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Revisiting the Image of Limited Good: On Sustainability, Thermodynamics, and the Illusion of Creating Wealth

Paul Trawick and Alf Hornborg

Abstract

This article focuses on worldview, examining two perspectives that are now contending for global dominance: the open-system model long promoted by economists, referred to here as the 'image of unlimited good', and a more traditional closed-system model, the 'image of limited good' explored by George Foster, who attributed it to members of peasant societies throughout the world. The former worldview -- which has become conventional to modernity, post-modernity, and the consumer culture -- rests on the assumption that people continually 'create' wealth, an illusion arising from a fundamental confusion about the respective properties of real wealth and virtual wealth, or physical capital and finance capital. This "positive-sum" or "expanding-pie" model ignores the near-total reliance of the world economy on fossil fuels and other non-renewable resources, finite forms of low-entropy matter-energy whose transformation into real wealth is governed by the laws of thermodynamics. In contrast, the "fixed-pie" or "zero-sum" worldview -- which is traditional to many indigenous and peasant societies -- rests on the verifiable assumption that most of the 'goods' that people value in life are scarce, being derived from those limited resources through the expenditure of human labor and the degradation of extra-somatic forms of energy, so that they form a commons that has to be shared according to a set of agreed-upon principles. Based on an ethnological argument centering on the successful management of scarce water for irrigation, a radical shift toward the closed-system view is necessary if people are to act collectively to limit their expanding consumption in order to regulate the global economy and stabilize the Earth's climate.

Revisiting the Image of Limited Good: On Sustainability, Thermodynamics, and the Illusion of Creating Wealth

Paul Trawickⁱ and Alf Hornborgⁱⁱ

Introduction: The dominant image of unlimited good

Several decades ago anthropologists learned of a belief, apparently held by people in peasant societies throughout the world, that any affluence enjoyed by one person inevitably comes at the expense of someone else. In the heyday of modernization theory this zero-sum or closed-system view of the world was labelled 'the image of limited good' (Foster 1965), and regarded by its critics as a cultural misconception standing in the way of development. Today, the planetary predicament unleashed by highly unstable growth, increasing economic polarization, peak oil, and climate change appears to be vindicating the intuitions of historical and contemporary peasant populations, now transposed from the village to the global scale. Although the acknowledging of biophysical constraints on the economy still tends to be rejected by mainstream economists, who refer to it as the 'Malthusian' fallacy, current concerns about sustainability are opening up opportunities for a renewed discourse on the limits to growth, not least on what the technological transcending of those limits tends to entail in terms of the displacing or 'outsourcing' of both labor inputs and environmental loads. These concerns are very much aligned with those of the alternative globalization and Occupy Wall Street movements, as they were with intellectual predecessors such as dependency theorists.

Malthus, like Ricardo and Marx, was right about some things and wrong about others. He famously worried that there ultimately had to be limits on the amount of land suitable for cultivation and for supporting human populations, regardless of the state of development of production technology. Ricardo was then astute in observing that nineteenth-century Britain was proving itself able to transcend those limits by substituting labor and capital for land, while outsourcing its land requirements to other continents. And Marx was prescient in pointing out that capitalists accumulate wealth through exploiting other people's labor,

by minimizing wages while maximizing profits from sales, a process that he noted was being extended imperialistically to other countries. But Ricardo and Marx had their own shared blind spot, particularly regarding the ephemeral nature of environmental constraints and the inherent virtues of technological progress. Although it is not possible to predict exactly when or where the limits to economic growth will be reached in a particular part of the world, since development strategies tend to displace such limits in time and/or space, it is no longer reasonable to conclude that such limits do not exist. And neither Ricardo nor Marx really foresaw them.

The open-system worldview that they appear to have shared, here called ‘the image of unlimited good’ -- which is adhered to today by most economists (Hornborg 1992, 2001, 2011, 2013, 2014a, 2014b) -- emerged out of the historical experience of a highly privileged segment of the population of nineteenth-century Europe. It reflects both a misunderstanding and a mystification of the related phenomena of economic growth and technological development, a fact that has become increasingly obvious from its incapacity to deal with twenty-first-century issues of sustainability. Although their perceptions focused on different scales and levels of social organization – local, national, and global – and had very different ontologies, the peasants of Tzintzuntzan (Foster 1965), peasants in Colombia, echoing the pre-industrial Physiocrats (Gudeman & Rivera 1990), Thomas Malthus (1820), Nicholas Georgescu-Roegen (1971a), and William Catton (1980) all adhered to a contrasting worldview and were not wrong: there *are* limits to the extent and the spread of material affluence. This is because its cost — the other side of the coin of growth — is a corresponding environmental decline that ultimately has to be shared by everyone. It is precisely when such limits appear to be transcended by novel technologies and sources of energy that we have reason to suspect some new form of environmental load displacement, some new externalization of costs, whose victims have now become the majority of people on the planet, the famous 99%.

The use of imported natural resources in devising technologies that replace local labor is a phenomenon that everywhere hinges on the relative price of labor; thus it deserves to be examined with new eyes by social scientists concerned with widening inequalities in the global distribution of wealth. These are profoundly anthropological issues, as they illustrate that the material modes of operation of economic systems are driven by cultural worldviews

(Gudeman 1986), all-encompassing perspectives that are rarely examined but are now in great need of close scrutiny.

Real wealth versus virtual wealth: A source of conceptual confusion

Economists have long championed 'growth' in the GDP as the key to widespread and cumulative enhancements in human wellbeing, and strongly promoted it as an alternative to the redistribution of already accumulated wealth. Yet, as Sen (1999), Stiglitz (2002), Wade (2003), Callinicos (2003), Pollin (2005) and others have shown, such expansion -- i.e. the increasing per-capita consumption of goods and services -- is only taking place in certain parts of the world and, even within that limited set of developed and newly-developing countries, its benefits are largely confined to the privileged classes, the nouveau rich, and the traditional elites. Everywhere that it is now underway, such growth is in fact a destructive boon and a luxury being enjoyed by a minority at the expense of the majority (Nash 1994, 2007), a fact that is illustrated dramatically by the declining real income -- very evident now for several decades -- of the middle and lower classes in all of the 'developed' countries.

The profoundly uneven benefits of this 'growth' are reflected in the most skewed distribution of income and resources the world has seen, certainly since the dawn of the industrial age, a pattern that is steadily getting worse. A unique study funded by the United Nations (Davies, Sandstrom, Shorrocks and Wolff 2006) recently concluded that the richest 1% of the world's people now own approximately 40% of the existing assets, and the richest 10% own an astonishing 85%, while the bottom 50% own less than 1% of the total available wealth. An unprecedented amount is now concentrated in so few hands that the per capita distribution cannot be represented graphically on a single printed page in a way that the average person can understand (Korten 2001:110-112). This is the kind of society that three decades of neo-liberalism has produced, under the famous Anglo-Saxon model (Gray 1998), i.e. the freeing-up of markets, particularly those involved in finance, which were formerly thought to be capable of regulating themselves.

People's reaction to this kind of news is instructive and reveals a great deal about their view of the world. When the findings of the UN study were announced in The Guardian

newspaper in England, Madsen Pirie, an economist then directing the Adam Smith Institute in London -- a free-market think-tank -- commented on the figures, disagreeing with a statement by Oxfam that the current distribution of wealth is unfair and ought somehow to be corrected:

"The implicit assumption behind this [assertion] is that there is a supply of wealth in the world and some people have too much of that supply. In fact wealth is a dynamic; it is constantly created. We should not be asking who in the past has created wealth and how we can get it off them....instead the question should be how more and more people could create wealth" (The Guardian, Wed. December 6, 2006).

One frequently hears these references to wealth creation nowadays in the media, generally made by financiers, pundits and politicians, in statements that invariably suggest we can all somehow join in the process. They go unchallenged because they express an almost sacred proposition lying at the heart of the worldview sustaining the relatively unregulated form of capitalism that now prevails in most countries. Such remarks are in fact a kind of category mistake, as we will see below, and are ironic at a time when an unprecedented amount of this 'created' wealth — i.e., virtual wealth in the form of finance capital -- has suddenly vanished, inducing a global economic crisis and precipitating the most massive bailout of private-sector entities by government and 'the public' — i.e. of banks and bankers, and of wealthy investors in general -- that the world has ever seen.

Note that if real wealth, the kind that cannot abruptly disappear, is not constantly created then the argument against redistributing it by imposing upper limits on its accumulation and consumption quickly falls apart. Certainly the argument would be greatly weakened if the creative process supposedly lying at the heart of global capitalism were shown to be an illusion. This would clearly be welcomed by members of the Occupy Wall Street movement, who in 2011 took to the streets all over the world to express outrage about the highly skewed distribution, but who seemed to be searching for a coherent alternative vision to guide them.

In order to debunk the proposition that people create wealth, and to see more clearly how the global system works from an ecological or materialist point-of-view, the properties of two basic kinds of wealth must be distinguished, and the common mistake of confusing them by using the concepts interchangeably -- as in the above example -- must be corrected. Such clarifications form part of a radical critique that has emerged during recent decades through the work of ecological economists, one whose implications for worldview have yet to be recognized widely, even in affluent parts of the world. Several of them have noted a widespread tendency to confuse the two basic forms of wealth, evident today among experts and non-experts alike, the first of whom was Nobel laureate Frederick Soddy (1921, 1926).

Real wealth -- sometimes referred to as *productive capital*, but a category in need of more precise consideration -- can be said to consist of material goods such as fossil fuels after they have been extracted and refined, other raw materials that have been transformed from their natural state, land which has been altered to make it habitable or productive, food of all kinds, manufactured goods such as tools, machinery, and technology, and consumer items in general. As Marx was the first to point out, these tangible forms of wealth, which typically become traded commodities, are modified through the expenditure of human labor energy, which imbues raw materials with utility or use-value as well as with exchange and surplus value. But the adding of that value also requires the expenditure of huge amounts of extra-somatic or non-human energy, a vital input upon which he placed far less emphasis.ⁱⁱⁱ As both Soddy and Georgescu-Roegen (1971a, 1971b, 1975) later observed, such inputs are finite and, in a situation of growing population, increasingly scarce, a point that echoed the early argument of Malthus.

Virtual wealth, on the other hand -- sometimes referred to as *finance capital* or, more usefully, *credit money* (Graeber 2011) -- consists of intangible and abstract forms of wealth such as stocks, bonds, securities and derivatives: paper or even merely digital assets that originate in the issuing of credit and debt, and the simultaneous creating of money, by banks. Although people do create such wealth -- nowadays mainly bankers at the behest of governments -- its value is merely symbolic, potential or virtual, i.e. largely imaginary and effectively projected into the future.^{iv} Note that very little expenditure of energy is required

to produce such virtual wealth, and very little labor and raw materials as well, a fact that highlights the contrast being made here and underlines the entirely symbolic and socially-constructed nature of the resulting value. If “real wealth” ultimately consists of inputs of physical matter-energy, virtual wealth is imaginary or fictive in the sense that it does not require such inputs.

Essentially consisting of a kind of promissory note on future flows of income, paper money and other virtual assets do not degrade with time, as does everything else in the physical world, including the sun upon which all life on Earth depends. On the contrary, they have the unique property of growing exponentially and increasing in value at compound rates of interest, thereby contradicting the laws of thermodynamics, nature’s most fundamental laws (Soddy 1921, 1926). By reproducing themselves in this ultimately illusory way, such virtual assets act as powerful catalysts that increase the production and consumption of real wealth, further accelerating the ongoing and linked processes of wealth concentration and thermodynamic decline, as we will see below. Thus their ‘creation’ is ultimately -- and quite inevitably -- a destructive process, i.e. destructive of order, as a number of ecological economists have pointed out, and as a growing number of people in the world now seem to understand.

Virtual wealth, financialization, and crisis

In order to illustrate the defining characteristic of finance capital, and to show how the “creation of wealth” works, let us say that someone -- either a real individual or a ‘juridical’ one, i.e. a corporation -- takes out a loan of \$1,000 from a bank. The first thing to note is that no cash actually changes hands when credit is given in these transactions; today they merely consist of an exchange of promissory notes, or promises-to-pay with future income or assets, issued by both parties. The interest-bearing note of debt will remain with the bank of origin, to be paid off by the borrower at compound interest, with the cash coming from their future wages or, in the case of a business firm, from future profits. Note that this debt, a flow of future income, has been ‘created’ by the bank only in the sense that the flow would not go where it ultimately ends up without the issued credit. The material and energetic inputs required for the financed activity have not been created, since without the lending agreement these tangible assets would merely be spent up and used up by someone

else in some other way. Nothing real has been created except a new creditor/debtor relationship and a corresponding change in the flow of the future income of the debtor. To speak here of the “creation of wealth” is therefore to engage in a fundamental mystification that obscures the heart of what is really going on and draws attention away from the ensuing degradation and dissipation of all the necessary energy and material resources.

Meanwhile, the borrowed money, if spent as a unit on some investment or on consumption, will end up as a set of electronic digits in an account file in another bank. Under current political conditions, the bank can then lend most of that fictitious money again at compound interest -- as before, without any currency actually changing hands -- issuing more credit and thereby creating more virtual wealth in a sort of repeating loop (Soddy 1921:24-56; 1926:303-305; Korten 2001:182-185). This process is widely misunderstood today; people commonly assume that it is the savings of individuals, or their monthly earnings entrusted to banks in personal checking accounts, that is lent and passed on temporarily to other people. In fact only a very small amount comes from that source; the rest is simply created by the banks *out of nothing* -- and profited on through the charging of compound interest -- when bankers decide to take on a certain amount of risk and to issue credit (Douthwaite 1996; Daly and Farley 2003; Lancaster 2010; Coggan 2011; Graeber 2011).

The idea that banks actually “lend” money to people in these situations, temporarily giving up something that belongs to them, which justifies the notion that banks and bankers should be paid interest for the ‘opportunity cost’ of the lent capital, is largely an illusion, one that has long been promoted by a transnational capitalist class of extremely wealthy people (Sklair 2000) who profit from the confusion at the expense of everyone else. What the banks are seemingly giving up is merely the future product of their debtors’ own labor, which they are effectively extracting beforehand, as Marx understood better than anyone else.

As many authors have noted, such ‘borrowed’-but-actually-created money is then lent by the banks again and again, to consumers and to businesses, at compound interest, and also lent by banks to each other. In the U.S., fractional reserve requirements supposedly restrict the amount to 90%, or \$900 of the initial \$1,000 loan. This ultimately means -- as Herman Daly, David Korten, David Graeber, and others have pointed out -- that, through the continual relending of this shrinking 90%, every \$1,000 deposited within the banking system

soon multiplies into \$10,000 of newly-created digital money, all bearing interest and accumulating in the accounts of banks (Korten 2001:182-185). This process of “wealth creation” actually drives the printing of money and determines the money supply in most developed countries, a fact that again is not widely understood. Modern paper currency -- the essence of Soddy’s virtual wealth -- is physically created by banks out of nothing through the issuing of credit and the creation of debt, such as that incurred by governments in order to finance wars, whether ‘cold’ or ‘hot’ (Graeber 2011).

In the US it is the Federal Reserve Bank that does this, which is merely a consortium of privately owned banks, headed by a government-appointed Chairman. The world’s other central banks, such as the Bank of England and the European Central Bank, operate in basically the same way. In each case an initial government debt, underwritten by purchased treasury bonds, is monetized by the reserve ‘bank’ and the respective national mint through the printing of cash money, and then circulated widely by lending it to other private banks, which in turn lend it on to businesses and to individuals. What this means is that if everyone involved were to suddenly pay off their debts while doing no more lending there would soon be no money in circulation, a fact of which relatively few people seem to be aware.

Nowadays, in the era after the abandonment of the gold standard in 1971, paper money, like the digital money in bank accounts — modern forms of what Graeber (2011:73-75) calls *credit money*, which itself has a very long history -- embodies and represents nothing more than debt; that is its primary function. Traded massively worldwide every day as a commodity, the value of currency — whether in the cash or the electronic form — ultimately rests on the trust and confidence of people that existing debts will eventually be repaid, even though that would be disastrous if it really happened. In many countries, there are no capital reserve requirements and no reserve banking system, particularly the offshore tax havens and centers of global finance. There the amount of self-reproducing wealth created by private banks through the “lending” of money is potentially limitless.

All of this is to say nothing about the practice — also largely unregulated today -- of banks selling on the consumer debt created through their lending, of repackaging it and selling it to each other and to wealthy investors, as a commodity, while insuring themselves against any possible future loss due to default on the initial loans. In the case of the housing market,

the resale of this debt and the buying of the insurance -- in the form of derivatives like “collateralized debt obligations” and “credit default swaps” —in 2008 became so massive that it brought the entire system of global finance to the brink of collapse. Note that this reselling is just as dubious, from a moral point of view, as the right to create money by issuing credit and interest-bearing debt in the first place. We hear a great deal today about the responsibility of debtors to repay loans and to avoid bankruptcy, for the benefit of society, but nothing about the duty of creditors to hold on to the resulting debt and to fully absorb the risk they have undertaken.

This is the legacy ultimately created by the political decision, made early in the sixteenth century in Europe, to legalize usury. That pivotal decision to recognize the opportunity cost of lending coinage – real-wealth money made from naturally scarce gold and silver -- was endorsed by Luther and later by Calvin during the Protestant Reformation, which eventually forced the Pope and other leaders of the Catholic Church to follow along (Hyde 1983:122-140; Graeber 2011:321-323). Initially the interest rate was limited by the early European states to no more than 5% per year; and usury continued to be closely regulated thereafter through caps on the rate right up until the financial system was deregulated at the end of the twentieth century. In any case, that decision ultimately led to the invention of a wide array of purely virtual forms of wealth — paper money and its many derivatives — all based on lending and on usury, a practice that was previously considered to be exploitative and inherently sinful by Christians and Muslims alike.

Today, this process of magical multiplication of other people’s future income – i.e. of the *benefits* of making loans but not the material and other associated *costs* of doing it -- ultimately generates a huge amount of virtual wealth, all bearing interest, thereby generating the enormous profits and exorbitant salaries that have come to characterize the banking sector in the era of financial deregulation. Those profits are generally reinvested today, speculatively, within the financial sector, and used in the purchase or sale of other forms of finance capital in an effort to continually increase their yield. Many of those extremely lucrative ‘instruments’ were only recently created, thanks to deregulation; and many -- such as the commodity indices widely traded by hedge funds, a widening array of

derivatives, and the opportunity to engage in High-Frequency Trading more generally -- are exclusively available to members of the transnational or global elite.

The entire financial system has become highly unstable as a result, due to the uncontrolled spreading of risk together with the accompanying concentration of profit, which now threaten the future of most people on the planet (Radelet and Sachs 1999; Krugman 2008, 2012; Stiglitz 2010). The system has always been unstable, for that is a part of its inner logic of creating and accumulating wealth, but deregulation has made it more volatile now than ever before (Harvey 2010). The current situation, wherein the famous “moral hazard” has been allowed to become structural or endemic to the banking system -- so that it massively shifts future income from debtors to creditors, from the increasingly poor to the increasingly rich -- led the editor of the world’s most prominent financial newspaper, Martin Wolf (2008) of the Financial Times in London, to say recently: “No other industry has a comparable talent for privatizing gains and socializing losses”.

The lifelong servicing of personal debt through continual interest payments to agents in the financial, insurance and real estate sectors of the economy has, in the view of some analysts, become the “new road to serfdom” (Hudson 2006; Toussant 2004; Hannan 2010), which people today tend to embark on without even thinking about it. A permanent relationship of dependency on finance capitalists for credit now seems to be widely accepted as somehow natural, or certainly necessary for modern life. This personal relationship may help to explain people’s complacency about the recent bank bailouts which, along with the wars in Afghanistan and Iraq (Stiglitz and Blimes 2008), have created enormous national deficits that have effectively mortgaged the future of hundreds of millions of people, especially the young. Note that this situation is analogous, if not exactly homologous, to the paralyzing debt servitude that people in ‘Third World’ countries experienced during the 1970’s through the 1990’s, a legacy of economic dependency that has not gone away. Instead, such servitude has become the defining feature of modern economic life under globalization.

Most people in the world now spend the majority of their working lives, i.e. of their labor time, working for someone else — generally a big corporation, or a sub-contractor of such a corporation — that is itself concerned with increasing profits and accumulating more and

more finance capital for its shareholders and its top executives (the fiduciary duty of the corporations and their C.E.O.'s). Whether they work in the service or the manufacturing sector, such people are engaged throughout every working day in 'making money' and 'creating wealth' for someone else, while at an individual level this is mainly done in order to: 1) satisfy the immediate subsistence, education, and health-care needs of family members, thus reproducing the household as a unit of production; and 2) pay off their taxes and their accumulating debt. Meanwhile, the hope of an accompanying wage increase, adjusted for inflation — of growth in their 'real' income in 'real' dollars — to support all the previous consumption, fades, and has been doing so for several decades now for most people, even in the developed countries.

The experience of living under the new debt servitude — so increasingly like the lived colonial reality of poor and exploited people everywhere, but especially those in Latin America (see Mignolo 2003; Walsh 2010; Escobar 2010) — is one of working harder and harder, faster and faster, just to try and stay in the same place relative to everyone else, as many critics have observed. The same logic applies to the intensification of resource extraction (Pérez Rincón 2006). This, paradoxically, is how open-system thinking is generated in most 'modern' people, and how the hegemony of the unlimited good worldview is ultimately maintained. Such people simply have to believe that all of this effort, all of this fruitless daily struggle in fighting a losing battle, is somehow mutually beneficial to everyone in the long run, in a fluctuating and cyclical kind of "positive-sum" game (cf. Wright 2000).

Unless they are subalterns or indigenous people -- who often tend to know that the 'game' has a different logic and that the struggle will in fact never cease — such people cling to a basic faith that it will all somehow come right in the end, with the market's invisible hand doing its promised magic by redistributing all of that 'created' wealth, trickling it down so that their children too can eventually benefit. Today, after the recent financial collapse, they do this even as it becomes increasingly obvious that the collective future of those children has effectively been mortgaged. Such faith can only be maintained, in a seemingly rational and logical manner, within an expanding universe wherein wealth -- i.e. real as well as

virtual wealth – is continually being created. This, we assert, is the sacred proposition lying at the heart of the open-system worldview of global capitalism. But no such universe exists.

The awareness of bankers, on the other hand, is not difficult to fathom, as they now spend most of their work time gambling with the money -- i.e. with the commoditized debt -- of other people, while off-loading all of the associated risk. There can no longer be any illusion among them of creating any wealth within an expanding physical world. Given the magnitude of the economic crisis that such thinking has induced around the globe, and the real possibility that such periodic crises will now be allowed to continue (Volker 2010; Harvey 2010), as well as the protracted daily struggle of most people merely to survive and to stay employed in the game, an obvious question arises: will a moment ever come when the majority of people finally see what is going on and decide they have had enough, and their worldview suddenly changes? David Graeber (2011:365), our most eloquent authority on the whole phenomenon of debt,^v notes that Henry Ford once said that “if ordinary Americans found out how the banking system really worked, there would be a revolution tomorrow.” Such a comment, given its original source, confirms the extent of the public’s mystification about the nature and the origins of wealth.

The steady, credit-driven growth of consumption during the last thirty years created a rising tide of optimism in global society that has now abruptly been reversed. That sudden change, brought on by the ongoing crisis, has effectively called into question certain secular myths that are all derived from the sacred presupposition underlying the dominant capitalist worldview. These too are central fictions supporting free-market ideology and sustaining the culture of over-consumption that prevails so widely today, especially in the global North. They include the popular and populist metaphor that “a rising tide lifts all boats”.

The current global distribution of household wealth, which has grown steadily more skewed for several decades now, shows that the metaphor is a false and misleading one. A global “free market” is, after all, just a massive system of voting in which people vote with their money; and, the more money one has, the more votes he or she gets (Chang 2007). Starting with the neo-liberal revolutions of Reagan and Thatcher, the political process of most states has effectively been distorted and subverted in this fundamental way, co-opting the very heart of democracy and other forms of modern governance.

The end result has been the accumulation of vast amounts of finance capital by an increasingly wealthy transnational class of people – the famous 1%, who are the world’s main creditors -- at the expense of the majority, the other 99%, who are the world’s debtors. The conflict of interest between borrowers and lenders that underlies such ‘growth’, although seemingly new -- and certainly becoming more intense every day -- is in fact a fundamental one with a very long history, which lies at the very core of the “free market” and indeed of modern democracy (Coggan 2011; Graeber 2011).

The facts of postmodern life have yet to dislodge another pervasive idea, strongly promoted today by the corporate media, that we can all somehow become rich and famous in a world potentially consisting of winners and no real or permanent losers. We all can have our fifteen minutes of fame, and can cash in heavily on that moment when it arrives; we too can be a star, be rich and famous, and have all the luxury goods and the associated “bling”. Such bits of conventional wisdom, reflected today in the expanding plethora of reality TV shows, in turn express a “positive-sum” or open-system model of the global economy, the view -- strongly promoted for decades now by free-market economists -- that the world consists of an unlimited and expanding “pie” of wealth. This essentially inflationary model is strongly appealing because it depicts a world where everyone can prosper without limit, with no need for anyone to sacrifice for the benefit of others -- for example, the next generation -- by forgoing any opportunities to consume. Such financial folklore again rests on the sacred postulate that wealth is created by people, so that it is not ‘subtractable’, or characterized by the quality that economists call *rivalness*, of which more will be said below.

If such false propositions are seen as true, then people’s decisions about spending money and about consuming more generally appear not to have any third-party effects, any opportunity costs or resulting losses in quality of life that are borne by someone else. That belief too is simply false, as Herman Daly and Richard Farley, two of the founders of ecological economics, have noted in discussing the concept of virtual wealth and other insights presented in the early work of Frederick Soddy:

“This undisciplined, imaginary magnitude was used as a symbol and counter for real wealth, which has an irreducible physical dimension, and cannot be created or annihilated. Money is a problem precisely because it leads us to think that

wealth behaves like its symbol, money; that because it is possible for a few people to live on interest, it is possible for all to do so; that because money can be used to buy land, and land can yield a permanent revenue, therefore money can yield a permanent revenue” (Daly and Farley 2003:255).

The fact is that money, which symbolizes only debt, cannot and will not do this kind of magic for everyone. The notion that it can is, like all illusions, based on a fundamental misperception of reality along with a deliberate, widespread, and very clever bit of ideological sleight-of-hand.

Production as destruction: The finite materiality of real wealth

Real wealth, unlike its virtual counterpart, is something that human beings do not, and cannot, create in God-like fashion, the way they create ideas and symbolic phenomena such as value. Yet the whole episteme of modern or Western culture -- the philosophical and metaphysical tradition lying at its core, and dating all the way back to Descartes -- ascribes that illusory power to humankind, i.e. to Man (Foucault 1970; Grosfoguel 2010:68). As a category, real wealth consists of the transformed products of low-entropy forms of matter-energy that are themselves scarce by definition and subject to nature’s laws. Such wealth -- sometimes referred to as *productive capital*, but basically just manufactured “stuff” — being a highly ordered form of matter-energy, can only be transferred from one person to another, converted into a different and less-ordered form, and ultimately consumed and degraded, leading in every case to a gradual increase of heat, waste and disorder (Georgescu-Roegen 1971a, 1971b, 1975). Its production takes place within a largely closed planetary system — i.e., one that can exchange energy and information with its cosmic environment, but not significant inputs of matter (Martinez-Alier 1987; Rifkin 1989). Within such a system the ‘creation’ of wealth is an illusion, since real wealth production is a physically destructive process.

Far from increasing the total amount of order and wellbeing existing on the planet, as neo-liberal theorists would have us believe, economic ‘growth’ — the increasing per capita consumption of goods and services — steadily reduces it, causing increasing disorder within

the system as a whole. To the extent that the world economy is fundamentally dependent on limited stocks of mineral resources such as fossil fuels, phosphates, and metal ores, the model of a limited world inevitably in decline merely expresses the Second Law of Thermodynamics, the famous Entropy Law, as we will see below. It is not derived from a narrative generated by affluent men jostling for wealth, power and prestige in the playing of some language game, like the other worldview, but expresses a single, universal, and potentially revolutionary truth.

In the long run there is no way that the majority of the world's people can benefit from such growth, which is in fact destructive of order, i.e. of *useable* raw materials and available energy. Admittedly, conceiving the ideas and technological insights that underlie production is very creative indeed — sometimes even miraculously so -- but the process of industrial transformation itself is exactly the opposite, as Georgescu-Roegen, the founder of ecological economics, pointed out long ago. Why, then, do we call it 'growth', and continue to speak — as Bill Clinton so enthusiastically does -- of "growing the economy?" Perhaps it would be best if, when talking about wealth in general, we dispensed with the metaphor of creating it.

All of the above points would be true of the global economy no matter how we chose to construct it. But note the full extent of our reliance today on a limited and very dirty supply of fossil fuels. In the United Kingdom, roughly 88% of the total energy consumed by people each day comes from these (I.E.A. 2004, 2009), while the much bigger economy of the United States is just as dependent, with hydrocarbons now accounting for approximately 86% of its energy consumption. The US uses up a huge percentage -- approximately 30% -- of the planet's dwindling oil stock. This is to say nothing of petroleum's importance as a raw material in making plastics and other synthetic compounds, materials that form a major component of the built environment in affluent parts of the world and are now the predominant form of waste or trash contaminating both terrestrial and marine ecosystems. According to the International Energy Agency (I.E.A 2010), we have nearly reached — almost exactly as predicted -- the critical consumption threshold known as "peak oil"; the recent surge of oil coming from fracking in the US, and from the rising exploitation of tar sands in Canada, are not exceptions to this phenomenon, as many people seem to think, but rather

clear illustrations of it. At a global level, more than 80% of the total energy consumed daily by people in one form or another now comes from non-renewable fossil fuels, a figure that varies significantly among countries but has generally shown a dramatic increase, especially in developing nations, during the last few decades.

In a world characterized by continued population expansion and the increasing per-capita consumption of finite non-renewable resources, the more we squander the limited resources that are available, by converting it into physical wealth, the faster the accompanying environmental decline and the bigger and more disruptive of our lives the problems of poverty, pollution, and climate change will become. In effect, the less time we will have as a species to make other and better institutional arrangements (see Rifkin 1989:64-65). All of the seemingly creative activities we engage in require raw materials and huge amounts of extra-somatic energy, and all of them consume and degrade huge amounts of that matter-energy, most of which is a direct substitute for displaced human labor. As Georgescu-Roegen (1971b:80) noted, like Soddy (1926) before him: “In entropy terms, the cost of any biological or economic enterprise is always greater than the product...any such activity necessarily results in a *deficit* [emphasis ours]”.

This, rather than the fictions of wealth creation, the rising economic tide, and the self-regulating market, is what science — both natural science and social science — now tells us. In the physical world, and in the “real economy”, the creation of wealth is an illusion, because to produce it, to accumulate it, and to consume it, is fundamentally to degrade and destroy. The current global system of economic and cultural production is thus violent by its very nature, a violence in which all affluent people are to some degree complicit.

Agribusiness, strangely enough, provides the best illustration of all of these points. In the US and other ‘developed’ countries, spectacular yields per hectare are achieved by virtually pumping extracted petroleum products back into the ground and into the air -- tractor fuel, petrochemical fertilizers, and insecticides -- while rapidly eroding the topsoil and mining the groundwater stored in underlying aquifers. This is what most farmers now do on a daily basis, whether they work for an agribusiness corporation or are struggling to hold on to a family farm. The self-contradiction that this generally involves, the utter negation of the traditional values that have always underlain stewardship of the land, has been emphasized

by many people (e.g., Berry 1977, 1981), as has the extent of the resulting cognitive dissonance and stress that many farmers now suffer from. From a scientific point-of-view, such creation-through-destruction is the defining feature of economic 'growth' as we now define it.

The efficiency of the U.S. food production system, as measured by its energy input-to-output ratio, is shockingly low and utterly unsustainable, as most farmers today must be keenly aware, simply because it costs them so much money and drives them so far into debt to continue to participate in that energy-intensive system. For every kilocalorie of food energy consumed by people in America today, ten kcal. of energy — mostly petroleum-derived -- are consumed and made unavailable for anyone else on the planet to use in the future (Pimentel 1993; Giampietro and Pimentel 1993, 1994). A large part of this consists of fuel for tractors and other equipment to replace the labor that has been displaced from the cultivation process, but the greatest amount is expended on packaging and on transport after the food leaves the farm.

In the short space of fifty years, this basic distortion of agriculture by agribusiness has 'progressed' to such an extent that fossil-fuel inputs now constitute approximately 60% of the total energy used in food production, while the solar energy harnessed through photosynthesis accounts for only 40%. Meanwhile, the nutritional content of our food has declined dramatically, even as the environmental costs of the industrialized production process have steadily gone up. Since agriculture is the sector of the economy tied most directly to solar energy capture -- the process upon which the food chain and the whole web of life depend -- there can be no clearer illustration of the fact that economic 'growth' as we have conceived it historically is fundamentally both inefficient and destructive. The belief that this kind of 'progress' is somehow creative and benign, and can therefore go on forever -- i.e., is sustainable -- emerged during the heyday of the seriously flawed worldview that we refer to as "the image of unlimited good" (Hornborg 1992; Nash 2007).

Vindicating the image of limited good

One of the first anthropologists to employ the concept of worldview was George Foster (1965), who spoke of a general "cognitive orientation" that guides people in their behaviour

and is shaped by a set of axioms or presuppositions about the world and how it works. Pointing out that we are not necessarily conscious of our worldview or able to say much about it, since the presuppositions are culturally inherited, Foster argued that people in peasant societies tend to share a distinctive model of reality, one profoundly shaped by their material poverty and the closed nature of their local social worlds, which -- as we now know -- are based on a relatively sustainable and labor-intensive kind of traditional agriculture (Netting 1993; Mayer 2002). The central axiom of that model he called the "image of limited good".

According to this hypothesized folk understanding, there is only a limited amount of 'good' available in the world; thus any good that one person acquires and enjoys necessarily comes at the expense of someone else, denying them of that same chance to acquire it. Foster insisted that peasants see their impoverished local worlds as closed systems and that they apply this simple idea to everything desirable in life: access to resources like land, water, and labor; the crops produced yearly through cultivation of the land; the opportunity to earn money and enhance one's social status; and the enjoyment of less tangible things like a sense of honor and prestige, or even parental love.

Peasants, he said, are highly aware of their lack of any power to increase the quantities of these that are available, so that any such 'good' "...like land, is seen as inherent in nature, there to be divided and re-divided, if necessary, but not to be augmented" (Foster 1965:296). Consequently, their subsistence-oriented village societies feature norms that discourage any effort to acquire more goods, and thus to draw attention to oneself, or to do anything else that might threaten the stability of established social relationships, which are based on the sharing of a prevailing scarcity.

Foster's argument was criticized for being tautological and providing a rationale for contradictory kinds of behavior, as well as for lacking scientific rigor (e.g., Kaplan and Saler 1966). Furthermore, he sided with the 'developmentalists' of his day by expressing confidence that capitalism and the opening-up of rural markets would eventually increase the material resources available to peasants, so that ultimately they would be able to abandon their traditional worldview and adopt a more modern one (Nash 2007). Neither he

nor most of his critics ever argued that there really is a limited good out there, and that peasants are more in touch with reality than 'moderns' are.

He did, however, point out that a closed-system worldview could, theoretically, just as easily sustain strong leadership and lead to widespread cooperation as it could promote envy and jealousy among individuals, the behavioural outcomes upon which he unfortunately placed the greatest emphasis. In any case, his work soon faded from view, but it was not forgotten. As one of the earliest attempts to consider the behavioural implications of a closed-system worldview, his work was destined to be revived.

Foster's influence can be seen in the later work of Stephen Gudeman (1986; Gudeman and Rivera 1990) and other contemporary anthropologists, but its implications are most clearly spelled out by June Nash (2007; also see 1994), who uses the concept as a central theme in discussing her years of experience with Mayan people affiliated with the Zapatista political movement in highland Mexico. She also employs it in reflecting on her previous experience in working with displaced peasants and tin miners in Bolivia, and an intervening period of study of Mandalese rice cultivators in Burma. For her, the idea of limited good is indispensable in accounting for the remarkable resilience of all of these people and the rural peasant societies of which they are a part.

The Zapatistas, still the most highly visible political movement of peasants on the world stage, are of course known for extraordinary forms of leadership and cooperation that extend across lines of gender, age and other social divisions, as well as for the practice of direct democracy. Nash portrays their ongoing struggle for autonomy and self-defence in the militarized zone of Chiapas, like other similar confrontations occurring today in Bolivia and other parts of the global South, as a conflict between two distinct ways of seeing the world: the "notion of limited good" and the "specter of the unlimited good". And there is no doubt about which of the two worldviews she considers more accurate as a depiction of physical and social reality:

"The growing awareness of the finite nature of the good has transformed the expectations of unlimited possibilities into a specter of paradise lost for growing multitudes of impoverished people...Those whose response is to declare war on

all who compete for control of diminishing oil, water, minerals and other resources are beginning to encounter resistance from social movements that seek to reinforce international covenants on the environment and the rights of the poor. I hope to rescue Foster's insights on the peasant worldview and what that may offer for those concerned with a sustainable future for world populations" (Nash 2007:36).

Nash's account firmly grounds the peasant worldview in the practical activity of people — both indigenous people and those who, like the Zapatistas, also call themselves *campesinos* or peasants — who derive their livelihood from cultivating, investing their limited labor every day in the exploitation of scarce resources such as tiny plots of land and inadequate flows of irrigation water. Her overall argument (see also Nash 1994), like Foster's before her, implies that when a person's subsistence and physical survival — i.e. their food or "daily bread" — come directly from such a limited resource base and their own constant household labor, they cannot help but to see the world clearly as it is, a world in which everyone's livelihood is similarly derived, i.e. from limited and exhaustible resources, whether they work in a tiny rainforest plot or in an office on Wall Street.

There is, of course, an academic version of this general way of viewing the world, a school of thought in political economy known as dependency theory. It originated in Latin America and, despite rumors to the contrary, it too is alive today and still very much a part of popular culture in the global South, although perhaps in need of some rejuvenation.

The classic anti-colonial formulations of Cardoso, Frank, Amin, Petras and others, published in the 1960's and 1970's, pointed to the disadvantageous position shared by most people in the 'underdeveloped' countries lying at the periphery of the world system, with its historically derived division of labor. Their arguments focused on the "unequal terms of exchange" that result from this structural marginality, rooted in colonialism, which have persisted largely unchanged through time. These circumstances constrain people in the developing countries by keeping real wealth, in the form of primary products (minerals, fossil fuels, other raw materials, and agricultural produce) along with the profits resulting from their exportation, flowing out of the periphery and accumulating in hands of people in

the developed countries. This has been well documented in studies of the so-called Physical Trade Balances of less developed nations (e.g., Pérez Rincón 2006).

The essence of the *dependistas'* argument has always been that the game of global capitalism is fixed, in terms of a predetermined division of labor and exploitative terms of trade, and that the net sum of all of this production and international trade is basically zero. Wallerstein (1974, 1979, 1984, 1995) took up the challenge of providing a more complex model in his famous “world-systems” analysis, wherein the same dynamics take place within a three-tiered hierarchy of core, semi-peripheral, and peripheral countries. Widely influential today, especially among academics and cultural theorists in Latin America, this formulation places the BRIC nations (Brazil, India and China) and other semi-peripheral countries in the advantageous intermediate position that they now occupy within the global economy.

According to this body of theory, the vast majority of the profits generated by the investment of foreign capital in the developing or peripheral countries — initially for the extraction of primary products and, nowadays, also increasingly for the assembly of low-cost consumer items in sweatshops — have always been repatriated by foreign capitalists to the metropolitan or core countries where they live, or put into offshore bank accounts in order to avoid taxes. The rest have been exported by the allies of foreign capital -- complicit national elites -- into foreign bank accounts, and then either used to finance consumption or reinvested, usually in speculative enterprises and in hedge funds. The end result in either case has been the “development of underdevelopment” (Frank 1966; Escobar 1995): the gradual enrichment of people in the global North at the expense of most of those in the South, where the profits resulting from international trade would otherwise have been invested or spent.

The *dependistas'* original argument was somewhat understated, being overly focused on relations of international trade while largely ignoring the worsening inequalities of wealth that are evident today within all countries, both the metropolitan or core ones and those of the semi-periphery and periphery. As numerous works have subsequently shown (Sen 1999, Arrighi 1994, Hardt and Negri 2000, Stiglitz 2002, Wade 2003) — especially the aforementioned UN study of the world distribution of household wealth (Davies,

Sandstrom, Shorrocks and Wolff 2006) — most recent growth has in fact occurred at the expense of the majority of people in both the ‘developed’ and the ‘developing’ worlds. Across the globe it can now be seen as the internally stratifying and class-based phenomenon that it always was, which many critical theorists regard as a process of increasing internal domination and, at a cultural level, widening ‘coloniality’ (Mignolo and Escobar 2010).

This perspective casts a sceptical and pessimistic light on the seemingly spectacular growth that is suddenly evident today in Latin America and even in Africa. The growth now occurring there is almost entirely based -- as the *dependistas* originally argued and as some of them ultimately predicted (Petras and Veltmayer 2001; Perez 2003; O’Hara 2004) -- on the exporting of primary products and now even on the “grabbing” of the best agricultural land, as in Africa, mainly to support the ongoing expansion of industry and consumption in China and other parts of Asia.

Most of the recent critiques of globalization lend support to this view in terms of their gloomy prediction of no significant social and economic mobility, and no substantial long-term economic gain, for the vast majority of the world’s people (see, e.g., Grosfoguel 2010). It has even been suggested that some governments in the southern hemisphere should consider “decoupling” their economies as much as possible and moving toward a more self-reliant strategy for development, particularly in the domain of food production (Taylor 1991; Barkin 1998; Bello et. al. 2000). Many Latin Americans will be struck by the fact that this is precisely the kind of ‘economic nationalist’ path pursued by governments throughout Latin America during the 1960’s and 1970’s, by popular leaders such as Allende, Roldos, Torrijos and Velasco, until they were deposed and assassinated, allegedly with U.S. government support (Perkins 2004).

Dependency theory and world-systems analysis continues to be highly influential today in Latin America and other parts of the global South, but its star has faded somewhat in recent years, just at the time when the seemingly spectacular growth in the hemisphere began to arise. By and large, this body of work overlooks the crucial role of energy and, despite the strong focus on primary products and scarce raw materials, it does not actually portray the global economy as a closed system. Perhaps its impact has diminished for these very

reasons. The irony is that a revival of sorts could easily have come about long ago, inspired by an unlikely source: economic theory.

Economic theory and energy: Revisiting the “science of scarcity”

Although it is not widely known outside the academic discipline, the canonical versions of market theory of the nineteenth century were based on a general equilibrium model, which depicted the economy as a closed system governed by the laws of Newtonian mechanics as well as the newly-discovered First Law of Thermodynamics. The global economy was said to be a closed system in which total economic value or utility was conserved, even as value was converted from one form into another through production and exchange. Beinhocker (2005:67) notes some of the implications in a recent overview of the history of the discipline:

“Traditional economics typically portrays value as a fixed quantity that is converted from one form to another.... New wealth isn’t actually created; rather, the world begins with a finite set of resources that are allocated among producers, who in turn create a finite set of commodities that are allocated among consumers. One can allocate that wealth in ways that are more or less efficient, just as one can burn a lump of coal in ways that are more or less efficient, but in general equilibrium models the economy can’t create new wealth any more than a lump of coal can reproduce. This emphasis on a fixed pie of wealth caused the English economist Lionel Robbins in 1935 to famously call economics the ‘science of scarcity’”.

One would never suspect any of this today, mainly because the ‘neo-classical synthesis’ emerged in the 1950’s, whereby the traditional theory was abruptly fused with endogenous growth theory, as Beinhocker goes on to explain. Unfortunately, that awkward synthesis – basically an academic coup de etat -- completely changed the theory of markets as a way of representing the physical and social world. The “fixed pie” of wealth was replaced with an “expanding-pie” view -- one based on an entirely new and faulty assumption of limitless and inexhaustible natural resources -- which was apparently more consistent with the political

agenda of most economists, or at least those of the dominant Chicago School, the famous shapers of the Washington Consensus.

According to the version of events handed down in the lore of the discipline, the basic elements of the original theory were established independently by several prominent thinkers of the nineteenth century: Ricardo, Walras, Jevons, Pareto, and others. Yet, as Mirowski (1984:8) has shown, those ideas were generally borrowed or copied directly from physics: "...economic theory was appropriated wholesale from mid-19th century physics; utility was redefined so as to be identical with energy". And if value was to be equated in the social world with a kind of energy, then that value, according to the newly discovered First Law, had somehow to be conserved in economic transactions. Both Mirowski and Beinhocker criticise early economists for this unacknowledged borrowing, and for inappropriate use of what for them is only a loosely fitting metaphor: value as a kind of social energy. Yet they also chide the early theorists for having basically ignored the Second Law of Thermodynamics, the so-called Entropy law.

Mirowski (1991:88-98) casts doubt on the relevance of both laws to economics and is quick to point out that value or 'utility' is ultimately a subjective and social phenomenon that cannot simply be reduced to embodied energy, as Georgescu-Roegen (1971a, 1971b, 1975) emphatically showed. But he seems to over-react in suggesting that economists today should abandon energetics altogether. What would the implications have been, for classical market theory as originally formulated, of the Second Law, which was not widely understood even by physicists until the latter part of the nineteenth century?

The Second Law of Thermodynamics states that, in an isolated system, energy, although conserved in absolute quantity, inevitably undergoes a qualitative change that proceeds in only one direction. The *available* or *free* energy steadily degrades, turning into *bound* energy and thereby becoming unavailable and incapable of doing any further work (Georgescu-Roegen 1971b:76-83). The Second Law is often dismissed as irrelevant to processes in the biosphere, as the Earth is not an isolated but a closed system, receiving a continuous input of energy from the sun. It is commonly argued that direct use of solar energy will enable us to recycle dissipated materials to an extent which would make thermodynamic constraints irrelevant (e.g., Kåberger & Månsson 2001). Nevertheless, the

continued strong reliance of the world economy on finite stocks of fossil fuels and other mineral deposits indeed implies that the Entropy Law is of crucial significance for economics. Not only does it mean that we will run out of those finite stocks, but also that the disorder generated in their conversion into commodities, e.g., carbon dioxide -- unlike the heat generated by biological processes -- will remain with us in the biosphere. Georgescu-Roegen (1993) argued that photovoltaic power, due to its massive material requirements, cannot replace fossil fuels as an important source of energy for modern civilization (cf. Ayres 1998; Hornborg 2014a). He is currently being vindicated by studies indicating that solar energy has a comparatively low Energy Return On energy Investment (EROI) as well as significant negative environmental consequences (Prieto & Hall 2013; Andersen 2013; cf. Hornborg 2014a, 2014b).

Entropy, as a mathematical measure of the disorder or randomness in the encompassing system, signifies gradual degradation, increasing inexorably with time. The early economists, when they appropriated the energy concept, were only dimly aware of the significance of this increasing disorder, which of course gives a direction to time and to history and imparts an irreversibility to all human affairs. Thus they equated value with energy in general rather than with *available* or *free* energy, as they probably would have had they been aware of the newly discovered Second Law. Georgescu-Roegen's (1971a) insights were to demonstrate that, rather than being strictly parallel phenomena, or being positively correlated, value and energy are in one sense *inversely* correlated in economic processes (Hornborg 1992, 2001). As the value or utility of a given set of resources is increased through the transformations that we think of as production, the remaining energy available in those same resources decreases. Again, this illustrates that the production of wealth is inherently destructive of order.

The implications of considering thermodynamic laws in economics could have been profound, since we cannot 'create' or increase the total amount of free energy and low-entropy matter that is available for use on the planet. The First and Second Laws, taken together, are simply incompatible with endogenous growth theory; their proper appreciation would arguably have prevented the neo-classical synthesis and precluded the

emergence of the expanding-pie worldview, which is promoted most strongly today by neo-classical economists, the high priests of capitalism.

Had the early economists correctly equated the ‘creation’ of value with the degradation of available matter-energy, the worldview promoted by the discipline today would be radically different. Value would not be said to be conserved or even augmented as economic ‘growth’ unfolds within an expanding global economy founded on the depletion of finite mineral stocks. Instead, it would be seen as undergoing an accelerating and inevitable decline, as does the total sum of matter-energy available, at least under current conditions. This insight would have strengthened the scientific credibility of political economy and given dependency theory and related forms of critical theory greater clarity and force than they have today.

The opportunity to generate wealth, and thus the opportunity to prosper economically, would be seen to be just as limited as are the quantities of land and other natural resources — both renewable and non-renewable -- from which all human activity (including ‘labor’) is ultimately derived. Prosperity would be regarded as a kind of scarce commodity, achievable by limited numbers of people during limited periods of time. Its cost, in terms of the entropy and general disorder produced, would be capable of being passed on to some other people in some other place (i.e. externalized), or even in some other time, as indeed it commonly is, in the form of exported pollution and waste, widespread environmental degradation, endemic poverty, and a warming and increasingly unstable global climate.

The economy would thus be portrayed not as a self-regulating mechanism, an abstract “free market”, but as the complex political, social, cultural, and *material* phenomenon that it actually is, one based on a fundamental and inescapable scarcity. Some countries would be seen to have occupied a privileged position in both geographical space and in historical time, having been effectively able to spend up the future that other countries might otherwise have experienced. Today it would be even more obvious that it is a new global class or society of people — the “high net-worth” and “ultra-high-net-worth” individuals now found in very small but growing numbers in all of the world’s countries — who are effectively colonizing and displacing the rest of us, gobbling up our collective future in this way. Certainly our cultural image of wealth would have changed as a result, along with our

illusions about creating it, and perhaps even our ideas about how that wealth — more correctly seen as a gift of nature, and thus a form of common property — should rightly be distributed. Although he lacked this overall clarity of vision, the words of Alfred Marshall, one of the foremost economists of the early twentieth century, nevertheless ring true today:

“Man cannot create material things...when he is said to produce material things, he really only produces utilities; or in other words, his efforts and sacrifices result in changing the form or arrangement of matter to adapt it better for the satisfaction of wants” (Marshall 1947:63, cited in Mirowski 1991:290).

The current distribution of the closed-system worldview

At this point it might be asked: who subscribes to the closed-system worldview today and who does not? Although the issue has never been adequately explored, an ‘entropic’ worldview (see Rifkin 1989) was clearly traditional at one time to many of the world’s indigenous peoples, as Nash (2007) insists. It is still widespread, for instance, among rural populations in Latin America (Gudeman & Rivera 1990; Nash 2007). It is probably still widespread today among groups inhabiting limited patches of the Amazon rainforest (see, e.g., Reichel-Dolmatoff 1974, 1978), and it may formerly have prevailed among hunter-gatherers living in circumscribed territories within more temperate zones such as aboriginal California (Bean and Blackburn 1976). At the other end of the spectrum of socio-cultural complexity, we believe that the closed-system model probably predominates today among most of the world’s scientists, who intuitively understand that all forms of economic activity on the planet — like all biological processes — are governed by the laws of thermodynamics, as Georgescu-Roegen pointed out several decades ago.

The closed-system worldview is highly consistent with the political agendas of countless subaltern groups allied with the worldwide alternative globalization movement, who participate in the biannual World Social Forum (Correa-Leite 2005; De Sousa 2006; Sen and Waterman 2012). *Via Campesina*, the extraordinary global peasant and neo-peasant organization, would be an obvious example. Another are the members of the emerging *decolonial* movement: an expanding group of academics — most of them social scientists

and critical culture theorists from Latin America, many of whom are women – who are exploring collectively the close historical and ideological links between modernity and coloniality, and who are seeking “*un paradigma otro*”, “an-other” way of thinking about and talking about the postmodern world (Mignolo and Escobar 2010:33). Their collective project seeks nothing less than a fundamental ‘decolonization’ of thought itself (Mignolo 2010, Walsh 2010, Escobar 2010): to free most people throughout Latin America and the world from domination by an alien and modernist Western tradition. We suggest that a step in this direction might be to adopt, or to endorse, a closed-system worldview. Indeed, this model is fundamental to, and is profoundly compatible with the “relational” worldview that members of this growing movement -- especially Arturo Escobar (2010) — are now advocating as a kind of culmination of the whole post-structuralist effort in the humanities and the social sciences.

The closed-system worldview continues to be widely sustained today by the materiality and the limited and cyclical nature of the peasant labor process (Trouillot 1988), which still holds many poor subsistence farmers tightly within its grasp. This is especially true when the resources being utilized belong, not to individuals, but to the peasant community, and are worked to some extent in a communal manner, as we will see below. This subsistence labor -- which has always been ignored by economists in their analyses of the dynamics of capitalism, as Nash has emphasized in her work with the Zapatistas (Nash 1994) -- is primarily devoted to reproducing the peasant household as an economic and social unit, i.e. to maintenance, sustenance and sustainability, and only secondarily to accumulating any capital (Netting 1993; Mayer 2002).

The limited labor so continually and heavily invested is of course gendered labor, with women playing a central role in that daily household struggle; and often today it is done by women alone, without the support of a man. Wherever this subsistence orientation persists – or where a strong appreciation of its economic significance exists, as among the members of the decolonial movement -- the limited-good worldview is likely to prevail. Wherever people are being exploited by forcing them to work harder and harder just in order to survive, for less and less material gain, that extractive and essentially colonial reality provides fertile ground for the emergence of a “limited-good” perspective.

Yet the point being made here is that both of the worldviews under discussion are in fact subscribed to, to some extent, by most people today, whether knowingly or not. We carry both of them around in our heads, and are often confused about how and when to use them appropriately. The relationship between them is somewhat paradoxical and homologous to the one that Parry and Bloch (1989) analyse so compellingly in their exploration of the two competing discourses -- seemingly found in most societies throughout much of human history -- that people engage in when talking about money. One discourse is a positive one generated by a short-term view, focusing on the liberating power of money for the 'individual' and for her creative pursuit of her own self-interest. The other discourse embodies a more skeptical longer-term view, focussing on the destructive and ultimately demonic nature of that selfish pursuit, if allowed to continue unchecked to the point that it undermines a more fundamental concern for the common good, thus threatening the very foundation of society. The strong moral message conveyed by the myths and rituals of a great many peasant societies throughout the world, Parry and Bloch (1989) argue, is that the latter discourse must always take precedence over, and somehow limit, the former, as a kind of final judgement about money and the morality of exchange.

One of the worldviews that we have at our disposal today, the image of limited good, must now displace and take precedence over the other, because we now know that it is supported resoundingly by science as well as by other more local regimes of truth and knowledge existing today throughout the world. It is supported by the other knowledges of many peoples, many Others, whose voices have for so long been ignored and silenced, particularly in the global South. Meanwhile, the contrasting and dominant worldview -- the image of unlimited good -- has been shown to be literally bankrupt and utterly refuted. Neo-liberalism and free-market theory have effectively been dethroned in the wake of the global financial crisis (see, e.g., Keen 2011), making possible, at least theoretically, a dramatic convergence that actually reflects, for the first time in history, the lived experience of the majority of people on the planet.

What would be the implications of such a thing happening? Would people become more cooperative in sharing the limited amount of 'good' that is available, or would they merely compete and fight over it with even greater intensity, perhaps being overcome by envy and

even resorting to the sort of witchcraft that seems to be universal in peasant societies? Rather than a more equitable and cooperative world, the outcome could be the darker dynamic portrayed in Taussig's (1980, 1991) various accounts of "the devil and commodity fetishism" in South America, or in the Comaroffs' (1999) disturbing tales of a new form of human sacrifice geared toward the trade in people's body parts, which is occurring today in Africa. The implications of such work are clear: as poor and marginalized but still 'traditional' people struggle to survive in a world characterized increasingly by market-driven greed and scarcity, they sometimes resort to sorcery and even to violence in their pursuit of wealth and power. That some people do so is hardly surprising, given the essentially magical and latently violent nature of the dominant capitalist worldview (see Austen 1993).

Beinhocker (2005:430), in a recent book on the origins of wealth, points to the crucial importance of worldview in determining the kind of economic behaviour that people engage in. He emphasizes the need for a cultural conviction that there are payoffs for reciprocity and self-restraint, but claims that "societies that believe in a fixed pie of wealth have a difficult time engendering cooperation". No evidence is given to support the latter assertion. Again, the statement reflects the prejudice that is nearly universal today among economists: surely people will only cooperate with each other if they are part of a system that is somehow expanding in terms of total available wealth. But a "zero-sum" or "fixed-pie" worldview can just as easily support strong leadership and widespread cooperation as it can encourage envy and mutual mistrust among individuals; that is the point that Nash makes so convincingly in her reflections on the Zapatistas. Beinhocker's error, like so many other economists before him, is to assume that, in a fixed-pie context where 'the good' is seen to be limited, there are no rewards for cooperation. Nothing could be further from the truth, as the ethnographic record clearly shows.

The prospects for cooperation in a closed-system world: Lessons from water management in irrigation

One of the major developments of the last thirty years in anthropology and other social sciences has been the emergence of a vast literature on the management of "common-property" or "common-pool" resources, forms of natural wealth that belong, not to individuals, but to communities and to local user-groups (NRC 1986; McKay and Acheson

1987; Bromley 1992; Ostrom 1990; Ostrom et. al. 1999; Ostrom et. al. 2002). A great surge of studies has focussed on the communal management of pasturelands, forests, inshore fisheries, and water for irrigation, many of them inspired by a desire to refute Hardin's (1968) classic argument on "the tragedy of the commons". These analyses reveal the complex dynamics behind many local situations, documenting and explaining many different outcomes -- positive and negative -- in people's efforts to cooperate in sharing scarce resources. But on the whole they show that human beings, when they face a mutual scarcity, are quite capable of working together and resolving the "commons dilemma", the supposedly inevitable conflict between the interests of the individual, assumed by Hardin to be entirely selfish, and the cooperative needs of the group.

The solution, and the key to avoiding a tragic outcome, is for individuals to exert a form of mutual self-restraint, as Hardin noted, each limiting her consumption so that the resource can be utilized in a sustainable way that is beneficial for everyone in the long run. A great number of ethnographic studies have shown that local resource-users are capable, by working together, of devising their own institutions or rules that accomplish this. They do not necessarily need to be coerced into doing it by an authoritarian State -- one of Hardin's proposed solutions -- nor would they benefit from having the resource privatized so that it can be allocated in a more selfish and competitive way by markets -- his other proposed solution. At a relatively small scale and on a local level, people can do this on their own, without a supporting institutional context provided by outsiders, and have been doing it for a long time.

The ethnographies in each case show how a fixed pie of natural wealth is shared within one or more user groups, a scarce resource that is "subtractable" in the sense that one person's use of it comes at the expense of everyone else by reducing the overall amount that is available. Natural resources cannot be expanded, or can be increased only with great difficulty; they can merely be recycled at very low cost by natural ecosystems and thus renewed. Their availability is ultimately driven by gravity and by the cyclical dynamics of the earth's hydrosphere, and here of course we are speaking of water, the quintessential subtractable common-pool resource, particularly water used for irrigation. This unique

resource, we suggest, can usefully be viewed here as being a kind of proxy for, or as representative of, real material wealth.

Some distinctive characteristics of water as a common-pool resource must also be noted. First of all, the boundaries of a sustainable irrigation system are necessarily fixed, like the boundaries of the planet, i.e. the land area irrigated and the total number of people using the resource. But the amount of water flowing through the systems every year is not. That flow or throughput varies widely between years but diminishes notably every year during the dry season, thereby imposing a cyclical scarcity, somewhat like that of the fluctuating global market. People can do nothing to increase the total amount that becomes available for use in a given year, as all irrigators understand and can clearly see in their daily work. They can only use the water more, or less, efficiently, by wasting or not wasting the resource, and by obeying or not obeying the rules for using and consuming it; and in sustainable irrigation systems that choice of behaviour directly determines the length of the irrigation cycle. Again and again in Peru, Mexico, the southwestern US, Spain, India, Nepal, Bali, and the Philippines, relatively autonomous communities of irrigators -- peasants and small subsistence farmers in nearly every case -- have been shown to share this vital form of natural wealth in a sustainable way, by imposing upper limits on their consumption of a scarce resource upon which the lives and livelihoods of all households depend.^{vi} This kind of collective action, now known to characterise a great many local hydraulic societies throughout the world, is an achievement that policy-makers, until recently, thought to be impossible. The benefits and costs of operating the systems and using the water are fully internalized by the community in each case, through a basic kind of circularity or self-closure: i.e. the exclusion of outsiders from using the resource (Trawick, Ortega and Palau 2014). The benefits are realized and internalized through an intensive labor process in which all households are continually engaged: that of distributing the water daily, of using it -- mainly for household subsistence -- and of maintaining the canal system each year through communal, and usually festive, group work. Most of this labor, it should be noted, falls into the special category of work being discussed here: i.e. that intended primarily for subsistence, and for the production of use value as opposed to exchange value.^{vii}

Comparative analysis of data on sustainable irrigation systems in a wide array of countries shows that these communal systems, which are bottom-up forms of social and political organization, together constitute the most striking example of convergent social evolution ever identified in the ethnographic record. They are based on the central principle of equity or fairness, which seems to be defined and achieved by all of these local farmers throughout the world in basically the same way (Trawick 2001a,b, 2002a,b, 2003, 2005, 2008, 2010). The specific rules -- in each case institutions that are local, 'traditional', and in that sense collectively-chosen -- require that the water scarcity be shared by all users on a single schedule of rotation, in such a way that it affects all land, and all landowners, in the same way and to a similar extent.

That achievement is highly significant because the communities are stratified in every case, including both large landholders and smaller ones, so that like all human societies they contain significant internal differences in wealth. While irrigation is taking place, at a rhythm or pace that is the same for everyone, a basic proportionality is maintained among household water rights, a uniform land-to-water ratio that limits the total volume of water consumed by the farmers during each distribution round. These upper limits are imposed by the farmers simply by following traditional rules and techniques in carrying out routine work, thereby exerting numerous forms of self-restraint throughout their daily effort.

A remarkable symmetry is ultimately created, a basic equity that pervades the existing set of rights, and the set of corresponding duties, and governs the relationship between rights and duties. The rules in each case require that the contributions of households to yearly maintenance of the canal system, in the form of labor, food, money, and other inputs, be proportional to the amount of irrigated land that each family has, and thus to the amount of water that people use. Because of this pervasive symmetry, created through constant work -- work shaped by communal institutions expressing a need and a desire for cooperation, fairness and mutual self-restraint -- and endorsed in most cases by unifying ritual, this type of system has been called "the moral economy of water" (Trawick 2001b, 2010).

The studied examples range in complexity from small-scale systems operated by a single peasant community to multi-community systems covering thousands of hectares and requiring the daily coordinated action of tens of thousands of small commercial farmers.

They exist today in remote corners of the Andes -- the highlands of Ecuador, Peru, and Bolivia – in small peasant communities throughout much of the Middle East and Asia, and in the bustling tourist zone of Valencia on the Mediterranean coast of Spain, one of the world's most cosmopolitan cities. The institutions governing them in these cases are hundreds of years old, and they appear to have emerged repeatedly, and often independently, on different continents, forming the heart of distinct Andean and Islamic hydraulic traditions (Glick 1970; Maass and Anderson 1978, Ostrom 1990, Trawick 2001b; Trawick , Ortega and Palau 2014).

From a practical point of view, fairness in these contexts has always meant the same thing that it does today: no one person or household is allowed to accumulate or use so much water that they jeopardize the rights and the livelihood of everyone else. In a context of scarcity, no one may irrigate more often, or use more water, than the prevailing conditions allow, in situations where mutual wellbeing and the minimization of social conflict are widely shared goals. Similarly, people's duties to give back to the community are proportional to the benefits that they derive from living there and using its resources.

Such collective agreements are achievable and sustainable because the canal systems are highly transparent, in that community members are routinely able to monitor each other's behaviour, in the act of irrigating. People can tell through direct observation whether or not the rules are generally being obeyed. The rules are simple and known to everyone, requiring the unbroken movement of water -- canal-by-canal and field-by-field -- through well-defined and contiguous sectors of irrigated land. Consequently, the stealing of water -- the most socially disruptive form of cheating or free-riding -- is easily detected, reliably punished, and extremely rare.

Scaling upward from the local to the global

Unfortunately, worldview has not been examined in any of these irrigation studies; thus it is not possible to claim that the limited-good view predominates among farmers in any of the systems, as likely as that may seem. These local societies merely demonstrate what people tend to do with such a fundamental and necessary 'good' – water -- once they realize that it is indeed limited and is circulating within a system that is effectively closed. But what would

it take to create the same kind of outcome in the production, distribution and consumption of material wealth, and of scarce resources more generally, at a global level?

A pervasive equity and transparency are certainly difficult to envision creating on such a scale, through mutually-imposed limits on the per-capita consumption of common-pool resources like petroleum, other fossil fuels, and the electricity that is derived from them. That, of course, is the main challenge we are faced with today at a global level, in order to stabilize the Earth's climate. The same can be said of the many other institutional changes that so many people and organizations are calling for so loudly today, taking to the streets all over the world in order to demand them: a limit on the size and structure of banks; the regulation and taxing of international flows of finance capital; and upper limits on bonuses and executive pay, not just in the financial sector but more generally throughout the corporate world. The latter, if extended to the entire public and private sectors all over the planet, would amount to a global maximum wage, a limit that is advocated today by growing numbers of people.

Such steps would set a series of upper limits or ceilings on economic growth, imposed in the name of the common good, in order to create new channels of redistribution to counter the wealth-concentrating and monopolistic tendencies of an unregulated global market. The same can be said of a system of fair and progressive taxes, both individual and corporate, that allows no tax havens and is fully transparent. The call for both of these radical reforms has become almost deafening throughout the world, both online and offline – with Oxfam, the World Economic Forum, the IMF, and even *The Economist* joining in^{viii} -- and is now being conveyed through increasingly bold and massive forms of direct political action. This, according to a great many activists, critical theorists, and 'ordinary' working people, is what a sustainable world would look like.

All of these various struggles are now underway, and what is at stake is indeed our mutual survival, as people in the global South have been insisting for some time. The forces arrayed against such collective action — economic, political, and military — are formidable and capable of extreme violence, a fact of which southerners need no reminder. Current revelations about the surveillance capacity of states like the US and the UK show that we all must be mindful of the grave threat to democracy that our digital links with each other have

ultimately created. Nevertheless, popular demand for all of these changes is increasingly expressed by northerners too and is now a truly global phenomenon. The greatest challenge in any effort to 'scale-up' existing cooperative institutions of this type lies in convincing people that they are all part of a closed system in which such mutual self-restraint is necessary, because of a prevailing scarcity, as Elinor Ostrom (1990) showed in her groundbreaking work on the management of common-property resources. That theme, consequently, has been the primary focus of our discussion here: the true nature of the global system, taken as a whole, and how it is represented in our worldview. We have no wish to understate the magnitude of a further step toward a more equitable global commons, and we cannot propose a plan for political action that would even begin to accomplish it here.

In order to scale-up effectively, states throughout the world would have to debunk the open-system perspective and promote in its place the alternative closed-system view, with the state in each case actually having to reverse completely its previous historical position in that regard. To expect states to do so voluntarily would be naïve in the extreme, but governments today are under a great deal of pressure "from below," and not least from the risk of financial crisis.

The pressure is to see and think no longer "like a state" -- as James Scott (1998) so compellingly portrays it -- but to think and act more like "the people", according to a realistic model of reality and in the name of the common good (see Scott 2012). To do this would require solving, on an unprecedented scale, Ostrom's (1990:42-45) "assurance problem", the second crucial step in any effort by people to cooperate by limiting their own consumption: 1) coming up with a set of rules and principles that constitute an agreement for doing so, one endorsed at various socio-political levels by mutual consent, and, more importantly, 2) assuring people that such an agreement would be enforceable and would work.

Yet, in the digital age, information technology makes it possible to do all this, and to create the needed transparency, on a scale never achieved before; that is the great advantage we now have. Such technology unfortunately also makes it possible for governments to watch us in unprecedented and all-pervasive ways, but the upside is that it has also become

possible, theoretically, for us to watch each other and the government just as thoroughly, holding each other accountable and reliably enforcing any agreed-upon set of rules at any level of social and political organization (Hart 2001).

Local economies can obviously be made much more equitable and transparent at the ground level; that much is clearly doable: witness the growing “transition town” movement in the UK, the US, and the EU; the alternative currency systems that have sprung up now in so many communities throughout the world (Lee 1996; Greco 2009), and of course the sustainable farmer-managed irrigation systems that exist all over the planet. These kinds of local experiments and alternative communities would have to be nested hierarchically within similar institutions at higher levels, creating and sustaining poly-centric governance in the regulation of economies at local, regional, national and global scales (Ostrom 1990, 1998; Ostrom et. al. 1999; Ostrom et. al. 2002; Dolšak and Ostrom 2003; Marshall 2005). As Roy Rappaport’s (e.g. 1979, 1999) work showed with such great foresight, it would probably all have to be made meaningful through ritual that promotes the new worldview and replaces the gaudy and grotesque spectacles that are emblematic of unregulated global capitalism in the postmodern era. Stephen Lansing’s (1991, 1993, 2006) extraordinary work on the famous *subaks* and water temples of Bali gives us an encouraging glimpse of how such a highly complex and ritualized system of production can work, on an impressive scale.

This will not be easy, of course, for the global economy is not just a big irrigation system. Yet there is no reason, theoretically, why the world cannot be made to work more like one. The political will to do this on a massive scale is growing rapidly today, and necessity will only add to the mounting pressure as time goes on. But the current groundswell of support, of popular resistance and revolt against business-as-usual, will only become truly global if people widely come to see the world in a more accurate and realistic way.

Conclusion: Acknowledging a world of limited good

The argument presented throughout this essay is that, if people come to realize that economic ‘growth’ is a physically destructive process rather than a creative one, based on the consumption of limited stocks of natural resources that are being rapidly drawn down and made more scarce every day at a planetary level -- both for contemporary Others and

for the members of future generations -- they may become more willing to take action to restrain that growth by mutually limiting their own consumption. The political challenges involved in moving humankind toward sustainability in this way are of course daunting, and any effort to scale-up existing cooperative institutions to the highest levels of organization will be fraught with great difficulty. But we have argued that they are fundamentally cultural challenges too, posing if nothing else an enormous task of mutual education, communication, and deliberation. What is ultimately most needed for such constraints on accumulation to finally be imposed is the adoption of a view of the world, and of the global economy now fully co-extensive with it, which acknowledges the kinds of material constraints and the zero-sum logic that mainstream economists have for many years now systematically denied. It requires people to finally see that, for human beings, there is no such thing as “the creation of wealth”.

This kind of worldview accurately depicts physical and social reality. That may explain why it first emerged in many peasant societies throughout the world, and why it appears to be prevalent today among exploited and displaced peoples, especially the former peasants and indigenous people of the global South. We believe that the limited-good perspective lies at the heart of “the light at the edge of the world”, the vast and rich body of indigenous knowledge about which Wade Davis (2009) writes so movingly, and that this light is now spreading from the Earth’s margins to its political and cultural center or core.

The “image of limited good” emerged and flourished briefly within academia, having been promoted initially by nineteenth-century theory in economics and then adopted by dependency and world-system theorists, and other radical critics whose work is still highly influential in Latin America and other parts of the southern hemisphere today. It is consistent with the views expressed by a wide array of participants in the World Social Forum, and more widely within the subaltern and marginalized groups that form the core of the growing alternative globalization and ‘decolonial’ movements. It seems equally consistent with the demands that were implied by the extraordinary Occupy Wall Street movement. Finally, that worldview is firmly vindicated by contemporary knowledge in the natural and social sciences, especially the relatively new field of ecological economics, based

on a renewed understanding of how the laws of thermodynamics express themselves as fundamental constraints in human affairs.

The magical worldview long promoted by neo-classical economists and finance capitalists must now be replaced with a more realistic one built upon the axiom that the ‘good’ in human affairs is always limited. It was possible to uphold during the historical space between the initial outsourcing of land and labor (i.e., energy) requirements represented by the Industrial Revolution, including its dependence on subterranean fossil fuels (Sieferle 1982; Pomeranz 2000; Hornborg 2006), and the contemporary acknowledging of global limits to growth. Today the closed-system worldview, which focuses the mind on everything we have in common as the inhabitants of a biosphere that is steadily deteriorating, seems destined finally to prevail.

It would be naïve to claim that this vision of reality has the capacity to unite people all over the world, producing a great “aha!” moment that suddenly changes everything, based on a new awareness of our shared relationship to forms of property that ultimately belong to us all. Yet we are all now deeply immersed in crises from which none of us can escape, not even those who are fortunate enough to be wealthy. Conventional politics appears utterly unable to save us; but new forms of political struggle are now breaking out everywhere. The time would seem to be ripe for a change, a global convergence on a scale never seen before. We may soon find out just how important worldview really is.

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ⁱⁱⁱ No less than other economists since the days of the Physiocrats, Marx at times appears to have confused physics and economics (cf. Hornborg 2014b). It is always potentially misleading, and thus inadvisable, to apply anthropocentric concepts such as “wealth” or “use value” to physical quantities such as energy. The notion of “real wealth” should thus be provided with quotation marks.

^{iv} The abstract nature of pecuniary wealth was evident even before the advent of paper money, but the material constraints of gold and silver at least implied a physical limitation on the creation of money.

^v It is noteworthy, however, that Graeber's (2001, 2007, 2011) voluminous and insightful critiques of conventional economic theory are completely silent on material aspects such as energy, technology, and ecology.

^{vi} A large number of studies document positive outcomes in farmer-managed irrigation: e.g., Glick 1970, Maass and Anderson 1978; Coward 1979; Siy 1982; Wade 1986, 1988; Ostrom 1990, 1992, 1998; Tang 1992; Treacy 1994a, 1994b; Gelles 1994, 2000; Sengupta 1991; Ostrom and Gardner 1993; Lam 1998; Lansing 1991, 1993; 2006; Trawick 2001a, 2001b; Palerm and Martínez 2002; Boelens and Davila 1998; and Boelens and Hoogendam 2000. For a debate about how equity is defined in these systems, and how much they all have in common in that respect, see Trawick 2005 and Boelens and Hoogendam 2000.

^{vii} It is important to note, however, that in Valencia, Spain, one of the largest and most complex successful systems that have been studied (Glick 1970; Maass and Anderson 1978; Ostrom 1990; Trawick 2008, Trawick, Ortega and Palau 2014), the irrigators are all small commercial farmers, who do cultivate for household subsistence but mainly produce for the markets and supermarkets that today help to provision a city of over a million people.

^{viii} See <http://www.oxfam.org/sites/www.oxfam.org/files/cost-of-inequality-oxfam-mb180113.pdf>; <http://www.weforum.org/issues/global-risks>; <http://blog-imfdirect.imf.org/2011/04/08/inequality-and-growth/>; <http://www.economist.com/node/21564413>.