combined and used. This includes how the environment and natural resources are used and combined with other inputs, such as technology and knowledge, in production.

The result, however, is that, despite rising ecological scarcity, the economy continues to use and exploit ecosystem goods and services in the same manner as before.

As ecosystem goods and services become scarce, the transactions costs of finding, using and developing either: (i) completely different ways of using the environment and natural resources; or (ii) novel ways of substituting other inputs for scarce ecosystem goods and services are extremely high. Our institutions and social order are oriented not towards reducing these new transaction costs but are instead built up around reducing the transaction costs of the existing production and exchange relationships.

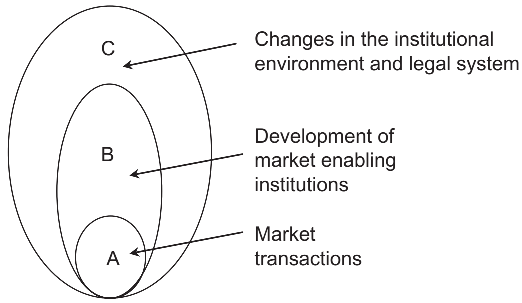

Figure 2. The transaction costs of environmental policy change.
Source: Adapted from McCann *et al*. (2005).

These relationships depend, in turn, on perpetuating the same way in which we use ecosystem goods and services in combination with other inputs.

Thus, from a social perspective, it is more cost-effective to continue the same production patterns, including replicating the pattern of finding, exploiting and using the same set of environmental and natural resources. As a consequence, we may become more aware of the rising ecological scarcity associated with perpetuating the same pattern of economic development, including overreliance on ecological degradation. But the high relative transaction costs involved in making the necessary corrections to the market, policy and institutional failures, compared to perpetuating the same pattern of production and environmental use, seem prohibitive.

Figure 2 illustrates the magnitude of the problem often confronted with instigating policies to correct market, institutional and policy failures that contribute to environmental problems. When a new policy is implemented, such as a tax on pollution or implementing licenses for resource harvest or establishing a new protected area, additional market transaction costs in the form of search and information costs, bargaining and decision costs, and policing and enforcement costs are bound to occur (Area A). Establishing some market-based instruments and trading mechanisms, such as taxes, tradable permit systems and new environmental markets, such as payments for ecosystem services, will also require the establishment or reallocation of property rights to facilitate these instruments, and the setting up of new public agencies and administrative procedures to record, monitor and enforce trades. Thus the full transaction costs of the policies will be areas A and B in the figure. Finally, if additional changes in the institutional environment and legal system are required, the transaction costs will be larger still, including areas A, B and C. Of course, if the type of new mechanism required is at the global level, such as the implementation of an international payments scheme for ecosystem services, then the magnitude of these transaction costs will be even larger, especially area C.

All three types of transaction costs have proven to be barriers to implementing a wide range of environmental

Table 2. Transaction cost barriers to establishing water markets and trading

- Water rights or water usage rights are not well established, quantified and separated from the land.
- Water rights are not registered, and people are not well informed about water trading.
- Organizational or management mechanisms are not in place to ensure that the traded water reaches the owner or owners.
- The infrastructure for conveying water is insufficiently flexible for water to be rerouted to the new owner.
- Mechanisms are not in place to provide "reasonable" protection against damages caused by water sale for parties not directly involved in the sale.
- Mechanisms are not in place to resolve conflicts over water rights and changes in water use.

Source: Based on Easter and Archibald (2002).

policies. They may be especially relevant for policies to combat global warming and promote the long-run transition to a low-carbon economy. As several studies have shown, transaction costs are attributed to delaying or inhibiting the implementation of carbon taxes or tradable permits; adding to the costs of technological change and greenhouse gas (GHG) abatement; and reducing the effectiveness of the clean development mechanism (Grubb *et al*., 1995; Michaelowa and Jotzo, 2005; Schwoon and Tol, 2006). Without the successful implementation of policies to: control GHG emissions; spur research and development into clean energy technologies; and disseminate these technologies globally, economies will remain fundamentally dependent on fossil fuel energy for some time to come.

Transaction costs have been especially problematic for ameliorating freshwater scarcity. Most policy recommendations for tackling water scarcity emphasize the need for more efficient water allocation and trading to conserve supplies and moderate demand (Easter and Archibald, 2002; Hellegers and Perry, 2006; McCann and Easter, 2004; McCann *et al*., 2005). The use of water markets and market-based reforms for a wide range of water sector applications is growing globally. Active markets are emerging in Australia, Canada and the United States, but also in Brazil, Chile, China, Mexico, Morocco, South Africa and Turkey, as well as in many other countries and regions. But, as listed in Table 2, the magnitude and incidence of the transaction costs associated with such allocation mechanisms are often significant. Establishing and enforcing water rights and trading schemes, as well as putting in place mechanisms to resolve conflicts over water rights and use are some of the more prohibitive costs to establishing effective water markets and trading.

For example, as Hellegers and Perry (2006) found, one reason why establishing irrigation water pricing in Egypt, India and Indonesia has proved less successful than in Morocco is that the irrigation system in the former countries is not designed for the use of volumetric charges and tradable water rights whereas the system in Morocco is. There are also no legally defined groundwater rights in Egypt and India. In Ukraine, there are problems with the smaller scale of privatized farms relative to the larger "block" supply of irrigation water. Finally, in many countries, farmers are resistant to switching to water markets when the predominant method of allocation has been the rationing of irrigation water, which does not involve charges to recover costs.

As these examples indicate, the transaction costs associated with correcting market, institutional and policy changes are significant but not insurmountable. What is clearly needed is for more research illustrating the consequences of not making these changes. As illustrated in Figure 1, that means more ecological and economic analysis of the consequences of increasing ecological scarcity, more valuation and policy analysis of the effects of failing to incorporate the value of ecosystem goods and services in market and policy decisions, and more studies of how the "five *i*'s" can help alleviate the excessive environmental degradation and ecosystem loss associated with the current pattern of economic development.

3. Funding challenge

The wide gap between the global benefits that humankind receives from ecosystems and what we are willing to pay to maintain and conserve them is a critical symptom of how oblivious we are to the risks arising from the excessive ecological deterioration caused by the current pattern of economic development. There are two aspects to overcoming this funding challenge. The first is the design of adequate global mechanisms that provide adequate compensation for ecosystem services. The second is to raise and provide adequate financing for these mechanisms and global ecosystem conservation in general.

Table 3 outlines actual and potential compensatory mechanisms and funding sources for global ecosystem conservation. One of the compensatory mechanisms, the Global Environmental Facility (GEF) of the United Nations (UN), has been in operation since 1991. To date the GEF has allocated US$ 9.2 billion, supplemented by more than US$ 40 billion in co-financing, for over 2,700 projects in 165 developing economies.[5] One type of scheme for international payment of ecosystem services (IPES) is the deforestation and forest degradation (REDD) mechanism, which has been operating as a pilot initiative with a budget

[5] From www.theGeF.org, as of November 2010. The GEF partnership includes 10 international donor agencies: the UN Development Programme; the UN Environment Programme; the World Bank; the UN Food and Agriculture Organization; the UN Industrial Development Organization; the African Development Bank; the Asian Development Bank; the European Bank for Reconstruction and Development; the Inter-American Development Bank; and the International Fund for Agricultural Development.

Table 3. Financing mechanisms for funding global ecosystem conservation

Mechanism	Description
Global Environmental Facility (GEF)	A multi-donor global mechanism to meet the additional costs of developing countries in achieving global environmental benefits from biological diversity, climate change, international waters, ozone layer depletion, reduced land degradation and abatement of persistent organic pollution
International payment for ecosystem services (IPES)	A global mechanism for raising and distributing funds from beneficiaries of ecosystem services to those who conserve them
Reduced emissions from deforestation and forest degradation (REDD) scheme	A specific IPES aimed at reducing greenhouse gas emissions from deforestation and forest degradation (REDD) in developing countries
Global carbon cap and auction systems	Allocating a proportion of funds raised from a cap and auction scheme for CO_2 emissions among wealthy nations
Global carbon tax	Allocating a proportion of funds raised from taxes on CO_2 emissions among wealthy nations
Financial transaction taxes (FTT)	Taxes collected on the sale of specific financial assets, such as stock, bonds or futures
Currency transaction taxes (CTT or Tobin tax)	Taxes applied to currency exchange transactions
International Finance Facility (IFF)	Mobilize financing from international capital markets by issuing long-term bonds repaid by donor countries.
Taxes on airline travel or fuel	Taxes applied to international airline ticket sales or fuel use
Taxes on global arms trade	Taxes applied to international export sales of armaments

Source: Author's elaboration.

of US$ 75 million but with promised pledges from donors totaling US$ 4 billion (Phelps *et al*., 2011). The other financing mechanisms listed in Table 3 have yet to be implemented but have been discussed and debated as potential ways of providing substantial additional funding for the GEF, REDD, new IPES schemes, or possibly as direct sources of financing ecosystem conservation globally.

Such additional funding is clearly needed in the case of the GEF. Although the multi-donor funding mechanism made a promising start in providing additional financing for a variety of global public goods in developing countries, since 1994 its total budget allocation has declined in real terms (Clemençon, 2006). Thus, concerns have been raised about its future role and the need to raise additional funds other than conventional development assistance (Clemençon, 2006; Mee *et al*., 2008). Increasing significantly the resources of the GEF is essential if it is to be transformed into an innovative mechanism for delivering global ecosystem benefits; this can only be accomplished if the GEF has sufficient funds to compensate developing countries for land use change and other economic activities that are the cause of ecological degradation worldwide. Currently, the GEF is incapable of doing the latter. As summarized by Clemençon (2006, p. 69): "The GEF's capacity to fund new initiatives and sustain results during the long term is questionable without a gradual but predictable increase in the flow of resources". Such an increase in funding through conventional development assistance for the GEF is unlikely, given the current concerns over budget deficits and long-term debt in the major North American and European donor governments.

Recent progress has been made in establishing international payments for global ecosystem services (IPES), and most notably the nascent financial mechanism to reduce emissions from REDD. However, several important concerns have arisen with respect to REDD, which are symptomatic of the general difficulty of establishing such international payment schemes. REDD is primarily focused on one global ecosystem service, the protection of forests for carbon sequestration. Yet, even attaining this objective faces obstacles. Monitoring and verifying changes in deforestation rates in developing countries and their impacts on carbon emissions could increase substantially the transaction costs of implementing a REDD scheme on a global scale (Karsenty, 2008; Kindermann *et al*., 2008; Olander *et al*., 2008). In addition, a carbon market for avoided deforestation may not necessarily be the best way of protecting forests that yield other global ecosystem services (Ebeling and Yasué, 2008; Grainger *et al*., 2009; Levin *et al*., 2008; Redford and Adams, 2009; Venter *et al*., 2009). There is also concern over the high opportunity costs faced by many developing countries from losses in foregone agricultural and timber benefits (Angelsen, 2010). These issues need to be resolved if there is to be a successful REDD financial mechanism implemented on a global scale. As a consequence, REDD projects currently face uncertainty over future demand for carbon credits, the feasibility of long-term donor financial assistance and the possibility of a short-lived REDD mechanism. (Phelps *et al*., 2011).

With regard to negotiating and implementing a more comprehensive international scheme to cover a wider range of ecosystems and yield global benefits, the best outcome that we can hope for currently is a scheme that is underwritten by only a handful of rich countries, and which is capable of providing a level of global ecosystem protection that is only slightly more than current efforts (Barbier, 2001). Although they may be supported through multi-lateral and bilateral assistance, developing countries will continue to bear the direct and opportunity costs of ecosystem conservation for the foreseeable future. Clearly, this perpetuates the unsustainability problem, especially given rising global ecological scarcity. But to overcome the economic disincentives that are reinforcing such an outcome, the international community needs to think more creatively as to how to agree, design, implement and verify international mechanisms for payment of ecosystem services. We also need to develop more innovative ways of financing such schemes, other than the traditional methods of development assistance or transfers.

In sum, IPES and REDD may represent promising new mechanisms of financing of global ecosystem conservation, but the challenge will be to find new sources of funding to make these schemes effective and to allow them to operate on a sufficient global scale. For example, Farley *et al.* (2010) argue that some of the funds raised through a global cap and auction system for greenhouse gas (GHG) emissions among wealthy nations could be diverted to fund international payment for ecosystem services, with the financing apportioned to targeted countries in accordance with how well they meet specific criteria for the provision of global ecosystem services. Similarly, in the case of REDD, the annual cost of reducing global deforestation by 10% may be around US$ 0.4 to 1.7 billion, but the additional financing through carbon markets could earn developing countries US$ 2.2-13.5 billion annually (Ebeling and Yasué, 2008; Kindermann *et al*., 2008). But the same disincentives that work against negotiating an international agreement for IPES mechanisms would also have to be overcome to set up an international cap and auction system for GHG emissions (Aldy and Stavins, 2007; Olmstead and Stavins, 2006).

Although the world economy has made tentative steps towards international trading in GHG emissions, it is not there yet by any means. By establishing the first regional carbon market with its emissions trading system (ETS), the European Union has demonstrated how international trading can function to provide regional incentives for reducing GHG emissions: a European-wide carbon price has been created; businesses began incorporating this price in their decisions; and the market infrastructure for multilateral trading in carbon has been set up. But expansion and reform of the ETS is needed if it is to become the basis of a global trading scheme (Convery, 2009; Ellerman and Joskow, 2008; Stankeviciutute *et al*., 2008). Similarly, the clean development mechanism (CDM) has become the basis for establishing projects and investments for large emerging market economies, such as Brazil, China, India, South Korea and Mexico, effectively linking them into global GHG emissions trading and financing. As with the ETS, however, reform and expansion of the CDM is essential to cover a broader range of GHG reduction projects and developing economies if it is truly to be the basis for a global carbon market (Barbier, 2010).

A number of important economies, such as Australia, Canada, Japan, New Zealand, Norway and Switzerland, have proposed or implemented cap-and-trade systems, which could link into the larger international trading network. In addition, GHG trading has been established in the northeastern US states, although cap-and-trade legislation for the entire US still seems unlikely for political reasons. The basis for a global carbon market is clearly emerging, but it needs to become a major priority not only for enhancing efforts to green the present economic recovery but also to provide the incentives for long-term targets to reduce carbon dependency in the world economy. But even the latter development is a far cry from establishing an international cap and auction system for GHG emissions that would also provide additional funding for biodiversity and ecosystem conservation globally. An alternative to raising funds through an international cap and auction scheme would be to implement a global carbon tax on GHG emissions (Hyder, 2008; Nordhaus, 2007; 2010). As suggested by Nordhaus (2007), countries set market penalties on GHG emissions at levels that are equalized across different regions and industries. The tax would be set low initially, and rise steadily over time to reflect the rising damages from global warming. Estimated revenues from such a scheme could range from US$ 318 to US$ 980 billion by 2015 (in 2005 prices) and US$ 527 to US$ 1,763 billion by 2030 (Hyder, 2008). Conceivably, some of these revenues could be used to finance IPES schemes, the GEF and other global initiatives for ecosystem conservation.

However, as Nordhaus (2010, pp. 5-6) acknowledges, international agreements on harmonized taxes on GHG emissions are proving to be more elusive than for IPES or carbon cap and trade: "Economists often point to harmonized carbon taxes as a more efficient and attractive regime, but these have been generally shunned in negotiations, particularly in the United States, because of the taboo on considering tax-based systems". In addition to its political infeasibility, a global carbon tax for ecosystem conservation will face a number of obstacles to its implementation. Any such tax is likely to be collected nationally, and then a proportion of the revenues allocated to an appropriate international institution. How tax revenues are to be apportioned between national and international spending priorities may be difficult to resolve. Although it is possible that some revenues would be allocated to global ecosystem conservation, a more likely use of a carbon tax would be to finance schemes related to combating global climate change, such as: developing REDD; expanding the CDM; transferring low-carbon and clean energy technologies to developing economies; and establishing an adaptation fund for poor countries. The projected funding needs for the latter schemes are also considerable; for example, to adapt to the impacts of climate change, developing countries are estimated to need around US$ 15 to US$ 30 billion in additional development assistance to 2020 (Project Catalyst, 2009).

The idea of an international finance facility (IFF) is to mobilize resources from international capital markets by issuing long-term bonds that are repaid by donor countries over 20 to 30 years. This approach has already been applied to the IFF for Immunization (IFFIm), which was launched in 2006 by the UK and supported by France, Italy, Spain, Sweden, the Netherlands, Norway and South Africa. These countries have pledged to contribute US$ 5.9 billion over 23 years.[6] IFFIm raises finance by issuing bonds in the capital markets to convert these long-term government pledges into funds for immediate investment. The government pledges are then used to repay the IFFIm. So far IFFIm bonds have raised US$ 2.6 billion in financial resources through its bonds, which receive a triple-A rating. The investments are disbursed through the Global Alliance on Vaccines and Immunization (GAVI), a public-private partnership of major stakeholders in immunization in the developing world. Since inception, IFFIm has approved immunization programmes of US$ 2 billion and disbursed US$ 1.2 billion to support vaccine purchases and delivery to 70 developing countries. The World Bank acts as financial advisory and treasury manager to the IFFIm.

One of the perceived advantages of the IFF approach is that, unlike other potential new sources of global financing or mechanisms, it can be started by a handful of donor countries without the need for an international agreement involving many countries (Addison *et al*., 2005). On the other hand, if the IFFIm is any guide, the funds raised are more likely to be in the tens of billions rather than hundreds of billions. Doubts have therefore been raised over the ability of the IFF approach to overcome on its own major shortfalls in international assistance, such as for global ecosystem conservation (Moss, 2005). Still, an IFF for global ecosystem protection would be an innovative and potentially viable financial mechanism, and as the IFFIm has shown, can easily work with existing development institutions, such as the World Bank. A similar funding relationship could easily be worked out between any IFF and the GEF, or possibly a new IPES scheme such as REDD.

A financial transaction tax (FTT) is gaining ground as one possible long-term funding source for global public goods, such as ecosystem conservation (Addison *et al*., 2005; Clemençon, 2006; Griffith-Jones, 2010; Koch-Weser, 2002; Spahn, 2010). An FTT is a tax collected on the sale of specific financial assets, such as stock, bonds or futures. A variant is a currency transaction tax (CTT), or Tobin tax, named after the economist James Tobin who first proposed it in the 1970s. This is a tax applied to any foreign currency exchange transaction.

An FTT is usually seen as a tax that would be implemented nationally, and in fact, such taxes already exist, as in the case of the stamp duty tax in the United Kingdom. The 2008-09 global recession has renewed impetus in establishing a global tax. For example, the UN-sponsored Leading Group on Innovative Financing for Development has concluded that a CTT is the most desirable and feasible option for overcoming the chronic underfunding of global public goods, partly because it would be relatively easy and cheap to implement (Griffith-Jones, 2010). There are concerns that a CTT or any other FTT could disrupt trading liquidity and fail to curb speculation, but as argued by Spahn (2010, p. 12): "A very small tax rate (0.005% or less) is unlikely to affect liquidity seriously. And there are ways of distinguishing between liquidity trading and speculation in practice". Even such a small tax rate could raise substantial funds globally for public goods, such as ecosystem conservation. Foreign exchange transactions totaled US$ 800 trillion in 2007, which means that even a negligible tax rate could raise substantial revenues for global public goods (Spahn, 2010).

Instead, the major obstacle to an international FTT is implementation. Any global FTT or CTT would still involve some form of negotiated international agreement involving many countries (Addison *et al*., 2005; Spahn, 2010). France and Belgium have adopted CTT legislation, but its implementation is contingent on other European Union (EU) countries adopting the tax (Spahn, 2010). Initially, then, a FTT or CTT is likely to be collected nationally, with a proportion of revenues transferred to international agencies, such as the World Bank or GEF, for disbursement. But that means the most likely priority for their revenues is to support national public budgets, including the reduction of chronic fiscal deficits in some countries, which in turn would limit the proceeds available for ecosystem conservation and other global public goods. As an alternative, proceeds from a CTT or FTT could be channeled to a global solidarity fund, which would then use the proceeds to fund international conservation and similar investments (Griffith-Jones, 2010). Negotiating and establishing another international funding mechanism would be yet another international policy challenge.

As in the case of an FTT or CTT, an arms trade or airline travel tax to raise revenues for global public goods has been proposed for some time (Addison *et al*., 2005; Brzoska, 2004; Koch-Weser, 2002). For example, a 10% tax on global arms exports could raise up to US$ 5 billion (Brzoska, 2004). However, compared to a CTT or FTT, this is not a negligible tax for revenue-raising purposes, and as a result, perhaps more difficult to implement politically and would create more incentives to evade or avoid, especially by arms importing developing countries. The result could be to raise the risk of transferring much of the trade to the black market. In the case of taxes on airline travel or fuel, national governments have already raised substantially such rates, and there are concerns of how further tax increases would affect a struggling international air travel industry. For an arms trade tax there is also the problem of low level of transparency, especially for the trade in small arms and light weapons (Brzoska, 2004). Finally, any tax on the arms trade or on airline travel or fuel would require a negotiated international agreement, which as we have seen is very difficult to negotiate successfully.

4. Conclusions

The sobering conclusion of this paper is that fostering increased investments in clean energy and energy efficiency

[6] Information on the IFFIm can be obtained from its website www.iff-immunisation.org.

is an important step to achieving more sustainable economic development, but it is unlikely to be sufficient. Unless a concerted global policy effort is devoted to overcoming the sustainability and funding challenges of rising ecological scarcity worldwide, the welfare of current and future generations is at risk.

These two challenges are clearly interlinked. If international policymakers are more willing to break the current vicious cycle and treat ecological scarcity as a threat to sustainable economic development, then the world is also more likely to address the current global shortfall in ecosystem conservation. This paper has tried to identify areas in which progress is currently being made to address these challenges.

For instance, there is a growing cooperation between natural scientists and economists in identifying and assessing the loss of economic benefits that are occurring with the decline in ecosystem goods and services (Millennium Ecosystem Assessment, 2005; Polasky and Segerson, 2009; TEEB, 2010). A good example of an attempt to make progress in these areas of research is the international project The Economics of Ecosystems and Biodiversity (TEEB), which is attempting to go beyond economic valuation to identify the five *i*'s indicated in Figure 1 that are required by policymakers and businesses globally (Sukhdev, 2008; TEEB, 2010). As awareness of the economic implications of ecological scarcity spreads among policymakers, hopefully it will spur more action at the local, national and global level to tackle this pressing problem.

The funding challenge to worldwide ecological scarcity remains a significant impediment. Nearly all major international efforts to address this problem will require some form of international negotiation and agreement. The failure of the international community to reach a deal on a post-Kyoto climate change agreement is yet another precedent for failure. Nor are prospects in the near future encouraging. As Nordhaus (2010, p. 6) concludes: "The checkered history of international agreements in areas as diverse as finance, whaling, international trade, and nuclear nonproliferation indicates the extent of the obstacles on the road to reaching effective international agreements on climate change". It is not clear that global ecosystem and biodiversity conservation will necessarily prove to be the first breakthrough of this policy conundrum (Barbier, 2001).

However, as summarized in Table 3, there are a number of possible innovative financial mechanisms available to fund the current shortfall in global biodiversity and ecosystem conservation funding. Perhaps the most promising way forward is some form of intervention in the global financial sector, either a financial transaction tax (FTT), a currency transaction tax (CTT) or an international financial facility (IFF). One advantage of the IFF approach — in comparison to other potential new sources of international public goods financing, such as a CCT, FTT, and taxes on airline travel or fuel or the arms trade — is that the alternatives to the IFF were less desirable, since they need international agreement among many countries (Addison *et al*., 2005). As the current IFF for Immunization (IFFIm) has shown, such a financing mechanism can be started by a handful of donor countries. The most likely outcome for implementing an IPES scheme for global ecosystem benefits or biodiversity conservation may be a scheme that is underwritten by only a limited number of rich countries (Barbier, 2001). If these potential donors are also willing to use an IFF to fund an IPES, then the long-term financing of such a mechanism is more likely to be secured.

Of course, as we have seen, the downside of an IFF is that the financing raised is likely to be insufficient. Only US$ 2.6 billion in additional investment funding has been leveraged by the sale of bonds by the IFFIm. Not an insubstantial fund but still much less than the "hundreds of billions" required for ecosystem and biodiversity conservation globally (Pearce, 2007). The only likely alternative that would raise more substantial funds quickly is a currency transaction tax (CTT). Although support for a global CTT scheme is growing in the international community, major implementation obstacles remain: the need for an international agreement on its operation and governance, as well as rules and procedures for the collection and disbursement of revenues. But there are still two reasons why a CTT might be attractive. First, there is the appeal of recycling funds collected from the growth of currency transactions to reinvest back in the conservation of natural capital for the greater global public good. Second, as argued by Griffith-Jones (2010, p. 17): "Improving the net contribution of the financial sector to the real economy, and to the welfare of ordinary people, would significantly rehabilitate the financial sector's battered image, a desirable aim for the financial sector itself".

Perhaps this is the greatest opportunity for hope. If not only policymakers but also the international business community sees the advantage of cooperating to improve human welfare, then maybe the world has a chance to address in time the threat to economic sustainability posed by increasing ecological scarcity.

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