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Re: The First 20 Years of NAFTA & the NAAEC: JPAC Meeting in Washington

I most appreciated receiving an invitation to the upcoming JPAC meeting in Washington and regret that scheduling conflicts prevent my attending.

That said, this is an important meeting and I hope your Committee and others present might have some interest in what I might have said. To that end I attach a couple of papers/presentations that touch on globalization, trade and related social and ecological issues.

Note that my concerns are not the usual ones, but rather the contribution of globalization/trade to ecosystems degradation, resource scarcity and geopolitical instability simply by doing what it is intended to do -- increase global economic growth through the efficiency gains associated with freer markets, deregulation, greater economic integration and intense competition.

Globalization/trade does indeed help to stimulate growth, but in the process generates several ecologically significant impacts beyond relaxed pollution standards. In particular, by exposing increasingly scarce pockets of quality resources to ever-larger, richer markets, unmanaged trade increases consumption (energy and material 'throughput') which, in turn, accelerates natural capital depletion and biodiversity loss (e.g., the collapse of the North Atlantic cod stocks in 1992 was the result of over-fishing largely to satisfy export markets; half of Canada's prairie crops are exported which accounts for a proportional share of irreversible soil and biodiversity degradation).

Unfortunately, people who are accustomed to living on imports from afar become spatially and psychologically insulated from any distant negative impacts of their consumption. This reduces their subjective incentive to conserve resources and may accelerate the depletion of distant stocks of the very natural capital upon which they have become dependent (particularly if competition among exporters so reduces producer surpluses that there are insufficient reserves for sound resource management at source.) In the meantime, open access to extra-territorial resources creates a disincentive for countries to develop population or family-planning policies and enables the unconstrained import-dependent populations to exceed their domestic carrying capacities with short-term impunity. Regrettably, this invites potentially serious long-term consequences in an increasingly uncertain world of rapid global change.

The probability of long-term regrets is enhanced if trade-dependence has had a negative impact on *domestic* natural capital. For example, urban populations who import cheap food from afar undervalue local farmland and are inclined to pave it over. Urban sprawl, usually the conversion of arable land to 'higher and better use' (in short-term economic terms) is accelerated, irreversibly destroying productive farmland (think Metro Toronto and Metro Vancouver much of whose territories wastefully occupy some of the best farmlands in Canada). Such land conversion, seemingly 'rational' today, may come to be regretted as climate change and other global forces negatively affect entrenched production and trade patterns.

The risk of long-term trade-induced material insecurity may seem fanciful but is an emergent reality. Most of the world's countries now survive largely or in part on food and fibre imported from 'elsewhere', an unprecedented degree of international interdependence made possible by regional and global trade agreements such as NAFTA and the WTO. Again, however, import-dependent nations that have exceeded their long-term domestic carrying capacities are in a state of increasingly perilous 'overshoot'. Long rejected by economists as irrelevant to humans, the concepts of carrying capacity and resource limits are beginning to influence international relations and long term geopolitics. For example, with the recent rapid rise and fluctuations in food and other resource prices, various dependent governments are losing confidence in trade and global markets as the means of acquiring secure supplies of food, energy and other vital resources. In the past decade, this has fostered the potentially destabilizing phenomenon of 'land-grabbing' by which relatively rich countries buy up or long-term least the productive lands of (usually poorer) countries to provide food and fibre for the rich countries' domestic populations. Various reports show that that as many as 227 million hectares of land – an area the size of Western Europe – had been sold or leased in developing countries since 2001 (this is enough to feed a billion people, roughly the number of currently calorically undernourished people on the planet). This latest expression of egregious inequality in an increasingly fractious resource-poor world is likely to foster civil unrest and exacerbate geopolitical conflict in coming years.

Details and documentation of these concerns can be found in the attached documents. I do hope that JPAC will find time to consider some of the longer term implications of globalization and trade in general and NAFTA in particular in this and future deliberations.

My sincere thanks for your attention.

Respectfully,

William E. Rees, PhD, FRSC

Carrying Capacity, Globalisation, and the Unsustainable Entanglement of Nations

Published in: Lawn, P (ed) *Globalisation, Economic Transition and the Environment - Forging a Path to Sustainable Development.* London, Edward Elgar (2013)

(revised from William Rees' *Blue Planet Award* presentation, Tokyo, Nov 2012)

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Oct 2012

Introduction: The Precarious State of the Planet

H. sapiens is the dominant species on Earth and the major geological force changing the face of the planet. The basic science of human-induced global change is undeniable – climate change, ocean acidification, fisheries collapses, land/soil degradation, desertification, tropical deforestation and biodiversity loss are just a few symptoms of wide-spread ecosystems degradation resulting from human activities.

The starting point for this article is that all such macro-ecological trends, whether characteristic of truly global systems (e.g., climate change, ocean acidification) or merely occurring simultaneously in ecosystems on several continents (e.g., desertification, biodiversity loss) are indicators that humans and their economies have exceeded the long term carrying capacity of Earth. The human enterprise is in a state of 'overshoot.'

This is not just another routine milestone along the road in the extended human journey. Overshoot is potentially catastrophic because systems science makes clear that: a) the behavior of ecosystems under stress is dominated by the complex interplay of positive and negative feedback and is typically non-linear and unpredictable; b) like other complex systems, ecosystems have multiple equilibrium states or stability regimes many of which may not be compatible with human purposes or survival; c) ever-increasing rates of exploitation will eventually force typical ecosystems over some previously unknown threshold (i.e., a 'tipping point') beyond which key components or the entire system may 'flip' into an unfamiliar stability regime; d) there is increasing evidence that such critical transitions or 'state shifts' can (and have) occurred at the planetary scale and; e) once such a shift has occurred it may be difficult or impossible to return the system from its new, potentially hostile stability regime to its previous human-compatible state (Holling 2001, Kay & Regier. 2001, Walker & Salt 2006).

Most significantly, Barnosky *et al.* (2012) argue that human population growth and rising material consumption, habitat transformation/fragmentation, energy production and consumption and climate change constitute global forcing mechanisms that all exceed in rate and magnitude, the forcings apparently responsible for the most recent 'natural' global-scale state shift, the last glacial–interglacial transition. Given the number and intensity of these forcings, they argue that "another global-scale state shift is highly plausible within decades to centuries, if it has not already been initiated" (Barnosky *et al.* 2012, p.57). In other words, human impacts on the ecosphere may well be sufficient to precipitate a whole-system transition that, in turn, could trigger the collapse of global civilization. Techno-industrial society would then suffer on a *global* scale what many earlier societies have brought upon themselves at the regional scale (Tainter 1988, Diamond 2005).

Humanity need not continue living under such a threat. Modern society has the scientific data, technological means and adequate resources to turn things around. These factors, combined with humanity's high intelligence and unique capacity for forward planning should be sufficient for the world community to implement a globally coordinated campaign to rescue civilization from ignominious chaotic collapse.

Is there intelligent life on Earth?

Remarkably, however, nothing of the kind is on the horizon. The world community seems chronically unable to act decisively to employ humanity's unique abilities in the collective interests of our species. On the contrary, the United Nations' Rio+20 Earth

Summit (the biggest UN conference ever) ended in June of 2012 with a vapid statement on *The Future We Want* containing little more than a bland renewal of commitment to 'sustainable development' and endless reassurances of international rededication to previously failed initiatives. The statement commits no national government to specific actions or targets on anything and repeatedly equates 'sustainable development' to 'sustained economic growth' (see UN 2012). Environmental journalist George Monbiot accused participating governments of concentrating "not on defending the living Earth from destruction, but on defending the machine that is destroying it." Accordingly, Monbiot declared Rio+20 to be "perhaps, the greatest failure of collective leadership since the first world war" (Monbiot 2012).

The primary drivers of the contemporary economic "machine", designed to deliver "sustained economic growth", are globalization, market liberalization and deregulation (especially environmental). The purpose of this paper, therefore, is to make the case that the integration of the global economy and so-called free trade are also instrumental in the destruction of the planet. Using ecological footprint analysis, we can show that: a) globalization and trade enable individual countries vastly to exceed their domestic carrying capacities; b) the aggregate human eco-footprint is excessive by half and; c) material trade is producing an increasingly unsustainable and destabilizing material entanglement of nations. Restructuring this system is essential if the world community is to avoid precipitating a global 'state shift' that could destroy human civilization.

Carrying capacity and does it matter?

> *"Carrying capacity is the fundamental basis for demographic accounting" (Hardin 1991).*

'Carrying capacity' (CC) is the term employed by wildlife and range managers to denote *the average maximum population of a given species that can occupy a particular habitat without permanently impairing the productive capacity of that habitat*.[1] Despite Hardin's confident assertion above, analysts have long contested whether the concept applies to *H. sapiens*.

The Reverend (and economist) Thomas Malthus opened the modern debate on human carrying capacity late in the 18th Century with his famous essay *On the Principle of Population*. Malthus' concern was based on elementary arithmetic. He observed that "population, when unchecked, increases in a geometric ratio, subsistence increases only in an arithmetic ratio" (Malthus 1798). Today we would say: 'population increases exponentially (like compound interest) while food production increases only linearly (in constant increments).' Clearly, Malthus though humanity would forever be pressing up against the earth's limited 'carrying capacity', bringing misery to millions.

While his theory seemed incontrovertible at the time, Malthus' warning was effectively squelched by the growing optimism of the dawning industrial age and the fact that there were whole new continents to be peopled. Those who did remember Malthus would come to dismiss his 'dismal theorem' on grounds that he had not anticipated the ability of technology to keep food production expanding a step ahead of population growth.

[1] We say "average maximum" here to recognize that the instantaneous carrying capacity of a habitat constantly fluctuates with the weather/climate, water availability and other factors that affect the productivity of the ecosystem.

And, for a while, the optimists seemed to be right. The good Reverend's geometric multiplier continued to grind away but it was not until the 1960s that the 'Malthusian spectre' remerged in popular discourse (see Ehrlich 1968). It had taken until 1930 – more than a century after Malthus death – for the human population to grow from one to two billion. But the third billion was added by 1960 in just 30 years and the forth in a mere 14 years! By the end of the century, the human population had topped six billion, having doubled since 1960. It had taken two million years for the human population to reach three billion; the second three billion were added in just four decades! (and we have since added the seventh billion – see UNFPA 2011). Such is the power of exponential growth.[2] Meanwhile, the economy had been expanding even faster than population. During the 20th century, energy consumption increased 16 fold, fish-catches 35 times, industrial output by about 40 fold and average per capita consumption grew by a factor of 10 or more (Arrow *et al*. 2002, citing McNeill 2000). By the 1960s, anxiety about urban, industrial, and agricultural pollution, and even resource scarcity, had spawned the so-called 'environmental movement' and added a new dimension to the question of human carrying capacity. Catton (1980) accordingly redefined *human* carrying capacity as the environment's "maximum persistently sustainable load".

The combined impact of the population and industrial juggernauts were predictable on a finite planet. By the early 21st Century, humans had: transformed half of the land on Earth – the most productive half – to suit human purposes; were using half the planet's accessible fresh water; contaminated virtually every eco-system; fully- or over-exploited up to three quarters of the world's major fisheries; and accelerated biodiversity loss to hundreds or thousands of times the background rate, all to the detriment of our supportive ecosystems. Meanwhile, to provision our seven billions, humans fix and inject as much atmospheric nitrogen into terrestrial ecosystems as do all natural processes combined (Vitousek *et al.* 1997); land clearing, industrial agriculture and burning fossil energy to keep the human enterprise going has inflated atmospheric carbon-dioxide levels from a pre-industrial 280 to 395 parts per million (40%), the highest level in at least 800,000 and perhaps as much as 15 million years) (CSIRO 2012); in response, mean global temperatures have reached record highs for modern times and many places around the world are being pummelled by more frequent and violent extreme weather events.[3]

By 1992, things looked threatening enough that 1,700 of the world's top scientists (including most science Nobel Laureates) issued *The World Scientists' Warning to Humanity* which concluded: "A great change in our stewardship of the Earth and the life on it is required if vast human misery is to be avoided and our global home on this planet is not to be irretrievably mutilated" (UCS 1992) More than a decade later, the authors of the Millennium Ecosystem Assessment echoed this earlier warning, asserting that "[h]uman activity is putting such a strain on the natural functions of the Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted" (MEA 2005). Clearly the consensus among natural scientists is that *H. sapiens* is near, or has breached, long-term global carrying capacity and is in danger of crossing a catastrophic tipping-point. They recognize it is physically impossible to sustain the

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[2] It was actually super-exponential for most of the 20th Century as the doubling time decreased with increasing growth rates.

[3] For a summary of 2012 weather extremes, see WRI (2012).

growth of anything real on a finite planet indefinitely, and that to attempt to do so is to invite catastrophe.

Not everyone agrees. According to Lawrence Summers (then Chief Economist, the World Bank):

> There are no... limits to the carrying capacity of the earth that are likely to bind any time in the foreseeable future. There isn't a risk of an apocalypse due to global warming or anything else. The idea that we should put limits on growth because of some natural limit is a profound error and one that, were it ever to prove influential, would have staggering social costs (Summers 1991, cited in McQuillan & Preston 1998).

Traditional economists and other technological optimists (including many politicians) assert that humankind has achieved mastery over the natural world and that, as the global economy expands, trade, technology and increased wealth will enable humanity to compensate for the depletion of natural resources and the loss of life-support services.

The trade argument is relatively straight forward: any human population (e.g., a region or country) that can trade surpluses of resource 'a', for needed supplies of essential resource 'b', need not be restricted in population or economic growth by limited domestic supplies of 'b'. Trade reduces negative feedback, fosters growth and appears to increase *local/national* carrying capacities. More generally, trade in local surpluses that might not otherwise be used enables greater global economic output. This can support greater *per capita* consumption or more people, and thereby effectively increases *global* carrying capacity. Conventional trade theory further argues that we can capture even more efficiencies (i.e., even *greater* net economic output and higher carrying capacity) if each region/country in the global marketplace specializes in those few goods or commodities it can produce most efficiently (goods with the lowest inputs per unit output) and trades for everything else.

But what happens if important globally traded commodities are eventually exhausted? No problem –free markets will come to the rescue. Rising prices will trigger conservation, greater efficiency, and the entrepreneurial search for technological substitutes, thus increasing supplies and, again, *raising* human carrying capacity. Beckerman (1995) puts the economic argument this way: "The finite resources argument is flawed in every respect. It is logically flawed and obviously at variance with the whole of historical experience… It is based on a concept of resources that is static and unimaginative, and an underestimate of the human capacity to make technological progress and adapt to changing conditions." One can hardly imagine a more confident and assertive rebuttal of scientists' concerns.

The Ecological Footprints of Trade

But that doesn't make it right. The economists' way of thinking originates from simplistic, mechanical, single-equilibrium economic models that have no systemic connection to anything outside of themselves (Daly 1985). These models therefore recognize neither the non-linear biophysical systems within which the economy is embedded nor the similarly complex social systems it supposedly serves.

We can get some understanding of at least the material *connections* between the economy and natural systems using ecological footprint analysis (EFA) (Rees 1996, 1012; Wackernagel and Rees 1996; WWF 2012). EFA starts from the premise that the human enterprise is an integral sub-system of the ecosphere and that the human sub-system can grow and maintain itself only by extracting energy and material 'resources' from its host system. People are therefore still very much dependent on ecosystem integrity and 'the land' for survival. The method also explicitly recognizes: a) that whether one consumes locally-produced products or trade goods from afar, the land connection remains intact and; b) that no matter how sophisticated our technology, the production/consumption process requires some land- and water-based ecosystems services.

EFA is closely related to 'carrying capacity.' However, rather than asking how large a population can be supported by a given area, eco-footprinting asks how much productive area is needed to support a specific population, regardless of the location of the land/water or the current state of technology. We therefore define the ecological footprint (EF) of a specified population as *the area of productive land and water ecosystems required by that population, on a continuous basis, to produce the renewable resources it consumes and to assimilate the wastes it produces, wherever on earth the relevant ecosystems may be located.* A complete eco-footprint analysis includes the population's use of domestic ecosystems, plus the *net* ecosystem area it 'occupies' through trade, plus its demands on the global common pool for free eco-systems services (e.g., the carbon sink function).

Three qualities of the eco-footprint are worth underscoring: 1) a population's EF represents much of its demand for global biocapacity; 2) by inverting the standard carrying capacity ratio EFA captures the effects of trade; the method also reflects whatever technologies are in use at the time of the analysis (i.e., EFA accounts for economists' objections to human carrying capacity); 3) since bio-capacity appropriated by one human population is not available for use by another, human populations everywhere are in competition for the available load-bearing capacity of the earth.

A planet in overshoot

As noted, globalization and trade constitute the engine of the expansionist economy. This is problematic. The argument that trade relieves resource constraints and increases local carrying capacity without limit implicitly assumes each trading region is an open system within an infinite universe. This is a poor representation of reality. In the aggregate, Earth is a materially closed, finite sphere with a limited (even shrinking) productive area. In this *real* world, exchange may result in a one-time increase in the population of trading regions, but it also increases global consumption and total pollution. Moreover, resources imported and consumed by country 'X' are no longer available for consumption in the exporting country 'Y' (and *vise versa*) which may limit future options. Thus, while trade increases the total human load on the planet, *there is no unambiguous increase in total load-bearing capacity*.

Indeed, in some circumstances unfettered trade can lead to a permanent *loss* of carrying capacity. Global trade exposes pockets of scarce resources everywhere to the largest possible market (and demand is still growing because of both population growth and increasing disposable incomes). This subjects even renewable natural capital to ever-greater exploitation pressure, often to the point of depletion or collapse. (Such is the history of trade in fisheries products, for example.) To reiterate, instead of increasing load-bearing capacity, trade simply shuffles it around. This enables local population increases but also accelerates resource depletion and ecosystems degradation which, in turn, ensures that all countries, their economies heedlessly expanding through trade, hit the (now shrinking) limits to growth simultaneously.

How far has globalization led the world down this path? By 2008, the aggregate human footprint had reached 18.2 billion global average hectares on a planet with a total global bio-capacity of only 12 billion gha.[4] Thus, while there are only 1.8 gha of productive ecosystem per person on Earth, the average person already consumes the output of 2.8 gha. The human enterprise has over shot carrying capacity by 50% – it would take the ecosphere 1.5 years to regenerate the renewable resources people consumed and assimilate the carbon dioxide they emitted in 2008 (WWF 2012, see also Rockström *et al*. 2009).[5]

This situation is the very definition of unsustainability – humanity's present consumption is liquidating Earth's *real* material wealth. As long as the human enterprise remains in overshoot, it subsidizes its growth and maintenance by depleting critical natural capital and over-filling essential waste sinks essential for its own survival. Regrettably, these impacts are among the many market externalities that remain unremarked in today's systems of national economic accounts. Such egregious accounting errors have led ecological economist Herman Daly to speculate that we may well have entered a new era of uneconomic growth – growth that generates more costs than benefits at the margin, *growth that makes us poorer rather than richer* (Daly 1999, 2102). Bottom line? If techno-industrial society stays its present course, it risks implosion within mere years or decades.

The unsustainable entanglement of nations

EFA enables us to identify which individual countries are most 'responsible' for humanity's ecological predicament and to assess the contribution from trade. First, EFA reveals that the majority of the world's approximately192 countries is in overshoot. Countries in overshoot depend on trade and exploitation of the global commons to grow or simply maintain current levels of consumption. Just ten nations account for over 60% of the world's biocapacity and only a handful, mostly large low population countries have domestic surpluses of biocapacity.

The world's wealthy minority generally sport the largest eco-footprints, generally ranging from just over four gha (e.g., Portugal, New Zealand, Japan) to seven or eight gha (e.g., United Arab Emirates, Denmark, United States) *per capita*. It would take the equivalent of two to three planet Earths to support everyone on Earth at the material lifestyles enjoyed by typical Europeans or Japanese. Four Earth-like planets would be needed to support everyone at current US levels of consumption. By contrast, if everyone lived on the 0.9 gha EF of the average Kenyan or Philippino, the human family would be using only *half* of Earth's biocapacity.

These numbers illuminate the gross and growing inequity in the world today. High-income people and nations are able to 'appropriate' vastly more than their equitable share of global biocapacity through trade and by exploiting the global commons. Consequently, many wealthy or densely populated countries exceed their domestic carrying capacities and are running large *ecological deficits* with the rest of the world (Table 1).

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[4] To facilitate international comparisons, national eco-footprint estimates are converted to 'global hectares' (gha), i.e., their equivalent in hectares of global average productivity.

[5] According to the Global Footprint Network, the human enterprise first went into overshoot in the 1970s (WWF 2012).

Table 1: The Eco-Footprints and Bio-Capacities of Selected Countries (data estimated from WWF 2012)

Country	Per capita Footprint (gha)	Biocapacity per capita (gha)	Overshoot factor (EF/biocapacity)
United Arab Emirates	8.4	0.6	14.0
United States	7.2	3.7	1.9
Canada	6.5	14.9	(.44)
Netherlands	6.2	0.9	6.9
United Kingdom	4.7	1.3	3.6
Japan	4.3	0.6	7.2

NB: An overshoot factor > 1 means an ecological deficit.

The United Arab Emirates (UAR) is an extreme case – this country depends on 14 times its domestic biocapacity to sustain its population at prevailing material standards. The UAR's demand for carbon sinks comprises over three quarters of the country's total EF, a burden that it imposes on other countries and the global commons. The UAR must also import most of its food and other renewable resources.

The Netherlands and Japan overshoot their domestic carrying capacities by a factor of seven. Again, both countries are trading nations with large ecological deficits. They are highly dependent on other nations and the global commons for food and fiber (which they acquire through trade) and as carbon sinks. The UK with and overshoot factor of 3.6 is perhaps more typical of high-income trade-dependent European countries.

The US is a special and somewhat worrisome case. This nation has overshot domestic biocapacity by 90% (mostly due to its large carbon eco-footprint). Long an agricultural powerhouse and a major net exporter of food, the US balance of trade (dollar value of exports compared to dollar value of imports) in this critical sector has been steadily dropping in recent decades from over as 2:1 in the mid 1970s to 1.4:1 in 2011-12 (see USDA 2012). Kissinger and Rees (2012) show that between 1995 and 2005 both the import share of U.S. consumption and the offshore land area embodied in those imports increased steadily. The US agricultural trade surplus (by weight) shrank by more than 50% during this period; some import commodities such as fruits, vegetables, beef, processed food, already exceed exports. Trade in wood products displays similar trends. Most critically from the perspective of the present analysis, the actual ecosystem area embodied in U.S. imports of agricultural and forest products was equivalent to the area of Germany, Italy, Spain, and the United Kingdom combined (Kissinger and Rees 2010). This is hardly a trivial claim on extraterritorial biocapacity. It seems that even the U.S. is becoming increasingly dependent on external sources of supply and that U.S. consumers now impose a significant burden on terrestrial ecosystems outside the U.S.

Canada is also a special case but for a different reason. Canada is one of only a few countries with an apparent ecological surplus (8.4 gha/cap). Canadians have large average eco-footprints at 6.5 gha, but their relatively small population (33 million) lives at low average density in a huge country. Even though much of the land is cold and unproductive much of the year, the available biocapacity (14.9 gha/cap) dwarfs domestic demand.

Not surprisingly, therefore, Canada is a major food exporter: it is the world's third largest producer of barley, fifth largest producer of wheat, and eighth largest beef producer. Tens of millions of people around the world are at least partially dependent on Canadian agricultural exports.

The Canadian prairies are the nation's agricultural powerhouse with 85% of the arable land in the country. Serving international markets makes significant demands on prairie agro-ecosystems. Kissinger and Rees (2009) found that, on average between 1989 and 2007, Canada effectively 'exported' 51.4% of the agricultural land (65% of cropland) in its prairie provinces and that the total area 'exported' increased from about 20 million hectares to 34 million ha in recent years (actual hectares, not normalized ghas).

Obviously Canada's agricultural exports benefit all partners in the exchange. Millions of people in importing countries acquire essential foodstuffs while Canadian farmers, chronically undercompensated, enjoy the extra income. However, there are both short- and long-term concerns associated with prevailing agricultural practices and trade policy. High-input production agriculture induces soil erosion, destroys native biodiversity, contaminates surface and ground water and generally accelerates the pace of ecological deterioration. In little over a century, conventional agriculture on the Canadian prairies has all but eliminated the natural grassland habitat and the rich flora and fauna associated with it, and has dissipated half the organic matter and natural nutrients that required millennia to accumulate on the post-glacial plains. Soils that only a few decades ago produced high yields of outstanding quality without artificial inputs now need to be fertilized to maintain both quality and quantity. Excess fertilizer, together with pesticides and mechanization, accelerate the degradation of prairie agro-ecosystems in what is arguably an unsustainable downward spiral. These impacts can reasonably be assigned proportionally to production for export and production for domestic consumption (Kissinger and Rees 2009).

Trade plays a similar role in the exploitation of Canada's forest and marine/aquatic ecosystems. Exports accounted for $26 billion of $57.1 billion (46%) in forest sector revenues in 2010 (FPAC 2011); exports of fish and seafood products contributed $3.9 billion to the industry's total revenues of approximately $5 billion, about 80% of the total (AFC 2011).

What these data illustrate is that Canada's apparent surplus of biocapacity (relative to domestic demand) is illusory in the global context and the same would be true for any other country with a nominal ecological surplus. In a closed global trading system, the apparent eco-surpluses of a few privileged countries are necessarily absorbed by the growing eco-deficits of net importing countries.[6] In ecological terms, trade on a finite planet is, at best, a zero sum game.

And we are not operating 'at best' – this is a world in overshoot. Trade has become a *negative* sum game. The few national eco-surpluses are insufficient to cover most other countries' eco-deficits. Trade-stimulated economic growth can therefore only accelerate the depletion of critical natural capital. Consider the North Atlantic cod fishery, among

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[6] This holds also for any terrestrial carbon sink capacity surplus to domestic requirements. Carbon sinks everywhere are overwhelmed by the excess – and still growing – carbon dioxide emissions of the global economy.

the world's greatest fisheries and one oriented largely to export markets. The collapse of cod stocks in 1992, under Canada's regulatory watch, was a major ecological and social tragedy and a classic example of a regional ecosystemic 'state shift' attributable to over-exploitation (see Barnosky et al. 2012).

It should also serve as wake-up call to the global community. Hundreds of millions of lives are now dependent on reliable resource flows from distant 'elsewheres'. These people are increasingly vulnerable to the potential disruption of trade flows because of climate change, natural capital depletion, systems collapse and potential international conflict as geopolitical tensions escalate in a resource-scarce world.

Regrettably, few seem to notice. Politicians and our corporate elites remain in deep denial, mesmerized by the progress myth and dedicated to continued growth. Trade-dependent consumers are blind to the negative ecological effects of distant production processes driven, in part, by their own material demands. Since people lack the direct 'negative feedback' that might otherwise induce them to behave sustainably, there is little serious grass-roots support for serious change (Rees 1994). Combined with general ignorance of systems behaviour and the ecological consequences of unsustainable resource exploitation, these facts encourage still greater material consumption and trade and hence increased reliance on external means of survival (Princen 1997).

Indeed, the present form of globalization facilitates the increasing growth-driven entanglement of nations in a sticky web of interdependence even as it undermines the ecological foundations of the entire system. This has created a perfect storm of unsustainability. We live in an ecologically over-full world breaching the limits of critical life-support systems whose behaviour provides the vey archetypes of lags, thresholds and multiple equilibria. Should any major system (e.g., global climate) be forced over a previously untested threshold into a hostile stability regime, there may be no recovery on a time-scale relevant to human civilization. Preventative action is inhibited not only by ignorance but also by denial that feeds on powerful individuals' and nations' short-term economic interests in maintaining the *status quo*.

The Way Ahead

Globalization and trade have enriched millions and improved the lives of billions of people. Nevertheless, there can be too much of a good thing. Global economic integration has produced an increasingly unsustainable and destabilizing entanglement of nations. The ready availability of trade goods encourages nations to run down their own resource stocks and exceed their domestic carrying capacities, oblivious of the risk this poses for themselves and future generations. The aggregate result is a world in gross overshoot, blindly pursuing a growth-based global development strategy that can only erode essential natural capital, undermine global life-support systems, and risk a global-scale state shift that could be fatal to civilization.

As noted at the outset, humans theoretically have the intelligence, knowledge and resources necessary to confront this dilemma.[7] However, any effective international solution will require a true 'paradigm shift', including abandonment of the core values, beliefs and assumptions underpinning prevailing global development policies. The simple fact is that circumstances have changed and global development policies must also

[7] This may not be enough. See Rees (2010).

change to reflect new realities. The question is whether the global community can muster sufficient political will to *choose* to succeed[8] (see Diamond 2005).

Most critically, the world must act to reduce human demands on global life-support systems and to restore the natural capital base that supports all human activity. To address these goals, the emphasis in international development must shift from growth and efficiency toward a sustainable steady-state with greater social equity (redistribution); competition must be paired with cooperation for the common good; dependent specialization should give way to greater local self-reliance and economic diversity. These are the minimum conditions necessary for the human enterprise to back away from critical systems thresholds and avoid precipitating a potentially catastrophic global-scale state shift.

Consistent with such new goals, the following specific questions flow logically from the forgoing analysis but have largely been ignored in both domestic land/resource planning and international trade negotiations to date (Kissinger and Rees 2009). In a rapidly changing and increasingly unpredictable world:

1. Is it wise for any nation to commit a significant proportion of its agricultural output and land-base to satisfying off-shore demand (i.e., creating dependent populations);
2. Should any population or country allow itself to become significantly dependent on increasingly uncertain external sources of essential food and other resources?
3. Should any region or country allow its prime agricultural lands to be paved over or otherwise degraded on the assumption that it can always import basic foodstuffs from elsewhere?
4. Is it not time to resurrect the virtue of greater self-reliance through investment in local natural capital?
5. What strategies can irreducibly import-dependent countries employ to diversify suppliers, enhance the security of existing trade relationships and share in management responsibility for critical ecosystems in other countries?
6. How can trade rules be modified to prohibit the overexploitation of critical forms of natural capital? For example:
7. How might the terms of trade for agricultural, forest, fisheries and other renewable resource products be adjusted to provide the economic surpluses necessary for the maintenance of the productive ecosystems (natural capital) for the long-term benefit of both producers and consumers?

Similarly difficult questions must be asked in virtually every domain of human economic activity.

Obviously, the paradigm shift necessary for global sustainability poses a daunting challenge beyond anything attempted by the international community to date. While not yet fully understood or appreciated, the motivation for such a dramatic shift is actually quite simple: for the first time in human history, long-term individual/national self-interest may well have converged with humanity's *collective* interests. Failure to recognize this reality and to accept the challenge of planning a cooperative transition to sustainability would be a failure to exercise the very qualities that distinguish modern *H. Sapiens* from all other species: high intelligence (e.g., reasoning from the evidence); the

[8] This has never happened in so complex a society nor one so large and unwieldy.

capacity for forward planning; and the ability to exercise moral judgement (Rees 2010). In this light, negotiating a just global sustainability would be a milestone achievement, marking our species' release from the grip of blind instinct and maladaptive emotion; failure and systems collapse would be tantamount to a backward step in human evolution.

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Ecological Economics 68 (2009) 2309–2315

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

ANALYSIS

Footprints on the prairies: Degradation and sustainability of Canadian agricultural land in a globalizing world

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ARTICLE INFO

Article history:
Received 11 November 2008
Received in revised form 17 February 2009
Accepted 25 February 2009
Available online 1 April 2009

Keywords:
International trade
Ecological footprint analysis
Material flows analysis
Canadian prairies
Ecological degradation

ABSTRACT

The 'Canadian prairies' represent one of the world's great breadbaskets, supplying people all over the world with agricultural commodities ranging from various grains, through legumes and oilseeds, to both grain and grass-fed meat products. However, the expansion and intensification of Canadian agriculture in the last century has significantly altered the structure and degraded the function of prairie ecosystems. This, combined with climate change, has put the ecological sustainability of the region at risk and raises questions about the region's ability to continue supporting millions of distant consumers. We use variants of two existing sustainability assessment tools, material flows analysis (MFA) and ecological footprint analysis (EFA) to estimate the terrestrial ecosystem area and other physical inputs used on the Canadian prairies to satisfy export demand and to link this production to documented processes of ecological degradation. We discuss the implications of this interregional framework for impact analysis and conclude that, in a globalizing, ecologically full-world, trade-dependence implies previously-ignored risks to both importers and exporters. The results underscore the importance for all countries to protect or restore their own natural capital assets and enhance their self-reliance. Citizens and their governments, particularly of countries that have become irreversibly import-dependent, have a direct interest in ensuring that the ecosystems that support them are sustainably managed, wherever in the world the latter may be located.

1. Introduction

Human societies depend for survival on various natural 'goods and services' (e.g., clean air and water, food, stable climate) provided by both local and global ecosystems. Over time, this dependence has actually intensified. People everywhere, both individually and in the aggregate, now consume vastly more energy and material than they have historically (French, 2000; Meadows, et al., 2004; MEA, 2005; Brown, 2006; FAOSTAT, 2008). Humans are demanding ever larger flows of goods and services—natural income—from what are often diminishing stocks of natural capital. For most of history, people relied mainly on the output of local natural capital. More recently, with economic globalization, they increasingly sustain themselves on trade goods (incorporating 'natural income') imported from all parts of the world (Princen, 1997, 1999; French, 2000; Rees, 1994, 2004; WTO, 2006; Hornborg, 2006).[1]

Globalization allows various regions to grow beyond their local carrying capacities, but it also increases their vulnerability to the degradation of now-distant supporting ecosystems; to climate change; and to geopolitical instability, any of which might jeopardize distant production or vital trade linkages. Significantly, signals that something is awry are often weak—the spatial separation of production from consumption prevents negative feedback from over-exploited ecosystems from reaching consumers particularly if, behind the scenes, transnational corporate traders can shift to alternative sources of supply (What is out of sight, is out of mind). The resultant consumer ignorance helps entrench the status quo and encourages the continued and sequential deterioration of affected ecosystems everywhere (Princen, 1997; Norgaard, 2001; Rees, 2004; Dauvergne, 2005; Young et al., 2006).

Indeed, a central premise of this paper is that, partially because of such hidden inter-regional impacts, the world is already reaching material limits to growth (Meadows et al., 1972, 2004; MEA, 2005; WWF, 2008) and that, in these circumstances, global development policy must shift from ecologically empty- to ecologically full-world thinking (Daly, 1991). In an ecologically full-world, natural capital becomes the limiting factor and the sustainability of any import-dependent region is increasingly tied to the ecological sustainability of supporting regions half a planet away.

Most densely populated and high-income countries could not maintain their current material standards without both international

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[1] In ecological economics terms, humans depend on 'natural income' (e.g., fish 'harvests') produced by various forms of 'natural capital' (e.g., fish stocks or marine ecosystems). In this context, sustainable income/consumption is any level of consumption that does not exceed the long-term productive output of relevant stocks of natural capital (i.e., exploitation should leave productive natural capital essentially intact).

0921-8009/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.ecolecon.2009.02.022

Land Use Policy 27 (2010) 589–599

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Importing terrestrial biocapacity: The U.S. case and global implications

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A R T I C L E I N F O

Article history:
Received 10 February 2009
Received in revised form 13 May 2009
Accepted 28 July 2009

A B S T R A C T

Human societies depend for their survival on goods and services provided by both local and global ecosystems. For most of history, people used mainly local resources. Increasingly, however, globalization and trade enable consuming populations everywhere to support themselves on the output of distant ecosystems. This is potentially problematic because of global change and because the spatial