A global natural resource consumption tax

Author: Sally-Ann Joseph

Affiliation: PhD researcher, Australian School of Taxation and Business Law (ATAX), University of New South Wales, Australia

Address: 19 Koorong Street, Berowra, NSW, 2081, Australia

Email: sally@corporatereform.com

Abstract

In 1992, at the Rio Earth Summit, developed countries accepted responsibility for financing the climate change adaptation costs of developing countries. The Bali Action Plan of 2007 calls for developed countries to allocate 'adequate, predictable and sustainable financial resources…[and] new and additional resources, including official and concessional funding' as well as 'innovative means of funding' to help developing countries adapt to climate change. While a number of models have been suggested, there has been little impetus to determine each country's share of financing largely due to a lack of consensus on the interpretation of burden-sharing. The majority of international public finance is generated through voluntary obligations and what has been pledged falls far short of what is needed.

The global natural resource consumption tax is a user-pays compensatory tax model based on current consumption of natural resources and absorption of wastes. The purpose of the proposed tax is to raise the revenue necessary to fund climate change mitigation and abatement programs. By applying a price on biological capacity, countries whose demand for resources exceeds their own national capacity supply should pay for what has traditionally been seen as 'the global commons'. The concept of the Ecological Footprint is used to determine a country's consumption level. The advantages of the Ecological Footprint are that it only accounts for the water and land types considered biologically productive and it takes international trade into account. It is therefore suitable for determining consumption.

Due to its inherent simplicity, the global natural resource consumption tax can aid in economic, environmental and social policy-making and decision-making. For example, it highlights the fact that refraining from engaging in economic activity that is harmful to natural environments may be more financially productive in the long run. Importantly, this tax ensures that the cost of resource consumption is measured. Once measured, natural resources can be monitored, thus more effectively managed.

Keywords:
global tax, biocapacity, ecological footprint

1. The issue

Every human activity uses biologically productive land and/or water. This is the area that supports human demand for food, fibre, timber, energy and infrastructure and absorbs wastes. This area comprises approximately one quarter of the Earth's surface or just over 11 billion hectares (Kitzes et al 2008). Areas such as deserts, glaciers and the open ocean are not considered to be 'biologically productive'. Biological capacity (or biocapacity), on the other hand, is the ability of the Earth to produce and/or regenerate biological resources and to absorb its wastes. It is not concerned with non-renewable resources.

A country's biocapacity is determined by two factors: the area of 'designated' land available and how productive that land is (WWF 2010). The 'designated' land consists of cropland, grazing land, fishing grounds and forests. Low-income countries are highly dependent on their natural resources where nearly 70 per cent of their natural wealth is cropland and grazing land (World Bank 2006).[1] Productivity is measured by the yield and varies between countries according to such things as climate and soil conditions. Technological changes and evolving management practices can also have an effect. As an example, the area of land used for growing cereals has remained relatively constant since 1961 while the yield per hectare has more than doubled (WWF 2010).

Over 60 per cent of the Earth's biocapacity is found in just 10 countries as illustrated for 2007 in Figure 1. The uneven distribution of biocapacity raises geopolitical and ethical questions regarding the sharing of the Earth's natural resources.

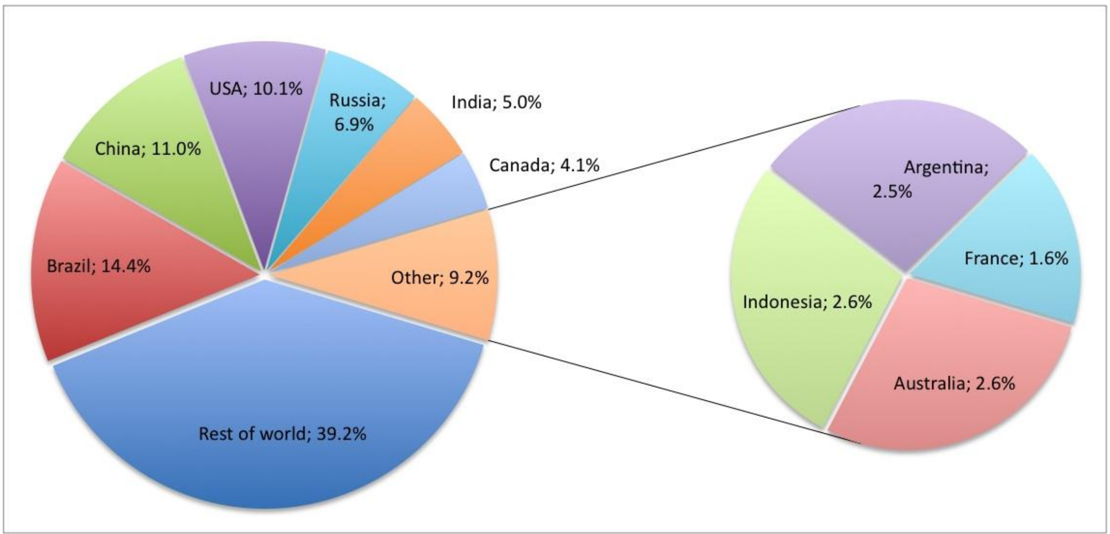

Figure 1: Global biocapacity distribution (Footprint Network 2010)

Biocapacity can also be viewed on a per capita basis. The biocapacity available per person is not fixed and will diminish as the population increases. This trend is depicted in Figure 2. Indeed, at a global level biocapacity per person is nearly half the level it was in 1961 (WWF 2010). To the extent that a country is able to consume

[1] These low-income countries exclude oil exporters.

more than its biocapacity can provide, it is imposing a direct environmental cost on those countries that supply it with such means (Torras 2003).

While biocapacity per person will improve as productivity increases, population growth outstrips productivity improvements which are minimal in comparison. Figure 2 therefore assumes constant productivity.

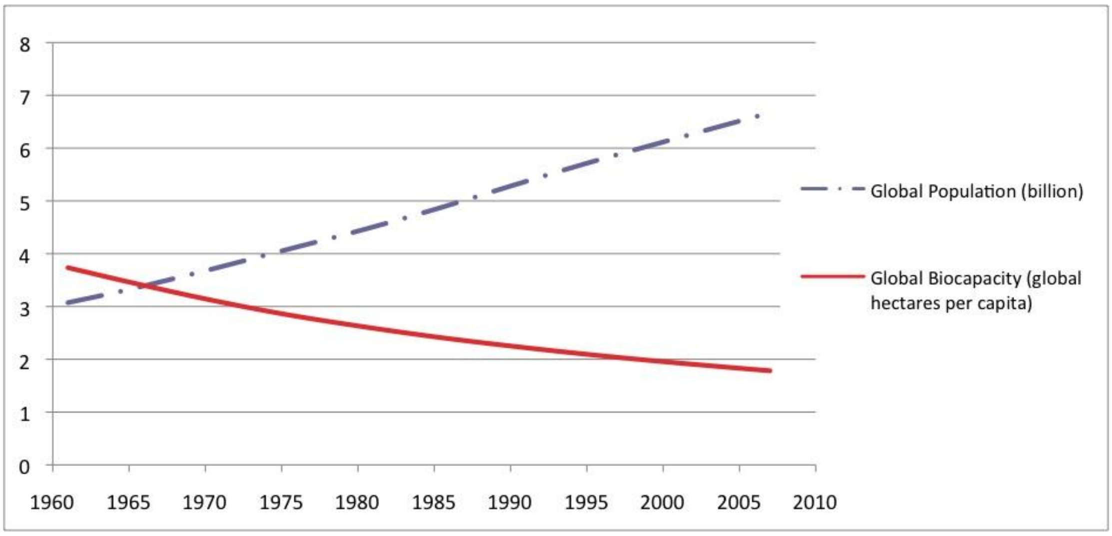

Figure 2: Trends in population and biocapacity per capita (Footprint Network 2010)

The populations of different countries differ greatly in their demands on the Earth's biocapacity, with those in higher income, more developed countries generally making higher demands (WWF 2010). The scale of the impact on biocapacity depends on three factors: (1) population, (2) the amount each person consumes (per capita demand) and (3) the efficiency with which natural resources are converted into goods and services (WWF 2010). Whenever demand for ecological goods and services exceeds supply (or biocapacity), not only is regenerated biological production being consumed but existing ecological capital is being expended. This not only limits what can be regenerated but also depletes the capital reserves for future generations.

Countries also make demands on biocapacity through carbon dioxide (CO_2) emissions. As these emissions disperse throughout the global atmosphere, biocapacity somewhere on the planet is required to sequester them. In addition, emissions are embodied in international trade. It is estimated that, for about 20 large economies, CO_2 emissions embodied in international trade may be 20 to 40 per cent of their domestic emissions (United Nations Environment Program 2010). Switching from a manufacturing to service economy does not necessarily decrease CO_2 emissions as import consumption generally increases. Similarly, manufacturing or resource-rich countries may 'export' significant quantities of CO_2 emissions. These effects can be significant as depicted in Figure 3.

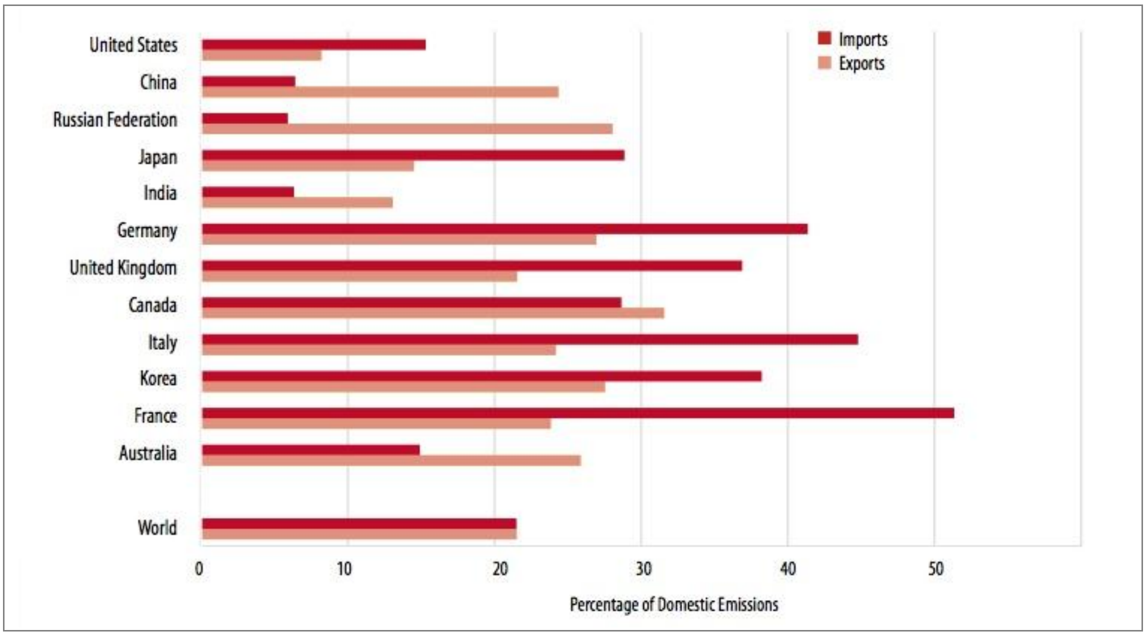

Figure 3: CO_2 emissions associated with internationally traded goods (UNEP 2010)

There is increasing awareness that the global commons provide 'public goods' (such as the absorptive capacity of the atmosphere) to which all human beings have an innately equal claim to but are currently unequally used (Simms 2002). The term 'ecological debt' has been coined to refer to the ecological damage caused by the indiscriminate exploitation of resources and appropriation of the Earth's absorption capacity, essentially as a result of economic and trade relations (Paredis et al 2004).

This paper rests on the underlying assumption that the threat to biocapacity exists and that funding for adaptation to, and mitigation of, climate change effects and the loss of biocapacity are required. The scope of the paper predominantly focuses on proposing a country-sharing financing model. Mentioned for completeness but largely out of scope is how the funds are used, that is the disbursement, distribution and implementation of the funds. Also not considered in detail is the management of the funds including institutional arrangements and governance of funds. Out of scope is a proposal to incorporate a technology-transfer tax rebate.

The remainder of the paper is organised as follows. Section 2 discusses financing. This introduces the applicable Conventions and financing requirements and also outlines current models of public international funding. Section 3 introduces the framework for the global natural resource consumption tax by outlining the concept and the aspects of responsibility and capability. Responsibility is determined using the interrelationship between biological capacity and the Ecological Footprint. With respect to capability, a number of possible indicators are noted. The structure of the proposed tax is enunciated in Section 4, which commences with ascertaining the tax base and tax rate that needs to be determined in order to calculate tax liability. Section 5 outlines options for the governance and disbursement of the tax revenues collected. This is followed by examples to illustrate how the tax is proposed to operate. This is followed by the conclusion in Section 6.

2. Financing

2.1 Conventions

The United Nations Framework Convention on Climate Change (UNFCCC) (Convention) in 1992 divided countries into three main groups according to differing commitments.[2] Annex I countries are those countries that were members of the Organisation for Economic Co-operation and Development (OECD) in 1992, plus countries with economies in transition. Annex II counties are the OECD members of Annex I, also referred to as 'developed' or 'rich' countries and as the 'global north'. They are required to provide financial and technological resources to assist developing countries. All other countries are Non-Annex countries, otherwise known as 'developing', 'poor' or the 'global south'. Of this latter group, 48 countries are classified as least developed countries (LDC) and given special consideration under the Convention.

This Convention became known as the Rio Earth Summit. It was here that developed countries accepted responsibility for financing the climate change adaptation costs of developing countries (United Nations 2009 Article 4; Jones and Edwards 2009). Explicit in the Convention is that responsibility for dealing with the issue is not uniform but should be a function of culpability or responsibility (that is, a 'polluter-pays' perspective) and capacity or capability to pay (Spratt 2009). This is described as 'common but differentiated responsibilities and respective capabilities'(United Nations General Assembly 1992 Principle 7).

The international community adopted the Bali Action Plan (Plan) at the 2007 United Nations Climate Change Conference (World Bank 2010). The Plan calls for developed countries to allocate 'adequate, predictable and sustainable financial resources…[and] new and additional resources, including official and concessional funding for developing country Parties' as well as 'innovative means of funding' (UNFCCC 2008a Decision 1/CP.13) to help them adapt to climate change. Explicitly envisaged was that financial assistance should be 'new and additional' and not count towards a country's official development assistance (Spratt 2009; Klein 2007).

Two submissions to the Bali Action Plan are worth noting: the Group of 77 and China (G77+ China) and the Mexican Climate Change Fund (MCCF) proposals.

G77+ China, a consortium with the political support of more than 130 developing countries, demanded a funding mechanism solely financed by the developed countries (Sinha 2009). It is a widely held view among this group that their responsibility for climate change is negligible given their small cumulative emissions compared to developed countries (Venema and Rheman 2007). Tabled at the Accra Climate Change talks in August 2008, the G77+ China's proposal is for financial contributions of up to one per cent of each developed countries' Gross Domestic Product (GDP) (Spratt 2009; UNFCCC 2008b; Parker et al 2009). Although not linked to emissions and/or population, it is nevertheless considered to be compliant with the Convention and Plan (Sinha 2009).

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[2] These commitments are related to action and reporting on climate change and to providing financial and technological resources. UNFCCC, 'Parties & Observers' <http://unfccc.int/parties_and_observers/items/2704.php> at 25 February 2011.

Under the MCCF (also referred to as a World Climate Change Fund or Green Fund) (Parker et al 2009), non-discretionary contributions to the fund are a function of emissions, population size and GDP. In this respect, emerging middle-income countries are also expected to contribute (Spratt 2009).

2.2 Financial requirements

Climate costs cannot be fully quantified because climate change destroys more than can simply be quantified or valued financially. In addition, too little adaptation has been done to provide robust cost assessments and many future impacts of climate change are still uncertain (Oxfam International 2007). Indeed, the severity of climate impacts will depend on how quickly greenhouse gas emissions are reduced.

While mitigation finance is concerned with reducing the sources (or enhancing the sinks) of greenhouse gases, adaptation finance is more in the nature of compensation for climate change impacts experienced by developing countries from emissions by developed countries.

Funding options for climate change mitigation and adaptation include carbon market instruments, capital market instruments, international taxes, public national funding, public international funding, commercial funding and private investment (Parker et al 2009). In line with the Convention and Plan noted above, this paper focuses solely on international funding.

The majority of international public finance is generated through voluntary contributions (Spratt 2009; Parker et al 2009; Oxfam International 2007). As at 2009, developed countries had pledged a total of US$41.8 billion over three to five years, US$38 billion for mitigation and US$3.8 billion for adaptation (Parker et al 2009). This equates to around US$8 to US$1 0 billion per annum, insufficient to meet the estimated US$80-$140 billion needed annually by developing countries to mitigate and adapt to the effects of climate change (Parker et al 2009).

Due to the scale of the issue, effective mitigation and adaptation will only be possible if it involves both developed and the larger developing countries as part of a global deal (Spratt 2009; Parker et al 2009). Adaptation finance is generally considered to be compensatory in nature; mitigation finance is more of an obligation on the part of developed countries as a result of their disproportionate exploitation of the environment (Spratt 2009).

2.3 Public international funding

There has been little impetus to determine each country’s share of financing largely due to a lack of consensus on the interpretation of burden-sharing (Parker et al 2009; Oxfam International 2007). Nevertheless, a few models have been suggested. Measures of determining financial responsibility differ according to whether both culpability and capacity are considered, the time-extent of emissions, the relative wealth of the nation and whether or not population is a factor.

Three such models are noted here. This is not intended as a critical review of each model but provides context for the proposal of an alternative model.

2.3.1 Stern Review

The Stern Review considers only culpability, does not take population size into account and deems responsibility to extend to cumulative historical CO_2 emissions (Hansen and Sato 2007). That is, from 1751 to 2009. This is depicted in Figure 4.

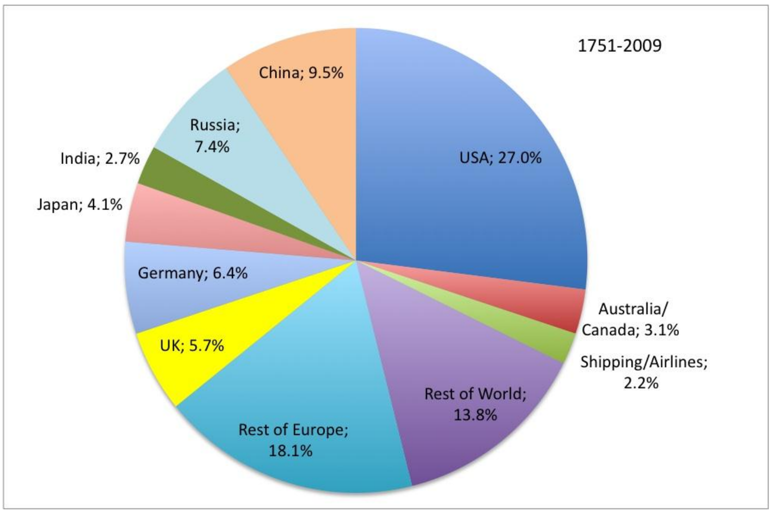

Figure 4: Cumulative emissions (Hansen 2010)

Under this approach, countries such as Russia and China have a larger share of the financial responsibility than the United Kingdom, Germany and Japan notwithstanding that the latter countries are more highly developed and have greater ability to pay (Spratt 2009).

In addition, cumulative historical data are not indicative of current emissions. For example, in 2005 fossil fuel emissions from China and the United States were approximately equal (Hansen and Sato 2007). However, in 2009 China was the single largest emitter as depicted in Figure 5.

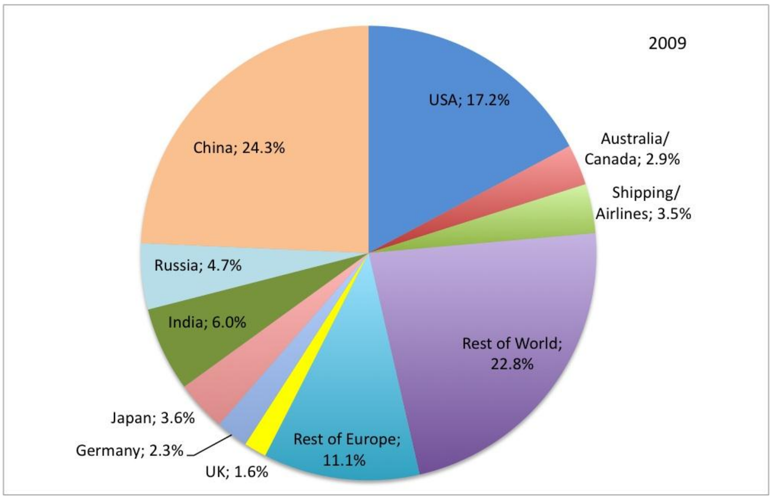

Figure 5: Annual emissions (Hansen and Sato 2007)

As no account is taken of international trade, this infers a producer- or territorial-responsibility rather than consumer-responsibility (Bastianoni et al 2004). For example, approximately 25 per cent of China's emissions are attributable to exports to developed countries (Spratt 2009).

This geographical approach is also proposed by the Intergovernmental Panel on Climate Change (IPCC) as the basis for greenhouse gas inventories (Eggleston et al 2006).

2.3.2 The Adaptation Financing Index

The Adaptation Financing Index (AFI) gives equal weighting to responsibility and capability and is calculated on a per capita basis (Oxfam International 2007). Responsibility is measured as 'excessive' (or greater than two tonnes) CO_2 emissions per person. These emissions are cumulative but only from 1992 when the Convention was signed. In terms of capability, only countries scoring more than 0.9 in the Human Development Index (HDI) are included. This therefore excludes large developing countries such as Brazil, Russia, India and China, the group commonly referred to as the BRIC countries.

Countries' shares of financing under the AFI, as at 2003, are illustrated in Figure 6 and the ratio of responsibility to capability in Figure 7.

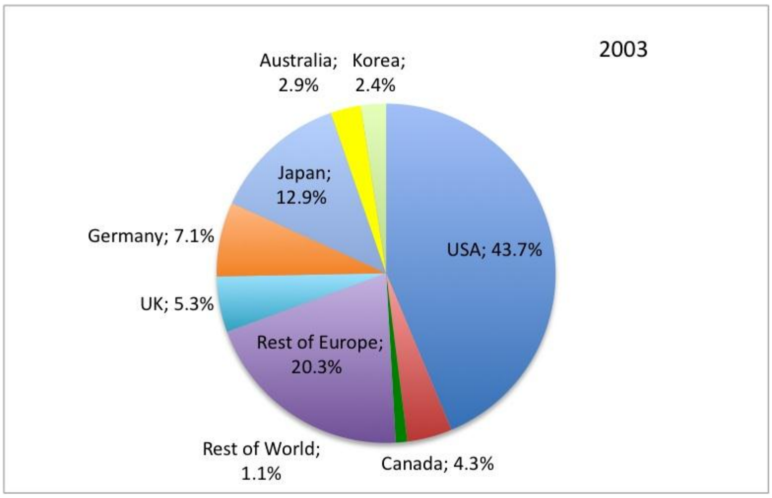

Figure 6: Adaptation Financing Index (Oxfam International 2007)

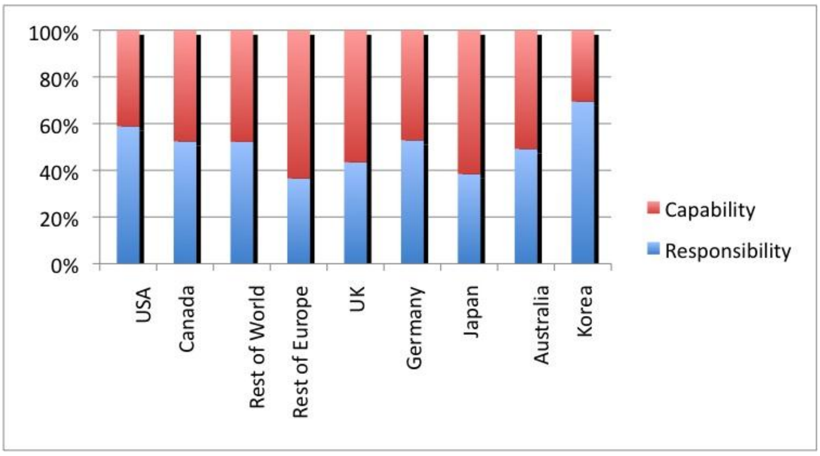

Figure 7: Ratio of responsibility to capability (Oxfam International 2007)

Under this model Japan was responsible for 9.9 per cent of excess global emissions from 1992 to 2003. With a high HDI and its population size, Japan has 15.9 per cent of international capability to assist developing countries. Its AFI is therefore 12.9 per cent.[3] The US, on the other hand, was responsible for 51.4 per cent of the same emissions but its capability is only 36 per cent, giving an average or AFI of 43.7 per cent. With respect to the European Union, only 17 of the 27 member states are included in the HDI with Germany, the United Kingdom, Italy, France and Spain accounting for over three-quarters of its total share (Oxfam International 2007).

Under the AFI model, 28 countries are both responsible for, and capable of, financing adaptation in developing countries (Oxfam International 2007).

2.3.3 The Greenhouse Development Rights

The Greenhouse Development Rights (GDR) approach is similar to the AFI (Spratt 2009) except that it takes explicit account of the unequal distribution of income within a country. A 'development threshold' is determined. This is a level of welfare that is beyond basic needs but below which people are not expected to share the costs of climate adaptation. Responsibility is defined as cumulative emissions since 1990 (the benchmark level of emissions agreed to at the Convention), excluding emissions that correspond to consumption below the development threshold. Similarly, capacity is defined as the sum of all individual income, excluding income below the threshold (Parker et al 2009; Baer et al, 2008). Were it to rely on national per capita averages, it would not reflect the distribution of income and emissions within a country. The resulting indicator depicting a country's share of the global total is referred to as a Responsibility Capacity Index (RCI). Based on projected data, the RCIs for selected countries for 2010 and 2030 are shown in Figures 8 and 9 respectively.

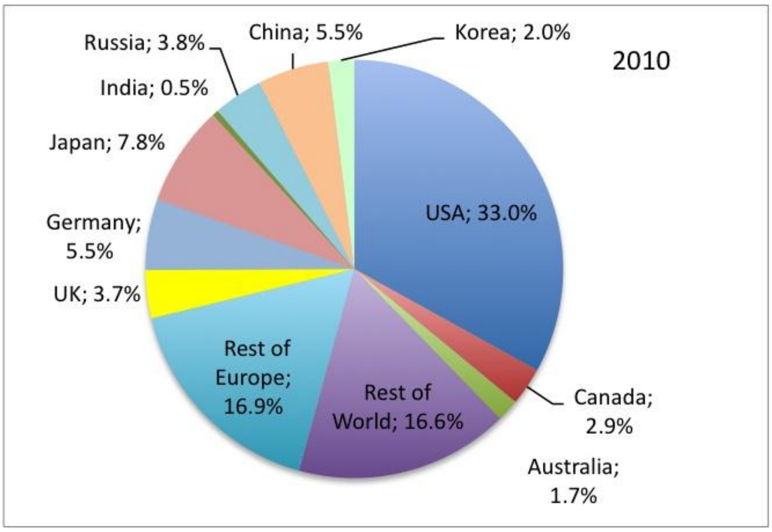

Figure 8: RCI under GDR approach 2010 (Baer et al 2008)

[3] Given by the equation (9.9% * 50%) + (15.9% * 50%).

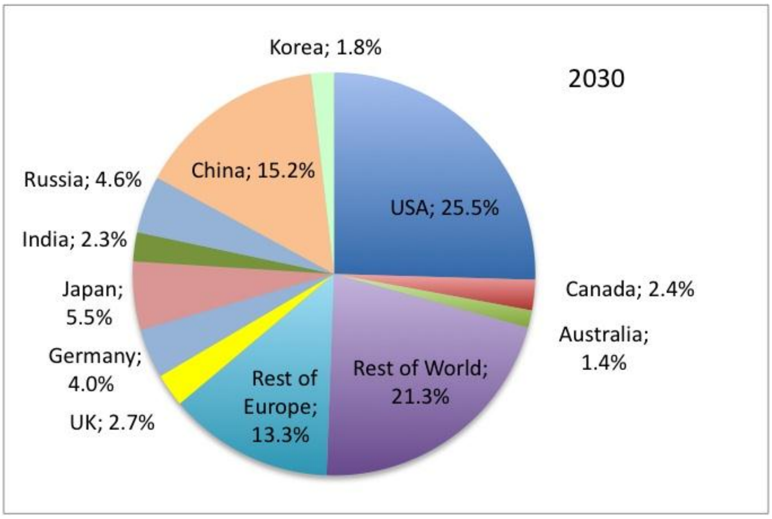

Figure 9: RCI under GDR approach 2030 (Baer et al 2008)

Under this approach, a rich country's capacity will be proportionally larger than its share of global income because the development threshold excludes the income of poor people. Similarly, a developed country's responsibility will be larger than its share of cumulative emissions as fewer of its historical emissions are excluded. Although not currently included in the index, there are plans to take account of emissions 'embodied' in international trade in future development (Baer et al 2008).

3. A global natural resource consumption tax

3.1 The concept

Climate change requires a global framework for international cooperation (UNFCCC 2007). 'Substantially increased international action is required to ensure that opportunities and benefits are widely distributed, and that common goals are realised.'(World Commission 2004) At an international level, the focus has been on trying to develop climate change agreements that impose significant costs on countries emitting carbon dioxide. The proposal here is to impose a tax not only on contamination of the atmosphere through carbon emissions but also on renewable natural resource use. Further, because biocapacity is embodied in imports of raw materials and exports of manufactured products, a consumption model is proposed. Such a tax can be viewed as compensatory transfers from resource-consuming countries to resource-producing countries irrespective of their level of development or wealth status.

Key attributes of this model are that it be principles-based, transparent in its application and respects the right to development. It must also be consistent with the Convention and Plan in that it must be a function of responsibility and capability to pay.

3.2 Responsibility

3.2.1 The Ecological Footprint

Whereas biocapacity represents the availability or supply of resources, the ecological footprint (EF) represents the demand. This is the area of land required to provide the food, energy and materials (or natural resources) people require, the areas occupied by infrastructure and the areas required for absorbing waste (Kitzes et al 2008). Thus the EF is a measure of the resources associated with the final consumption of goods, including imports and exports.

The EF can be described as a measure of the land required to produce a tonne of product. However, because different land types have different capacities to provide resources, land types are converted to a common currency of 'global hectares'.[4] This allows for international comparisons and facilitates tracking embodied biocapacity in international trade flows.

The EF is divided into six major components as listed and explained in Table 1.

Component	**Explanation**
Fishing grounds footprint	Calculated from the estimated primary production required to support the fish and seafood caught, based on catch data
Forest footprint	Calculated from the amount of lumber, pulp, timber products and fuel wood consumed
Sequestration land (or carbon) footprint	Calculated as the amount of forest land required to absorb CO_2 emissions from burning fossil fuels, land-use change and chemical processes, other than the portion absorbed by oceans
Cropland footprint	Calculated from the area used to produce food and fibre for human consumption, feed for livestock, oil crops and rubber
Grazing land footprint	Calculated from the area used to raise livestock for meat, dairy, hide and wool products
Built-up land footprint	Calculated from the area of land covered by human infrastructure, including transportation, housing, industrial structures and reservoirs for hydropower

Table 1: Component definitions (WWF 2010)

With the exception of the sequestration land or carbon footprint, these categories refer directly to similar categories of biologically productive land and water. This therefore allows a comparison to be done to ascertain whether a population group is consuming within its biocapacity or not. This is illustrated at a global regional level for 2007 in Figure 10.

[4] One global hectare (gha) represents the productive capacity of one hectare of land at world average productivity.

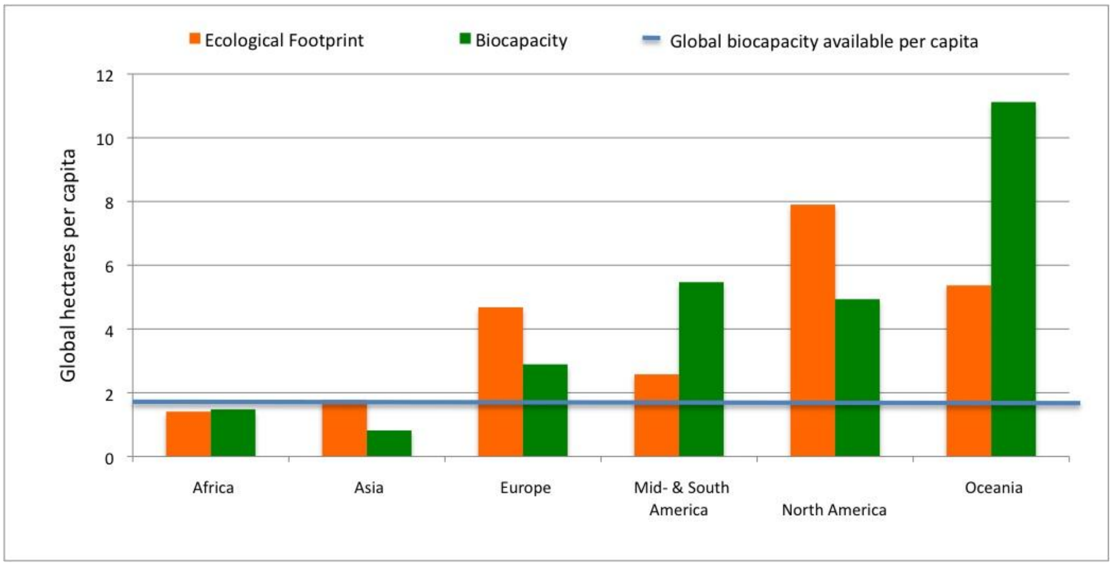

Figure 10: Per capita Ecological Footprint and biocapacity of world regions (Footprint Network 2010)

In 2007, the global biocapacity available per person was 1.8 global hectares as shown by the blue line in Figure 10. Regions such as Europe and North America are net importers of biocapacity whereas Oceania (which includes Australia and New Zealand) and South America are largely net exporters.

The smaller the EF, the more sustainable that pattern of consumption is deemed to be. This is because the size of the footprint is directly related to the size of the land appropriated to support consumption.

The EF is not an economic measure of the amount of output produced; it does not consider labour and capital requirements. The EF is essentially an accounting tool that attempts to measure the extent to which human activities exceed two types of environmental limits: natural resource production and CO_2 absorption. Developed by scientists, the methodology is well established and consistently and uniformly applied (Paredis et al 2004). It is used extensively throughout the world in both developed and developing countries (McDonald and Patterson 2003).

The EF accounts quantitatively for the ecological resources used and waste generated. It does not prescribe what resources should be used and in what quantities nor does it set emission targets. While footprint accounting can determine the average biocapacity available on a per capita basis, it does not stipulate its allocation among individuals or nations. It is objective and non-judgemental. It therefore respects the rights of each country to determine its own optimal land allocation to different crops (food, biofuel, biomaterial and fibre), carbon storage and environmental conservation and thus its level and direction of development. Land competition is likely to be a greater challenge in the future than conventional wisdom suggests (WWF 2010).

3.2.2 Ecological overshoot

When demand (the EF) exceeds supply (biocapacity), the population is consuming renewable resources at a rate faster than ecosystems can regenerate them and/or releasing more CO_2 than ecosystems can absorb. This situation is called 'ecological overshoot'. At a global level, ecological overshoot occurred in the latter half of the 1970s (WWF 2010). Figure 11 shows the relationship between demand and supply since 1961 at a global level.

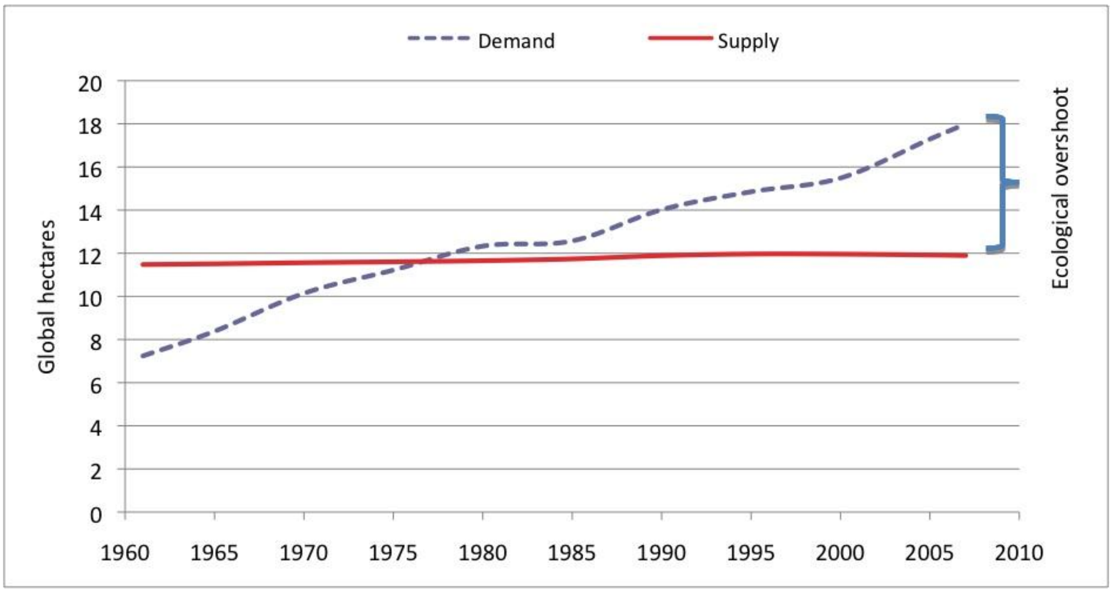

Figure 11: Global overshoot (Footprint Network 2010)

While the biological productivity of the planet changes each year, the net effect is that biocapacity is relatively stable, as shown by the fairly constant supply line in Figure 10 (WWF 2010). Reclaiming degraded land, making marginal land more productive or increasing crop yield can increase biological productivity. Productivity can also decrease. This can be due to, for example, climatic events, increasing temperatures, salinity and pestilence. In addition, a number of factors influence land availability. Examples include competing claims such as food versus biofuel, water availability and land ownership and tenure especially with respect to indigenous people. The EF, on the other hand, is increasing rapidly. This is mainly due to the carbon footprint as shown proportionally in Figure 12.

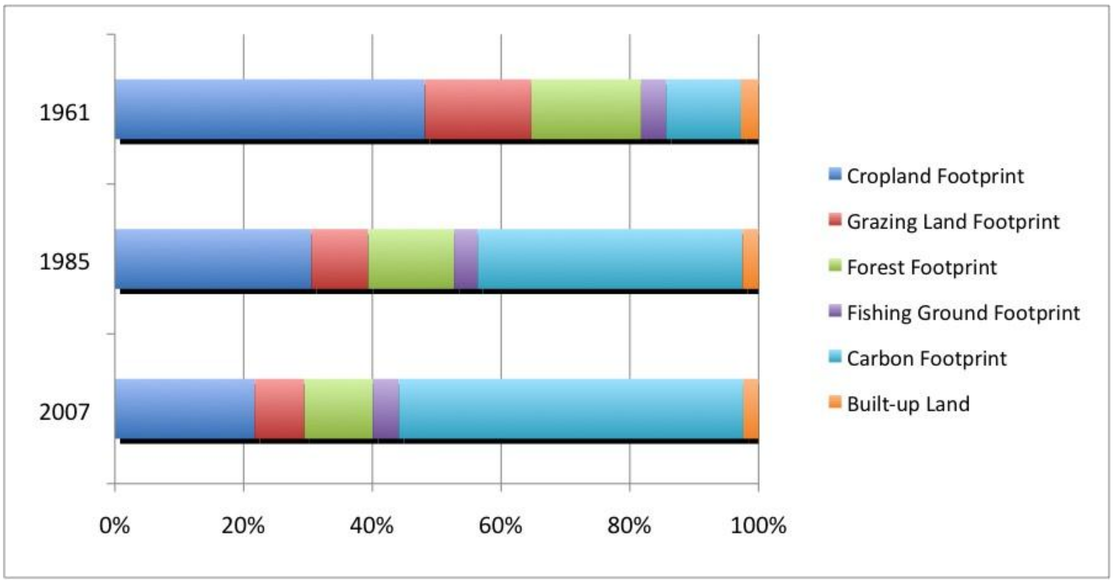

Figure 12: Proportion of footprint components on global basis (Footprint Network 2010).

The carbon footprint of OECD countries is the largest of all regions, increasing 10-fold since 1961 (WWF 2010). However, it has not increased the most rapidly. Over the same period, the carbon footprint of Brazil, Russia, India and China (BRIC) has increased 20-fold, African Union countries by 30-fold and Asian countries, as a region, by over 100 times (WWF 2010).

Population levels are also highly determinate of overshoot. For example, it is generally acknowledged that the higher income, more developed countries make higher demands on biocapacity. As a consequence, the average EF per person in OECD countries should be much larger than in BRIC countries. However, given the population size of BRIC countries, their per capita EF approaches that of OECD countries (WWF 2010).

The top five countries in 2007 for both gross and per capita overshoot are shown in Table 2.

Country	**Region**	**Gross Overshoot (000 gha)**	**Country**	**Region**	**Per Capita Overshoot (gha)**
China	Asia	1,652,027.1	United Arab Emirates	Asia	9.8
United States of America	North America	1,274,129.8	Qatar	Asia	8.0
Japan	Asia	526,122.6	Belgium	Europe	6.7
India	Asia	469,041.4	Kuwait	Asia	5.9
Germany	Europe	259,981.4	Singapore	Asia	5.3

Table 2: Top five overshoot countries in 2007 – gross and per capita (Footprint Network 2010)

On a per capita basis, China ranks 44, India ranks 85 with Japan and the United States of America at 11 and 12 respectively. On a gross overshoot basis, United Arab Emirates is at 21, one behind Belgium at 20. Qatar is ranked 61, below Kuwait at 45.

Where ecological overshoot occurs, ecological debt arises. Such countries (debtor countries) ecologically fund their consumption from the resources of countries whose biocapacity exceeds their footprint (creditor countries). This is illustrated diagrammatically at a global level in Figure 13. The colour and size are representative of the debtor/creditor scale (overshoot in red; ‘undershoot’ in green).

The trend over the period 1961 to 2005 is shown for selected countries in Figure 14.[5]

[5] Note that scales differ.

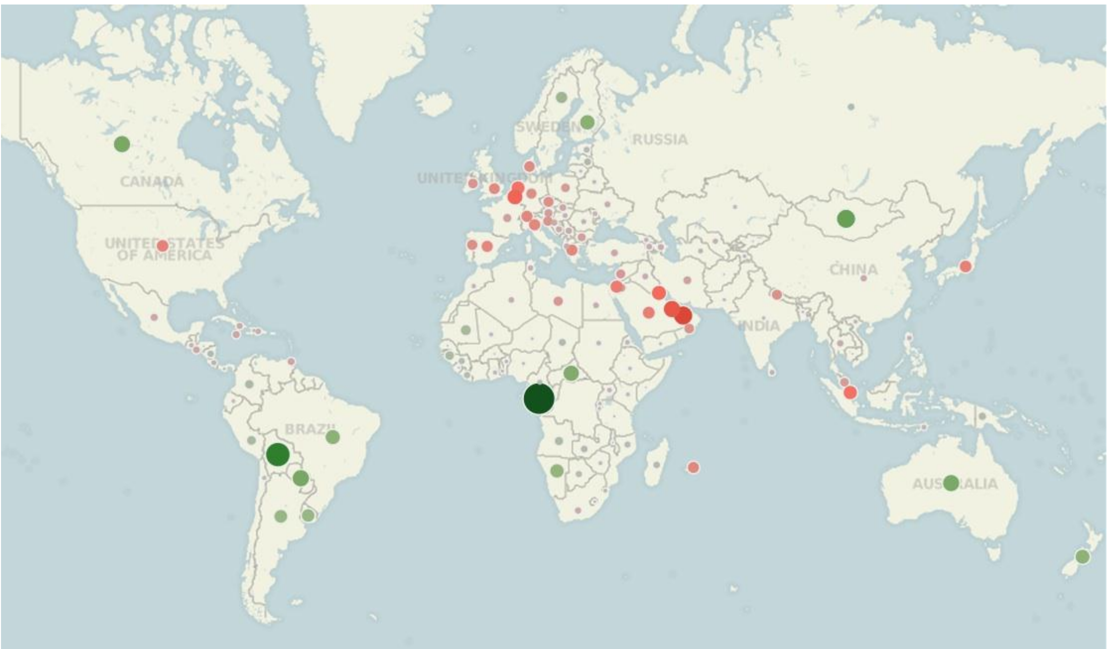

Figure 13: Debtor and creditor countries (Footprint Network 2010)

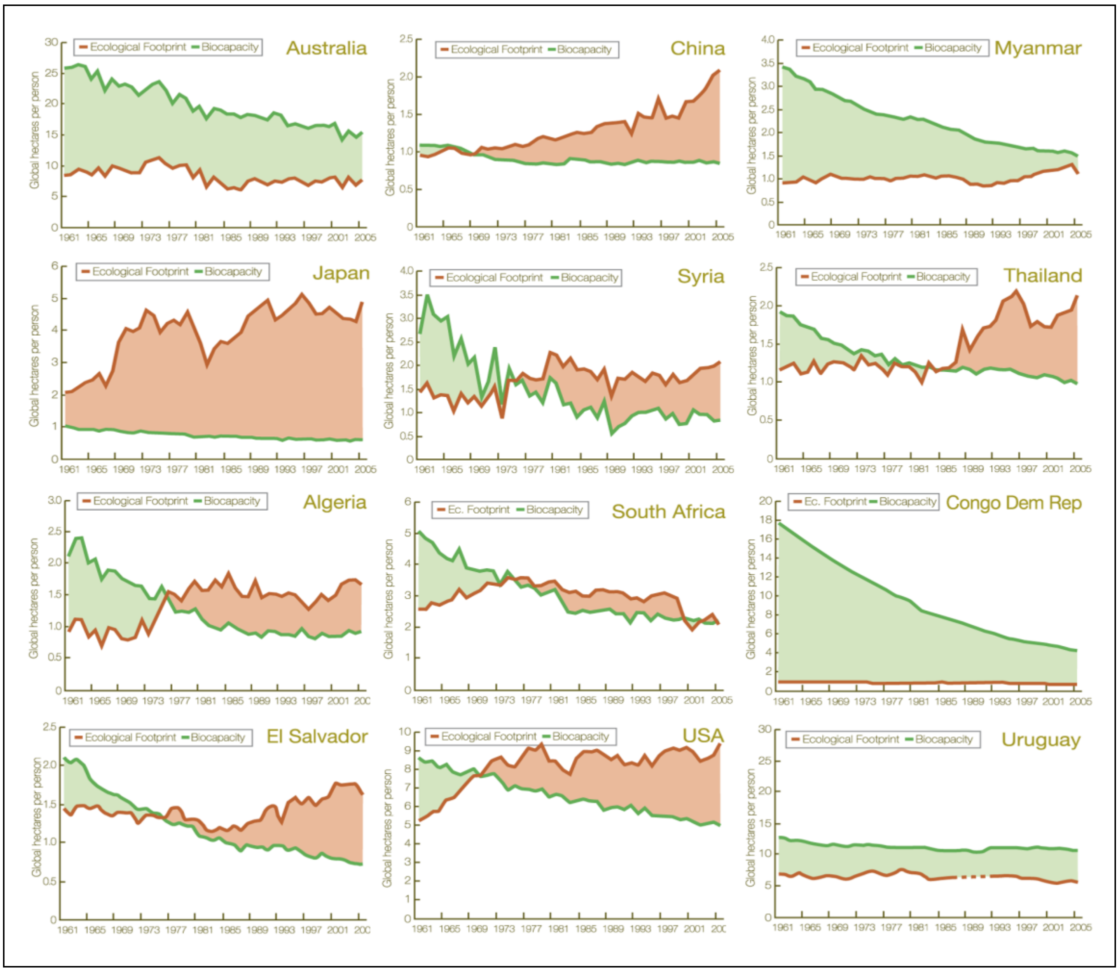

Figure 14: The overshoot and 'undershoot' of selected countries 1961-2005 (Footprint Network 2009)

Globally, the total of ecological debt exceeds the total of biocapacity credit meaning that ecological capital is being consumed.

In addition, because each component of biocapacity and the EF can be separately calculated, this aids in policy development and decision-making with respect to land usage. The per capita overshoot by category for selected countries is shown in Table 3 with debtor countries, or those with an ecological debt, shown in parenthesis. This example will be used to illustrate how the global natural resource consumption tax may be calculated.

	USA	Germany	India	Russia	Brazil	Gabon
Cropland	0.50	(0.33)	0.01	(0.00)	0.32	(0.21)
Grazing	0.12	(0.12)	0.00	0.25	0.11	4.07
Forest	0.52	0.04	(0.10)	3.76	6.07	20.69
Fishing	0.31	(0.06)	0.01	0.05	0.00	3.32
Carbon	(5.57)	(2.70)	(0.33)	(2.72)	(0.43)	0.00
Built-up	-	-	-	-	-	-
Total	**(4.13)**	**(3.16)**	**(0.40)**	**1.34**	**6.08**	**27.88**

Table 3: Per capita credit/(debit) for selected countries (Footprint Network 2010)

3.2.3 Measure of responsibility

The major threats to biocapacity arise from human demands for food, energy and materials and the corresponding need for infrastructure. The EF is an accounting framework that compares this demand on the biosphere to the regenerative capacity or biocapacity of the Earth. It reflects both the consumption of ecological resources and capital within a country, and the flows of biocapacity between countries.

The EF is solely concerned with land directly related to provision of natural resources and space for infrastructure, and the absorption of CO_2. It is therefore relatively easy to calculate at a country level.

A global tax, based on EF calculations, is proposed as a means of compensating low-consumption countries for their share of natural resources, including air contamination, consumed by high-consumption countries. It is therefore essentially a price on the opportunity cost of the global commons as determined by the extent of ecological overshoot. Unlike the other global models discussed above, it does not take into account accumulated CO_2 emissions, whether to 1751, 1990 or 1992. It deals solely with current domestic consumption and current international trade. It is therefore a 'price' on current usage. This has three implications.

Firstly, this 'price' is proposed to be the tax. Imposing a tax now on past emissions is akin to retrospective taxation. Retrospective tax law changes are those changes that have effect before the actual change is made in relevant legislation (Australian Taxation Office 2010). Governments rarely legislate with retrospective effect, especially in the areas of penal and tax laws (Sandler 2009). Whilst in some countries non-retroactivity is observed as a legally binding principle, most countries uphold it as a principle of tax policy (Vanistendael 1996).

Secondly, this approach is not to be construed as denying that past emissions do not warrant attention. However, it is submitted that this is best achieved by compensation rather than taxation.

Finally, it allows countries to make decisions as to the level of development they wish to attain and/or maintain, as there is a positive correlation between industrialised development and ecological debt. This can be illustrated using forests. Emissions from deforestation account for around 17 per cent of global greenhouse gas emissions, more than the entire transport sector (Parker et al 2009). Forests are both a source and a sink for carbon emissions. Forests will therefore be an essential component of countries' efforts to combat climate change (Parker et al 2009). Indeed, countries may determine that maintaining forests for carbon sequestration is more economically viable than proceeds from timber.

However, it is important to recognise that footprint reduction efforts in one area could lead to footprint increases in another. Fossil fuel use is the most significant contributor to the EF. However, proposals to replace liquid fossil fuels with biofuel crops have the potential to increase pressure on land use and to increase problems caused by agriculture – a significant threat to biodiversity and a major footprint contributor (WWF 2010).

The approach advocated in this paper determines responsibility based on consumption. The rationale for a consumption tax is that taxpayers should contribute in line with what they 'take out of the pot' rather than what they 'contribute to society' (Musgrave 1967, 46). As a measure of current responsibility, the global natural resource consumption tax reflects current environmental decisions made by countries. Efforts to combat climate change will be reflected in decreased footprints and hence in lower tax payments.

3.3 Capability

3.3.1 Ability to pay (and to receive)

Ability to pay is usually associated with direct taxation generally and income taxation in particular (Utz 2002; Dodge 2005). It is viewed as reflecting fairness and equity, being synonymous with justice in taxation (Buehler 1945). Out of social considerations, those with incomes at or below the subsistence level arguably have no ability to pay. Complications often arise in determining the level of 'subsistence income' to be exempt (Buehler 1945).

Income is generally considered a criterion of distributive fairness. However, because a just distribution of economic resources goes to standards of living, consumption may also be so considered (Warren 1980; Andrews 1974). Fairness, in this context, must involve distributional equity – the question of how environmental resources ought to be distributed in a globally fair society. This extends beyond consideration of who should pay, to include who should receive, compensation.

3.3.2 Indicators

Historically a country's ability to pay has been premised on its economic activity, given by its GDP. However, a number of other indicators have been developed that can be used to the same effect. These are essentially measures of economic well-being, incorporating aspects of GDP, non-market activity, leisure and wealth (Bergheim 2006).

The more widely known and commonly referred to indicators that could proxy for an ability to pay are tabled in Table 4.

Indicator	Name	Summary
GDP	Gross Domestic Product	Measures overall economic activity. Although often positively correlated with the standard of living, it is not designed to measure well-being or development.
HDI	Human Development Index	Well-being measurement. The index measures development on the basis of three attributes being life expectancy, knowledge/education and standard of living/GDP per capita.
HPI	Happy Planet Index	An index of human well-being and environmental impact. Captures the amount of well-being achieved per unit of resource consumption at the national level.
QLI	Quality of Life Index	Based on a methodology that links the results of subjective life-satisfaction surveys to the objective determinants of quality of life.
TFP	Total Factor Productivity	Obtained from a neoclassical production function of capital, labour and a technology. It accounts for effects in total output not caused by inputs. TFP plays a critical role in economic fluctuations, economic growth and cross-country per capita income differences.
GPI	Genuine Progress Indicator	An attempt to measure whether a country's growth, increased production of goods and expanding services have actually resulted in the improvement of the welfare or well-being of its citizens. GPI combines flows from consumption and changes in wealth. It developed from the Index of Sustainable Economic Welfare (ISEW) also known as the Measure of Economic Welfare (MEW).
GSI	Genuine Savings Indicator	A measure of natural, physical, human and intangible forms of capital. Builds on the concepts of green national accounts but in terms of stock or wealth rather than flows of income and consumption. Also known as Adjusted Net Saving (ANS).
MDP	Measure of Domestic Progress	Based on GDP but factors in the environmental and social costs of growth. It is designed to reflect progress towards sustainable development by including economic progress, environmental costs, resource depletion and social factors in a single composite measure.

Table 4: Ability to pay indicators

Pursuing alternatives to GDP is still an area of development especially when seeking to incorporate quality of life, a broader concept than economic activity and living standards 9Stiglitz et al 2009). However, most work is being done in the area of living standards. For example, a flow welfare index has been proposed, building on related work such as the HDI and the MEW (Jones and Klenow 2010). This index calculates consumption-equivalent welfare using widely available data on consumption, leisure, inequality and mortality.

3.3.3 Measure of capability

Two methodologies are discussed here. Both are premised on the fact that capability is not merely the ability to pay but also encompasses the need to receive. The first is threshold-based whilst an indicator determines the second.

Using a threshold-based approach requires considering the two aspects of 'ability to pay' and 'need to receive' independently. Firstly, there are ecological debtor countries that have limited financial resources such as Gambia and Haiti. As such, a capability threshold is required below which no country is required to pay the tax. Secondly, there are ecological creditor countries that arguably do not require financial assistance to adapt to, or mitigate, climate change effects. Examples include Australia and Canada. In this case, a capability threshold is required above which no country is entitled to receive the tax. Instead, the amount 'owing' to such countries for the 'use' of their biocapacity can be added to an adaptation or mitigation fund as discussed below. These thresholds may be based on the same criteria that are used for determining whether a country is considered to be 'developed', 'developing', or 'less developed'.

An alternative methodology for determining capability is by the indicator itself. Any indicator that has broad appeal can be used. If the Human Development Index (HDI) is chosen, a single threshold, determined to be equivalent to the United Nations Development Programme threshold for high human development, may be used. Here, countries below the threshold (such as China and India) are excluded from payment whilst those above the threshold (such as Argentina and Chile) are not permitted to receive (UNDP 2010). If GDP is the chosen mechanism, the thresholds may be determined by the median (below which they do not pay – and therefore again excludes China and India) and the average (above which they do not receive).

4. Tax model

4.1 Tax base

A tax base is the measure upon which the assessment or determination of tax liability is based. It is, in essence, the source of the tax revenue.

The biologically productive land available to each country differs according to size and productivity. While differing productivity can be made comparable by converting available land into global hectares, this does not facilitate in making size comparable. Comparing values among groups of different sizes can only be achieved by taking a per capita approach. And, as population density and consumption are positively related, a per capita approach is also in line with a consumption-based approach. The World Bank also advocates a per capita approach to welfare sustainability, its reason being that population is not static (World Bank 2010).

The tax base is therefore net biocapacity (biocapacity less EF) per capita. The ecological overshoot determines that a tax debit (or tax liability) arises. Alternatively, where biocapacity exceeds the EF, a tax credit arises.

4.2 Tax rate

Because different land types have different values, economic, environmental and social, these should be the de facto ‘rate’ and determine the ‘price’ or tax.

Valuing natural resources and ecosystem services has become a significant and rapidly evolving area of research, involving both market and non-market values (Kaval 2006; Turner et al 2003; Wilson and Hoehn 2006). Its innate complexity creates difficulties (Richards 1998), not least of which is determining the economic and ecological concepts of ‘value’ (Faber et al 2002; Turner et al 2003). While attempts are being made to include such values in GDP accounts, this is generally on the basis that ecosystem services are a stock of inputs which are depreciated or depleted over time (Alexander et al 1998). A further constraint is that environmental assets are only considered if they have an identifiable owner who can benefit economically from the use of the asset (Voora and Venema 2008). This methodology is not suitable for a global natural resource consumption tax as it does not account for the productivity of ecological inputs on which reliance is made in economic pursuits (Alexander 1998). Nor does it include the significant ecosystem services for which no monetary value has been assigned (World Bank 2010).

Ecosystem services are the benefits derived from ecosystems. These include provisioning such as food, water and fibre, regulating such as flood mitigation and disease control, cultural such as recreation and spiritual benefits, and supporting services such as nutrient cycling and soil formation (Kumar and Kumar 2008; Kontogianni et al 2010).

The issue of valuation is inseparable from the choices and decisions governments must make about ecological systems and land usage (Costanza et al 1997; Bingham et al 1995). Loss of environmental resources is not simply an environmental problem. It is also an economic problem because values are lost or eroded when these resources are destroyed or degraded (Kumar and Kumar 2008). Valuation methodologies are being increasingly utilised to quantify the benefits provided by natural environments (Voora and Venema 2008). However, no widely accepted standardised method has yet been developed (Carpenter et al 2006).

Notwithstanding multiple methodologies which are well documented (Kumar and Kumar 2008; Goulder and Kennedy 2009; Barbier and Heal 2004), very little attempt has been made to assign monetary values to land types and biocapacity. A team of researchers from North America, South America and Europe, led by Dr Robert Costanza, made one of the first attempts (hereafter referred to as the Costanza research) (Costanza et al 1997; World Resources Institute). This was computed on the basis of a ‘willingness to pay’ for each land type, taking into account both direct and indirect ecosystem services. More recently the World Bank has attempted to estimate the natural capital wealth of countries. This methodology, however, includes non-biologically productive land, minerals and sub-soil resources, and excludes fishing grounds. This exclusion is significant given that the value of fishing is around US$78 billion annually with most export trading originating from developing countries (World Bank 2010). As all elements included in the World Bank’s proxy are estimated using market values, natural assets and ecosystem services that do not have market values are ignored (Voora and Venema 2008). As such this natural capital assessment approach is very limited.

4.3 Tax liability

The term 'tax liability' refers to the amount of tax owed. It is calculated by applying the tax rate to the tax base.

Once a value has been ascertained this is applied to the net biocapacity per capita or per capita ecological overshoot for each debtor country to determine the tax liability. Similarly, it determines the amount payable to creditor countries. At a global level the gross tax debt will exceed the gross tax credit, reflecting the use of natural or ecological capital as opposed to merely utilisation of regenerated and regeneratable biocapacity. This 'surplus' tax can be paid into the adaptation and/or mitigation funds for further redistribution.

4.4 Calculation example

4.4.1 Capability not disputed

The first example uses countries that meet the capability criterion as noted above. That is, countries that have the ability to pay or the ability to receive.

In Table 3 the net per capita credit (biocapacity exceeds footprint) and debit (footprint exceeds biocapacity or overshoot) for six countries were shown. This is the net biocapacity per capita of each country. These countries were selected because they typify the diversity of land uses available. This net biocapacity per capita is the tax base.

For the purposes of this example, the tax rate will be taken as the values determined by the Costanza research. These are provided in Table 5. Of the biomes with values listed, both 'open ocean' and 'wetlands' have been excluded, as they are not considered to be biologically productive. The value for carbon is the same as forest in line with the definition of sequestration land (or carbon) footprint as shown in Table 1.

Biome	**Value**
Cropland	92
Grazing	232
Forest	969
Fishing	12,550
Coastal	4,052
Lakes and rivers	8,498

Table 5: Values attributed to biomes (Costanza et al 1997)

The tax liability is given by the formula tax base multiplied by tax rate. This is shown in Table 6. These should be considered as units to which some factor is applied.

	USA	**Germany**	**India**	**Russia**	**Brazil**	**Gabon**
Cropland	46	(30)	1	0	29	(19)
Grazing	28	(28)	0	58	26	944
Forest	504	39	(97)	3,643	5,882	20,049

Fishing	3890	(753)	126	628	0	41,666
Carbon	(5397)	(2,616)	(320)	(2,636)	(417)	0
	(929)	**(3,388)**	**(290)**	**1,693**	**5,520**	**62,640**

Table 6: Tax liability for selected countries where capability is not disputed

An alternative methodology is to calculate a single value such as a weighted average for all land/water types and apply this to the total overshoot or 'undershoot' for each country.

The above example shows that those countries whose consumption exceeds their assets will have a tax liability. While Russia has a carbon component rivalling that of Germany, it is able to sequestrate this via its forests. The Russian government can use the tax credit it will receive either to decrease its carbon emissions or to increase its forests. Gabon, being a least developed country, could invest its tax credit in social programs.

4.4.2 Capability disputed

It is generally acknowledged that there are countries with such limited financial resources that they should not be required to pay any tax. Examples include Gambia, Nepal and Haiti which are classified as 'least developed countries', requiring special international support.

Similarly, it is arguable that industrialised and highly developed countries do not require international financial assistance. Canada, Australia and Sweden are examples of this category.

The tax liability for these six countries is illustrated in Table 7.

	Gambia	**Nepal**	**Haiti**	**Canada**	**Australia**	**Sweden**
Cropland	(37)	(2)	(12)	153	101	(24)
Grazing	(9)	0	(2)	(5)	1,093	(46)
Forest	10	(136)	(87)	6,628	1,483	1,870
Fishing	(20,331)	0	(502)	43,548	45,807	26,732
Carbon	(281)	(2,762)	(97)	(3,905)	(2,994)	(2,646)
	(20,648)	**(2,898)**	**(700)**	**46,419**	**45,490**	**25,886**

Table 7: Tax liability for selected countries where capability is disputed (Footprint Network 2010)

5. Governance and disbursement

The global natural resource consumption tax is a tax on the current consumption of natural resources including the sequestration of CO_2 emissions. It is therefore principles-based. The tax calculation is derived from data that is publically available and internationally accepted, namely the EF. Being not only transparent but also objective, this data cannot be manipulated. It is envisaged that international consensus on the value of ecosystems can also be reached, providing transparency and objectivity to the tax rate.

Apart from revenue raising, there are two other policy functions to be considered (United Nations Africa Partnership Forum 2009). The first is governance, dealing with how the funds are managed including oversight and accountability. Second is disbursement covering how the funds are distributed and applied. As each of these are deserving of a paper in their own right, this paper merely presents some potential options.

5.1 Governance

A mechanism is required to collect the tax from debtor countries, to disburse payments to creditor countries and to administer the remainder. With a relatively simple calculation performed annually, transaction and staffing costs can be minimised. Payments and/or disbursements may, however, be made on a more regular basis.

Options include creating a new institutional arrangement or making efficient and effective use of current institutional arrangements. While the United Nations may be an obvious choice given its experience in international cooperation and governance, other possible organisations include the International Monetary Fund, the World Bank, a G-20 working group or separate independent body.

At the 2010 United Nations Climate Change Conference held in Cancun, Mexico, it was decided that a Green Climate Fund be established (United Nations 2011, 102). The framework was also agreed with the design of the fund entrusted to a Transitional Committee, 62.5 per cent of committee members being from developing countries (United Nations, 2011, 103-111). This may be a viable option. Alternatively an adaptation or mitigation fund, such as those managed by the Global Environment Facility[6] or one of the Climate Investment Funds[7] jointly managed by multilateral development banks, could be used.

5.2 Disbursement

The main policy options concerning the disbursement of international funds usually centre on activities of mitigation, adaptation or a combination of these (United Nations Africa Partnership Forum, 2009). With the global resource consumption tax, disbursement options only relate to the residue funds. That is, those tax receipts that are not distributed to creditor countries because they fail the capability test. These may be distributed according to some arrangement already existing or yet to be devised. For example, it may be decided to distribute on a needs basis, even returning funds to debtor countries. Alternatively, the funds may be divided between the Least Developed Countries. Another option is to use the funds to finance inter-country projects. One example is the agriculture pest management project in South and South-East Asia, covering Cambodia, China, Lao People's Democratic Republic, Thailand and Viet Nam (Food and Agricultural Organisation of the United Nations, 2009).

[6] Such as the Least Developed Countries Fund or the Special Climate Change Fund.
[7] The Clean Technology Fund or Strategic Climate Fund.

Possibly more contentious is whether or not to impose restrictions on how the creditor countries use their funds. One approach is to allow for sovereignty, as is the case with domestic tax collections. This allows each government to make its own decisions as to what it perceives as in its country's interest be this economical, environmental or social. At the opposite end of the disbursement spectrum is to regulate how funds are to be expended.

6. Conclusion and consequences

The global natural resource consumption tax is a user-pays compensatory tax based on the current consumption of renewable natural resources and absorption of wastes. It does not conserve nor preserve these resources nor make any attempt to impose targets to do so. But, like any tax, it has the potential to change behaviour. However, its primary purpose is to raise revenue necessary to meet the costs of climate change mitigation and abatement programs. It achieves this by applying a price on biocapacity. Being easily calculated and transparent in its application, it is difficult, both technically and ethically, for any country to deny liability.

Due to its inherent simplicity, the global natural resource consumption tax can aid in economic, environmental and social policy-making and decision-making. This tax ensures that the cost of resource consumption is measured. Once measured, natural resources can be monitored, thus more effectively managed.

Less developed and developing countries often engage in economic activity that is detrimental to their natural environments with the aim of generating adequate export revenue to finance external debts (Anderson et al 1995; Muradian and Marinez-Alier 2001; Kox 1997). Deforestation is such an example. Indeed, natural capital exceeds produced or built capital in low-income countries. Properly managed, natural resources are capable of delivering economic profits. This, in itself, can be an important source of development for these countries and should therefore be a key part of development strategies. Diverse land-use patterns generate and deliver different environmental outcomes. They can also determine the resulting 'winners' and 'losers' from alternate land uses (Torras 2003).

It is incumbent upon each country to understand how much biocapacity they have as well as their rate of depletion. It is equally important for countries to understand their global ecological asset dependency associated with natural resource consumption. Such levels of understanding can only assist in identifying the current and future risks as well as the opportunities they present.

The amount of biologically productive land is relatively stable, though increasingly difficult to maintain as population pressures increase. Climatic events, increasing temperatures, salinity and pestilence also tend to counteract any efficiency gains obtained through productivity and technological advances. So, while renewable, there is finite capacity of usable land and water resources. This is being further eroded by the expenditure of ecological capital as demand for ecological goods and services increasingly exceed the supply.

This must be acknowledged. An absolute reduction in global resource consumption is an imperative if dangerous climate change, irreversible environmental damage and the fallout of food insecurity are to be averted. These concerns are more than environmental. They are economic and social too.

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