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Addressing meta-externalities: investments in restoring the Earth

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1) Necessary changes in economic theory

Ecology teaches that everything is connected to everything else. Economics teaches that the market is a – some say *the* – great connector. Its specialty is to connect demand (what people want) to supply (what people produce), via prices.

There are, of course, known problems in the use of prices as a society's key connector. For one thing, those with more money have more of what is sometimes called "effective demand"; they can send louder, more effective signals to suppliers to produce the goods and services they want. Those with very little money can hardly get their needs and wants noticed. Aside from this translation of unequal purchasing power into unequal impact, the other most notable problem with markets as connectors is the presence of externalities, when something that matters simply is not picked up in market signals.

Ecologists sometimes complain that economists dismiss such important issues as "just" externalities – implying that these issues are regarded as unworthy of consideration. Good economists do not do this: they recognize full well that where there are externalities (where an economic actor produces effects that do not translate as signals to other economic actors) there is a market failure. Unfortunately, in situations of significant market failures markets do not produce the optimal outcomes that are expected in standard economic theory. This does make mainstream economists squeamish about admitting to externalities, since the optimality of market outcomes is one of their main boasts, and they don't have an alternative theory to pull out of the hat. Some economists who have positions of influence in academic or policy circles have begun to grapple with Stern's famous remark that "Climate change is a result of the greatest market failure the world has seen".[1] However, in the absence of a widely accepted alternative theory, the growing acceptance of climate change reality by economists simply creates cognitive dissonance without resolution.

The existing dominant system of economic theory is used to justify the current conformation of the economy of the United States, and of much of the world. It is becoming increasingly clear that it is producing very sub-optimal results for most of society, though benefitting the short-term gains of the rich and powerful. It has permitted and sometimes encouraged economic actors – especially powerful corporations and governments – to ignore the harms they impose on people and other parts of nature having little political/economic power. These harms are not trivial; they have included the murder of indigenous people for the value of their lands or of the minerals under their lands; toxic wastes dumped in oceans and in the neighbourhoods of poorer people; schemes to cover-up the harms of profitable products like tobacco and fossil fuels; and, over many decades, effective prevention of public education about the dangers of climate change, and of ways to avert it – until it is too late to prevent a future of ever more catastrophe.

[1] Quoted by *Alison Benjamin* in the *Guardian*, London, *29 November 2007*. *"Stern: Climate change a 'market failure'"*.

In order for economic theory, teaching, and policy application to provide useful guidance in this time of great danger, it must change in many ways. The following is a brief summary of the most critical changes that are needed.

Recognition of context and history; there is not much that can true and useful in economic theory that is relevant to all times and places. This is because the economy is not a stand-alone system, but is embedded in, and dependent on, the contexts of the natural world and the built environment as well as human social systems – the latter including history, culture and ethics. Realities of power, politics, institutions and history are essential parts of the human fabric in which the economy is woven. Beyond direct externalities, and even less visible to current economic theory, are *meta-externalities – unwanted side-effects of the whole economic system upon its physical and social contexts*. To give just one example: the idealized concept of "free markets" along with an ethic of individualism have degraded political culture by belittling the roles that need to be played by collective action, aside from the particular kind of collective expressed through individual purchases of industrial products. This is not a small thing; the ability of governments to produce public goods and services has been seriously weakened in many nations due to effective campaigns to denigrate their effectiveness and efficiency (see Sekera, 2016).

An economic theory appropriate to our time must also address the **normative aspects of economic thinking**, starting with a recognition that any economy is a human creation, designed to support the goals of some people. *Whose* goals get addressed most effectively is of course a critical question to which we have just seen the answer: they are the ones with the money to have a lot of effective demand.

Sometimes it is not just money that determines how the goals of some economic actors are most emphatically expressed in the design of an economy; there is also the matter of **political power** – an issue that is so closely associated with Marxian economics that it has been a third rail for mainstream economists of the West. However, if we look at the economy in which we live, expecting to see that it works best for those with the most power and money, we will find that, for the most part, this is the reality. An economic theory that ignores this reality cannot expect to be useful for the real world.

Another critical issue is the prevalence of **idealization and idealized assumptions** in 20th century textbooks: human beings are idealized as perfectly rational and endowed with extraordinary capacities for maximizing calculation, while markets are idealized as the way to achieve the best of all possible worlds. If an economy is designed to support the goals of some participants, economics, as a discipline, is also the result of design, with a purpose. Idealization is a way of ignoring critical realities that are inconvenient for those in power. A more useful economics must include a thorough rethinking of the standard 20th century economic idealizations and associated assumptions.

One purpose for the idealizations just mentioned was the desire to make economics a respectable "hard" science. This was in part a result of consternation over the ejection of economics from the Royal Academy of Sciences in England at the beginning of the 20th century. As has been noted by a number of observers (e.g, Mirowski, 1989) the science that then appeared to have the most respectability, the most purity, was physics. Accordingly, economics adopted assumptions that allowed heavy dependence on **mathematical modelling** in order to emulate 19th century physics; for example, the use of various

mathematical, scientific-looking techniques is made possible by the assumption of highly simplified, maximizing behaviour on the part of economic actors.[2]

The other reason for the idealizations and increasing mathematization adopted in economic theory was that all of this could be used to support the idea that "**free markets**" would bring about the best possible outcomes (this can be more or less 'proven' – *given acceptance of all the assumptions and idealizations*). From this emerged the truly suspect idea that market actors – especially large, powerful or rich economic actors – should be free to do whatever they choose; any meddling from non-market forces (such as governments) would divert the economy away from the best possible outcome.

A related issue is the kind of quantification employed to assess the performance of an economy through the single metric, **Gross Domestic Product** (GDP). Among many problems with current uses of GDP, they are used to support policies that emphasize growth in throughput over increase in well-being. They ignore the contributions of unpaid workers (especially women, especially but not only in household work) as well as the cost of environmental damage – unless that damage requires compensatory activity, in which case it is listed as an *addition* to GDP.

Methodological change is thus required if economic theory is to contribute to addressing the challenges of climate change and other forms of environmental loss and degradation. A new balance must be found between simplifications imposed for the purpose of making sense of the economy, and attempts to recognize the actual complexity of the world. A more relevant and useful theory than that now prevailing would pull this balance somewhat away from methodologies that require extreme simplification, towards a richer understanding of the nature of economic actors and economic activity. This requires a broader conception of "the economy," to include economic activity that occurs not only in the business sector, but also within households and communities, and in governments and other public purpose organizations.

An economic theory that can help to mitigate the ecological and civilizational catastrophes bearing down on us must differ significantly from that which currently dominates policy-making. The points made above are only a few of the changes that are needed – more are illustrated in the textbooks I and my colleagues have been writing over the last few decades[3].

To summarize very briefly:

- Economics for the 21st century must describe and understand the workings of any economy within its physical and social contexts.

[2] As physics evolved over the decades, to look less and like the early object of economists' physics envy, the discipline of economics also evolved, but retained many of its commitments to 19th century physics methodology, including a fundamental reliance on idealization. In the mid twentieth century Paul Samuelson, a man with a very tidy mind, took on the project of cleaning up the fuzziness that was left over from the work of such as the great early theorizer, Alfred Marshall (who openly expressed opinions on the purpose of economics – namely, to alleviate the misery of the poor and elevate the moral lives of all), and from John Maynard Keynes. Keynes was a believer in mathematization, but when he had to face a trade-off between the simplifications required for mathematical modelling vs. addressing real world issues, he generally went for the latter. Samuelson's so-called "Keynesian synthesis" in fact got rid of all the parts of Keynes' thinking that could not be fitted into the Procrustian bed of ever-more complex modelling techniques.

[3] These include *Microeconomics in Context, Macroeconomics in Context, Principles of Economics in Context, Environmental and Natural Resource Economics,* and, forthcoming, *Essentials of Economics in Context* – all published by Routledge.

- It must openly recognize how imbalances of power and resources affect the economic decisions that are taken at every political level.
- It must openly embrace a normative stance that recognizes that there are better and worse states of the world. Such a stance opens up the discipline to untidy discussions about what is better and worse: for example, how much inequality is tolerable, what trade-offs are necessary in order to reduce inequality, and how important it is to prevent harm to future generations.
- Regarding methodology, it must address the question of how much our understanding of economic matters is harmed by accepting the simplifications and idealizations that have been found necessary in order to use sophisticated, mathematized methods of analysis.

Such changes will require drastic alterations in economics curricula as well as in the honesty that should be encouraged in politicians by economic analysts who can see how political-economic decisions affect the world.

The foregoing begs many questions, such as: How can we change the mindset of economists? And: Who will ensure that those in power listen to people who care about the future, rather than only about their own enrichment? The first is the question I have spent my working life trying to address, through the production of better teaching materials – but these have not yet swept the field. As students and teachers see the relationship between economic behaviour and ecological outcomes, and as students increasingly give voice to their dissatisfaction with the irrelevance of most existing economics curricula, it is to be hoped that teachers of economics will be swayed by the force of demand.

The second question has to do with public education, and also with the hope that earlier cultural beliefs in morality will return. It is about time for such a shift; one can perceive, looking back over centuries and cultures, times in which a more caring culture has prevailed, as well as times when that was swamped by a culture of greed and selfishness. We may be at about the lowest point on the latter cycle; and enough people are witnessing and feeling the harms of climate change, ecological destruction and growing economic inequality that many small voices may coalesce into an effective force against the currently centralized and empowered voices united to enrich the few at the expense of the many.

2) Investment in ecological restoration

This paper has addressed, very briefly, the question of how the discipline of economics must change if it is to play a constructive role in addressing the huge challenges of the 21st century. A practical application of this question is a second one: how can the global economy be altereded so as avoid ecological collapse? This second question is strongly motivated by a growing awareness that we have reached or surpassed several indicators of collapse. The most enormous is the set of disasters attendant upon the amount of climate change already occurring and on track to increase. No less critical is the degradation of virtually the whole of the natural world through human action; by some estimates only 5% of ice-free land areas on the globe is still in pristine condition.[4]

[4] "Assessments of the percentage of ice-free land affected by human action vary from 20% to 100%.... Ellis and Ramankutty (2008) concluded that more than 75% of Earth's ice-free land area could no longer be considered wild. Of Earth's ice-free land area, 83% is likely directly influenced by human beings

These two issues are closely connected in their causes: human activities. They also share an important remedy. Ecological restoration has the potential to turn many ecological systems and sites away from net export of carbon and other greenhouse gasses into the atmosphere. Other sites that are still net importers of carbon etc. can import and store even more. It is increasingly believed that even the most optimistic projections regarding other kinds of change in human activity cannot be enough to keep the earth's atmosphere from warming well above what has been deemed the lowest safe global temperature increase. Ecological restoration, by capturing large amounts of greenhouse gasses, has the potential to close this gap. At the same time, massive efforts at ecological restoration will be essential if the earth is to provide the goods and services needed for humanity to survive and thrive in the future.

This paper began with the ecologists' insight that everything is connected to everything else, and the economic observation that markets have the capacity to make some important kinds of connections. One of the most important connections they can make are between the present and the future, via investments. I will focus the rest of this paper on the question of where to find the resources – especially financial resources – for investments in ecological restoration.

Ecological restoration is defined as the process of assisting the recovery of ecosystems that have been degraded, damaged or destroyed (Society for Ecological Restoration, 2004). Although it is vital to protect existing intact ecosystems, conservation alone is insufficient, given the extent to which ecological degradation has proceeded and continues to expand. Inherent adaptive characteristics of ecosystems make it possible for humans to help change their trajectory away from degradation and toward recovery, repair, and self-sustaining regeneration and renewal. In some cases this requires large, expensive efforts, while other cases require little more than a cessation of harmful activities.

In general, investments offering clear, short-term benefits that can be readily captured by the investor are easy to fund through private market action. More difficult are the investment opportunities that include positive externalities, such that the investor cannot capture all of the benefits; or where the return will occur over a relatively long time. In the latter cases investors, using a present value calculation, will demand higher returns for the outer years. Investments in ecological restoration are very often deterred by one or the other of these characteristics. Restorative activities can provide enormous benefits, including carbon sequestration, biodiversity, support for livelihoods, and support for critical ecosystem services such as the production of nutritious food and of healthy trees and plants, as well as water filtration and absorption. However these activities are often characterized by relatively long time scales to produce the desired benefits, while the benefits generally include values that may be realized by groups aside from the investors. To give a few examples:

- Where farmers preserve strips of uncultivated land to attract pollinators and beneficial insects, neighboring farmers who do not do this may also benefit. Thus there is a positive externality, inviting free-riders and unlikely, through normal markets, to attract investment commensurate with the social benefit.
- City-dwellers benefit from the added nutritional value of food grown organically. Some are able and willing to pay extra for this food, making it easier for farmers to get through the years when the switch from conventional to organic farming has not yet fully paid off in productivity. However the demand for higher priced, more nutritious food is limited, and

(Sanderson et al., 2002). Our pollutants affect plant and animal physiology worldwide (McKibben, 1989, e.g., p. 38, 58)". Hooke, 2012

> many farmers lack the resources to tide themselves over to a future in which more nutritious food will be cost-effective to produce. When that transition is complete, the result will be a huge externalized health benefit to large populations, but some kind of assistance is normally required to help farmers make the early investments.

Such cases argue for non-market interventions, to support a social good. This paper will first emphasize solutions that fall more within the purview of economics, per se, and will then list some "market-plus" and non-market approaches that have the potential to fill the gaps left by market action alone.

Market-led restoration activities

In fact it is hard to find cases in which private investors or commercial enterprises invest in restoration programs simply based on an expectation of competitive risk-adjusted returns. Endowments with long time horizons, such as that of Harvard University, may hold ownership positions in forests with the expectation of receiving returns with a lower present value than some more risky investments, but that are considered competitive because of their low risk. These holdings have not generally been regarded as restoration projects to start with, but, as investors and other stakeholders have increasingly pushed for "triple bottom line" accounting, there has been pressure to demonstrate social and environmental as well as financial returns. Over the past few decades there has been a cultural shift that makes businesses increasingly aware of the need to maintain a good public image. Where an institution can, without too much effort or expense, add some evidence of environmental and social responsibility, this is increasingly considered a sensible thing to do. Thus large investors with a stake in the Northern forests of New England have felt and responded to local pressures to keep the logging roads open for local people to use for camping, hunting, or snow-mobiling; they have also been aware of more dispersed sources of pressures to pay increasing attention to how and where trees are cut, and what is left on the ground as habitat for fauna and to allow regrowth of native flora, including trees.

The preceding paragraph is not a description of a brilliant ecological restoration project. If we want to find examples – and they exist – of corporations that put an ecological restoration motive high enough in their priorities so that they are willing to search out best practices, we must include in our understanding of market motivations psychological issues such as the wish of executives to be admired. That wish has been operative all along; it is becoming increasingly relevant as the cultural definition of "admirable" moves to take into account markers of success other than Milton Friedman's singular emphasis on high profits.

Seeking restoration projects carried out by corporations that understand the full meaning of meta-externalities (more on that below), I turn to the World Business Council for Sustainable Development (WBCSD), which describes itself as "a global, CEO-led organization of over 200 leading businesses and partners working together to accelerate the transition to a sustainable world." In a 2018 report, "The Business Case for Investing in Soil Health", it is noted that

> "The health of our soil is a critically important component in the production of food and the promotion of water and food security. Organic matter in soil increases its ability to store water and is directly related to the biodiversity in the soil. When soil biodiversity decreases so does its capacity to infiltrate and thus capture and store water… Sustainably managing land can… reduce surface erosion of

> soil into reservoirs, energy generating systems such as hydropower dams, public water supply, and industrial uses. This helps to reduce operation and maintenance costs and improves the longevity of investments.
>
> …global soils contain two to three times more carbon than the atmosphere. If this carbon level was increased by 0.4%, or 4‰ per year, in the top 30-40 cm of soils, the annual increase in CO_2 in the atmosphere would be stopped" (WBCD, 2018).

This commentary may be read as a list of some of the positive meta-externalities that may be created by, and that can benefit, businesses that have any kind of interaction with the natural world. In the broadest sense, this includes all businesses, because all production derives from the natural world, which supplies humans (including workers) with the essentials for life: nourishing food, drinkable water, and breathable air. From the natural world, also, we derive all the materials – animal, mineral, or vegetable — that go into the production of every other conceivable good that goes through a market.

When a modern corporation builds its corporate headquarters, or any other structure in which its business will be carried out, it tries to avoid barriers to the flow of communication or movement among its functions. It seeks to maximize the efficient use of resources, minimizing the amount that is turned into waste. It pays attention to how lighting, air quality and other environmental issues affect human productivity. Corporations that are serious about accounting for the triple bottom line of their business treat a broader part of their environment as the structure within which they will need to continue doing business for as long as they exist. To some extent, thus, they internalize the meta-externality of their interaction with the social and physical environment. Here are two examples provided by WBCSD:

> "With the launch of the Good Growth Plan in 2013, Syngenta committed to improving the fertility of 10 million ha of degraded farmland by 2020. The company has subsequently worked with partners to develop and promote local solutions farmers could easily adopt. One early success was in Andalusia in Spain, where the company supported olive farmers in adopting vegetative cover in their orchards. Syngenta partnered with Asaja Sevilla (a farmer association), the Andalusian environmental authorities and a group of producers to introduce vegetative ground covers. The practice helped producers reduce erosion by up to 70% by replacing bare ground with vegetation and improving soil water-holding capacity. Local environmental subsidies linked to the region's rural development plans were also leveraged."

This account is especially noteworthy because Syngenta acknowledged the necessity of involving local people in the process of a restoration program that emphasized the needs of the people at least as much as the reversal of soil and crop destruction. Another account from WBCSD demonstrates another aspect of what is critically needed in order to keep a multinational corporation's intentions credible, and increase the efficiency and effectiveness of ecological restoration work; namely collaboration with independent scientists, in this case at a world-class university:

> "In South Africa, [the paper pulp, paper, and plastic wrapping company] Mondi manages large plantations interwoven with conservation corridors and

> nodes of natural habitat. The management of this mosaic – what Mondi calls "ecological networks" – is central to protecting biodiversity and the ecosystem services that sustain long-term productivity. Mondi has cooperated with Stellenbosch University for more than 10 years to understand how biodiversity can be conserved in ecological networks. More recently, the collaboration has started to investigate the role of soil health in plantation landscapes. The aim is to understand how different harvesting and silvicultural practices impact soil biodiversity, on the premise that soil biota are essential for soil health and long-term production."

Early readers of this paper have protested that WBCSD may be giving too much credit to corporations. Without inside knowledge of the particular cases cited here, thus unable to assess whether they are as good as suggested, the points to be made are that companies do sometimes see it as in their interest, however defined, to engage in ecological restoration; and that much of the world's financial and other resources are controlled by corporations – therefore, their engagement is essential. As the world economies are now structured it is unlikely that, in fact, corporations will step up to this task to the required degree. However popular awareness is growing regarding corporate corruption and their ability to assign an ever greater share of global output and wealth to an ever smaller fraction of the population. If, or as, this popular sentiment translates into opportunities for restructuring and redirecting corporate power and resources toward the common good, one of the more promising ideas is the 're-chartering' movement, whereby transnational corporations, in particular, would "have an obligation to define and pursue a self-declared social mission." (Great Transition Initiative, 2010).

Internalizing meta-externalities

The world's major insurance and re-insurance companies have more reason than most companies to be aware of meta-externalities, and have shown this awareness in a number of actions. ForestRe is an insurance company with a focus on forests and ecosystems. It is active in the region of the Panama Canal, where deforestation has increased the amount of sediments and nutrients reaching the canal, requiring expensive dredging. ForestRe "has been working with other insurance companies to underwrite a bond to finance watershed reforestation. It has been proposed that companies heavily dependent on the canal buy the bond and receive a reduction in their insurance (against closure of the canal) in exchange" (de Groot et al., 2007).

Like insurance companies, some of the very large pension funds have also shown a serious awareness of meta-externalities: they are responsible for supporting the lives of their pensioners into the future, and if their investments degrade the possibility for a good future quality of life, high investment returns are not a full excuse. This seems to have had a place in the thinking of the huge California pension funds, CalPers and CalSters, as well as some British funds that have been leaders in early attention to social and environmental investments impacts. This has largely shown up in the form of negative screens, for example against tobacco and fossil fuels – but it is a starting point.

A 2005 article in *The Economist* discussed the relative benefits of conservation and restoration of natural capital as compared to the industrial approach to land that assumes a gain in efficiency when natural diversity is replaced with single crops, whether of trees or other plants. The conclusion: "every dollar invested [in nature conservation and restoration]

saves anywhere between US$7.5 and US$200 in avoided damage and repair costs" (quoted in de Groot et al.). However, many business entities are unaware of their dependence on a healthy natural world; and the meta-externality argument cannot, on its own, be expected to make all corporations into environmentalists, in part because of the issues of free-riders and of short-termism. A variety of other motivators, such as regulatory requirements, costs reduction or avoidance, and reputation, can be called upon to reinforce such constructive behaviour.

Some observers see a hopeful trend in which private sector investment models increasingly take sustainability issues into account. These trends can be further promoted through economic as well as regulatory and other incentives to producers and consumers. Market-based economic instruments to this end include taxes, subsidies, permits, and payments for ecosystem services. Taxes and subsidies are fairly obvious. For example, taxes on products sold with excessive packaging are a way of using the connective/communicative aspect of markets to affect consumer choice. Subsidies can be given to companies or individuals that employ sustainable fishing methods, including compensation for increasing the time that boats are idle, or limiting catch. Permitting is also a tool commonly used by governments to prevent undesirable behaviors or encourage desirable ones.

Payment for Ecosystem Services (PES) programs (also sometimes known as "markets for environmental services") are generally less familiar. The most widely known example is the US$1.5 billion investment made by New York City, when it paid upstate landowners and other stakeholders to engage in watershed conservation. In 1997 a memorandum of agreement was signed by the City and State of New York, the US EPA, 73 local municipalities and eight counties in the watersheds, as well as five environmental organizations. This allowed the city to receive filtration avoidance determinations from the EPA, avoiding the necessity to invest in a Catskill/Delaware filtration facility, whose cost had been estimated at approximately $US 6 billion for design and construction and $US 300 million in annual operating expenses (Pires, 2004). Among other examples is the Grain to Green Project in China which is paying farmers to convert steeply sloping cropland to forest and pasture.

PES programs may be used to solicit private investments in restoration. For example, they may offer financial credits to parties for actions that maintain or increase the provision of ecosystem functions. These credits can then be purchased, sold, or traded. This is the idea behind many proposals for carbon markets, in which economic actors that increase the storage of carbon (or prevent its release), as compared to a benchmark, receive carbon credits that have a monetary value. Often such schemes allow the producers of carbon credits to sell their credits to entities that are causing carbon emissions. An example that depends on individual concerns about climate change involves people who feel guilty about the emissions associated with their jet travel; they may make voluntary contributions to foresters who are allowing their forests to regenerate, sequestering carbon in the wood and in the soil. Programs with more teeth include carbon trading systems in which governments impose a cap on businesses, for each one mandating how much greenhouse gasses they are allowed to emit during a year. If a business exceeds this cap, in order to avoid financial penalties it must purchase carbon credits from other businesses whose emissions were below their cap.

"Carbon farming" is an idea that is gaining popularity in the United States, where some farmers anticipate that the losses borne in the early years of transitioning from industrial to organic farming models can be covered by payments from states or other entities that have

established a scheme for measuring and compensating the gain in carbon storage in the soil's increasing organic content[5]. The primary intent of such schemes is to counteract climate change, but their promoters see enormous additional values in arresting and reversing soil degradation, improving nutritional value of crops, and increasing biodiversity. Carbon farming depends on market functioning, but it must first create a market where one has not previously existed. There are, indeed, a vast array of requirements for a carbon trading system of any kind to work, not least the technical and administrative issues of credible measuring and monitoring of carbon storage.

Australia boasts the first soil credits worldwide to be eligible under the Paris Agreement; the first Australian Carbon Credit Units were just issued to a soil carbon project under the government's Emissions Reduction Fund (ERF). This is the result of a collaboration involving the government, which has created a soil carbon market with assured credits, and several business including Corporate Carbon Advisory, a multi-sector carbon contractor with over 40 million tonnes of abatement (100 projects) contracted under the ERF; and Bootstrap Environmental Services, offering field based soil sampling services and consultancy to the carbon farming sector. The Bootstrap media release of 14th March 2019 notes that

> "Soil organic carbon is in effect a scorecard for regenerative farming practices. The broader remit beyond carbon is to commercialise regenerative practices to enable producers to access a premium supply chain while the public gains access to more nutritious food and a regenerating environment. Australia is uniquely placed for its land sector to commercialise large scale carbon abatement. It has the measurement methods in place, the mechanisms to build soil carbon and a market for soil carbon credits including the $2.55B ERF, the Safeguard Mechanism and a growing voluntary market" (https://www.bootstrap.net.au/carbonfarming).

Where governments take the lead

This discussion has edged farther and farther into the area of government regulation and other "market-plus" interventions. Some impressive commitments have been made at all different levels of governments. On the international level, there are in existence international commitments for ecosystem restoration that add up, remarkably, to one-quarter of the world's arable land (Strassburg et al., 2018). Several international and national laws hold parties liable when they damage ecosystems. For example, in the US the Endangered Species Act and Clean Water Act hold responsible parties liable for restoring certain types of ecosystems. Under the US Conservation Reserve Program (CRP) "landowners are paid to retire agricultural land of high conservation value (primarily next to streams) and restore it to a grassland or forested ecosystem. The amount paid to the farmer for undertaking this restoration is based on the profit that could have been made had the land remained in production" (de Groot et al.). Since 1996, CRP has created nearly 2.7 million acres of restored wetlands. Other governments programs include a system of environmental assurance bonding, whereby extractive industries or other environmentally damaging activities post bonds that can be used to pay restoration costs if they default on their commitment to return an ecosystem to some specified condition. This approach is widely

[5] The increase of carbon in soils with higher organic material is not accounted for only by the storage of carbon in the organic materials themselves. These materials also encourage the multiplication of biota in the soil biome, which also play as yet not fully understood roles in capturing and storing carbon.

used, for example, by the Australian government to promote restoration of lands that have suffered from mining activities.

While the Australian government's interactions with the mining sector has endured for a long time, with results that are generally considered at least acceptable, and the USDA's CRP is protecting more than 170,000 stream miles with riparian forest and grass buffers, "enough to go around the world 7 times" (USDA, 2005), the examples given here also remind us of the weakness of governmental commitments, whether local or international. The laws may be made at a time that a particular government is strongly pro-environment, and then ignored or weakened by a subsequent administration, such as that of the Trump presidency in the US, which has other priorities. Too often, as well, governments lack the capacity to enforce treaties signed onto at an international level.

These are among the reasons that many have turned to public-private partnerships in an effort to combine private resources and capacity with the goals of the public purpose sector (which includes governments and NGOs). Turning again to examples provided by the World Business Council for Sustainable Development, "a public-private partnership of Rabobank and UN Environment has created a USD $1 billion facility to finance forest protection and sustainable agriculture projects beyond what is commercially viable. It identifies and minimizes barriers to sustainable agriculture on existing degraded land, improving productivity and thus avoiding deforestation." Another example is the Land Degradation Neutrality Fund (LDN Fund), which was launched in 2017 with the support of UNCCD.

> "The LDN Fund is an impact investment fund blending resources from the public, private and philanthropic sectors. It seeks to channel resources towards land-based private sector projects contributing to addressing land degradation through sustainable land management and land restoration projects" (WBCSD, 2018).

Recap: what are the current sources for investment in ecological restoration?

After surveying the role of government, the *Business Case for Soil Health* adds that "Other capital sources that could be further incentivized to invest in soil include pension, insurance, and sovereign wealth funds, public expenditures and foundations." Some philanthropic foundations have been moving into 'impact investing,' where the effort is not merely to avoid doing harm, but to actively promote their mission values through their investments. Leaders have been relatively small foundations, such as the F.B. Heron and Nathan Cummings Foundations; the latter intends to "align 100 percent of our nearly half-billion dollar endowment with our mission" (Calhoun, 2014). The Ford Foundation has put aside $1 billion of its endowment for impact investing. The John D. and Catherine T. MacArthur Foundation, with the Rockefeller Foundation and the Omidyar Network, have jointly allocated $150 million to help address financing gaps in impact investing.

To put this in perspective, "foundations hold only around $800 billion in their endowments. But there are trillions and trillions in private capital markets, while the 400 richest Americans alone have a net worth of $3 trillion" (Ibid.). Some modern billionaires, such as Bill Gates, Michael Dell and Pierre Omidyar, have invested heavily in new, sustainable energy technologies. Michael Bloomberg is working with a consortium of individuals and family foundations to show the irrationality of continuing to invest in coal as an energy source. This is the low-hanging

fruit; energy is big business, and, while many energy investments are risky, there is also a reasonable prospect for high returns.

So far, it has been much more difficult to make a case for market-rate returns to be expected from investments in ecological restoration. Thus, as indicated above, such investments have been made through a variety of market-related or non-market approaches. To recapitulate: some companies, moved by a variety of motives, have made significant investments in more sustainable farming methods and related aspects of soil protection; it is hoped that this trend will grow. Governments sometimes put their funds into activities such as the extensive efforts, in South Africa, toward removal of invasive plants or, in Rwanda[6] (with assistance from the UNDP), towards rebuilding the organic content of soils. More often governments seek to work with the private sector, either through public-private partnerships, or through instruments such as regulations, subsidies, permits, and payments for environmental services. And foundations and philanthropically-minded individuals have been moving cautiously towards ecological restoration, asking themselves whether they can accept 2-3% returns in the portions of their portfolios that are invested in this way.[7]

This list leaves out a segment of society that is critically important for ecological restoration. Before offering some comments on the role of local communities, I will take a brief detour to look at the issue of prioritization.

Prioritizing restoration projects

In November, 2017, The Brazilian government announced the National Plan for the Recovery of Native Vegetation (Planaveg). The initiative, announced during the 23rd Conference of the Parties to the UNFCCC (COP23) in Bonn, Germany, represents an important step by Brazil towards the recovery of its native vegetation and the fulfilment of its commitments under the Paris Agreement. The goal is to recover the native vegetation of at least 12 million hectares of area by 2030.[8] While this piece of news may, in the 2019 context, be a depressing reminder of a point made earlier – that commitments by one government may be dismissed by a new, anti-environmental party – it is still instructive to look behind the scenes at some details in how Brazilian Ministry of Environment devised the particulars of its plan. (These details are elaborated on in Strasburg et al., 2018)

The preexisting Brazilian Native Vegetation Protection Law "requires Atlantic Forest farmers to keep at least 20% of their farms under native vegetation. Farmers currently below this threshold must comply either by implementing restoration in their own farms or by financing

[6] Overall project cost is 1,562,000US$, with 600,000US$ from GEF, and 962,000$ from co-finance: 300,000$ from UNDP, 397,000$ parallel co-finance from the ICRAF (World Agroforestry Centre), and 265,000$ in –kind from the Government of Rwanda. UNDP/GEF-MSP PROJECT ON LAND DEGRADATION IN RWANDA, proposal 2007:
http://www.rw.undp.org/content/dam/rwanda/docs/operations/Projects/Environment%20and%20energy/RW_EE_Sustainable_land_use_and_management.pdf

[7] The focus of this paper on investment should not exclude the banking sector. However, very few banks are willing to lend funds for the rates of repayment that can normally be expected to come from restoration projects. It is relevant here to mention the Community Development Financial Institutions (CDFIs) in the United States, which bundle together federal funds with private sector capital (some of it at market rates, some in the form of very low-interest loans or gifts from the philanthropic community) to generate economic growth and opportunity in economically disadvantaged communities. In the past these have focused heavily on housing, but are occasionally supportive of food coops and other activities that are relevant to regenerative farming. See the quotation from Jacob Israelow.

[8] http://www.brazil.gov.br/about-brazil/news/2017/11/government-launches-national-plan-for-the-recovery-of-native-vegetation

conservation or restoration offsets elsewhere within the biome" (Strasburg et al., 2018). Strasburg's team used a linear programing model with multicriteria spatial planning to reveal and manage the trade-offs and synergies involved in selecting areas for conservation/ restoration offsets. The restoration benefits to be maximized included reduction in projected extinctions of native flora and fauna, and potential aboveground carbon sequestration. (They did not include below-ground carbon storage, as the relevant soil science was not yet sufficiently advanced.) The constraints included restoration implementation costs (expected to be borne by farmers), and potential conflict with agricultural production. The decision tool identified significant economic and ecological efficiencies of scale, while also recognizing some important reasons for valuing certain small-scale projects for having smaller patches of restoration dispersed across the entire biome, creating a mosaic of large and small. These conclusions, and the methodology for reaching them, led to the application of this approach to the other five Brazilian biomes as part of the National Plan for Native Vegetation Recovery.

The argument in favor of larger scale occurred in a context where a national plan could connect areas regardless of ownership. It is also relevant for very large farms, ranches, haciendas, etc., to the extent that their owners are aware of the fertility losses that occur over time under industrial monocropping. Naturally, given the scale of the problem, such opportunities are appealing. Nevertheless, this should be balanced by a note about the realities facing small farmers in most of the world:

> Most regenerative agriculture can only happen at a small scale. This leads to impact investment opportunities that are also small-scale, which can make them risky and challenging to effectively underwrite for several reasons (eg – size of team, assets managed, concentration risk, whether it is worth it for an investment adviser to spend time evaluating a smaller opportunity, etc). I do not disagree with the advantages of large-scale projects, it can just take tremendous efforts to coordinate among many small-scale actors, which takes even more time and management effort (Jacob Israelow).[9]

Community restoration, from the bottom up

While the Brazilian example, and a few others mentioned earlier, have taken into account the impact on local people, and made some attempts to engage their cooperation by making known the benefits they could receive from restoration activities, virtually all of the approaches described in this paper have been top-down. Restoration of the world's damaged ecosystems is an enormous challenge; it will require enormous amounts of investment funds. With such big challenges, it is perhaps natural to look to big players. However a recent book by Gary Nabhan provides compelling examples of effective bottom-up actions by individuals or communities, depending mostly on their own efforts to provide the work that, in top-down projects, is contracted out by planners.

Tucson, Arizona, is a city that suffers from urban problems of poverty and job insufficiency, as well as a severe shortage of water. In 1998 a citizen of the city, Brad Lancaster, set out to capture rainwater from his street front, roof, and other hard surfaces, working up to the ability to store a hundred thousand gallons every year in containers in his yard. He also began to cut away curbs, allowing storm-water from the city's paved streets to flow into basins placed between the streets and the sidewalk, with the goal of planting there, and irrigating, trees

[9] Personal communication from Jacob Israelow, Founder and Managing Director, Dirt Capital Partners March 11, 2019.

bearing edible fruits. Initially the city proposed arresting those who cut curbs without permits, but by 2001 "Lancaster had worked with the city to legalize the process and get block grants to help one neighborhood after another transition their provision of moisture" to use harvested rainwater in support of fruit trees (Nabhan, 2018). The city caught on to the potential, and offered rebates to citizens who were using harvested rainwater instead of drawing on the scarce municipal supplies.

The results snowballed into a remarkable diversity of businesses, for example providing cisterns, gutters and drip irrigation systems, while Tucson became a center for the collection, sale, and free distribution of native, drought-tolerant varieties of edible plants. The Pima County library has created the largest free seed interlibrary loan program in the country. (The distribution from this and other seed libraries in the area count as "loans" because 60 percent of the people who checked out seed packets have returned some seeds after their harvests to replenish the stocks available to others the next season.)

> "By the summer of 2017, Tucsonians had local access to more than 2,020 named varieties of 130 cultivated annual food crops; 140 species of wild, native desert edible plants, and more than 200 varieties of domesticated fruit, nut, berry, and succulent edibles…Young entrepreneurs – from wild foragers and farmers to millers, bakers, tortilla makers, cactus syrup processers, distillers, brewers, *mole* makers, mixologists and fermenters – have begun to use these local ingredients to develop new products, most of them unique to Tucson or the border region" (Nabhan 2018, pp. 156-7).

The Tucson example is only one among many described in Nabhan's book, where local people confront the resource degradation problems in their own region, whether that be as large as a city or as small as one farm. Sometimes these stories start with one inspired leader, such as the "'harvest rain' guru", Brad Lancaster in Tucson. Sometimes they depend on a family's commitment, over multiple generations, to increasing the productivity of their land by building terraces or planting living hedgerows to prevent erosion. Sometimes they stem from knowledge and understanding about the land that is held by local groups, often including indigenous people and those who learn from them. Some of the cases described by Nabhan have benefitted from a little access to outside resources, whether of money or of knowledge; but more often the stories are of people using their own time and knowledge and muscle to bring back beauty, diversity, and productivity to the land on which they depend.

Conclusion

There are 7.7 billion people in the world today, with more than half living in urban settings. Who thinks about the health of soils in cities? Not very many people yet (an exception is HUMI, see below); however with the explosion of the field of soil science, knowledge is growing rapidly regarding the difference, for humans, between living in an environment of degraded soils and impoverished flora and fauna, vs. living in a place where the surfaces on which we humans travel allow water to flow or filter through; where native plant and animal species are encouraged to flourish; where anyone can find a genuine green space in just a ten minute walk from their home.[10] The EcoHealth Network[11] is one of several organizations

[10] This is the announced goal of The Trust for Public Lands.
[11] Based at the Missouri Botanical Gardens, in St Louis; the steering committee consists of James Aronson, Cristina Eisenberg, Laura Orlando and Neva Goodwin.

now working to provide scientific analysis for the hypothesis of a strong link between soil health and human health. Another is the Healthy Urban Microbiome Initiative, "HUMI" in Adelaide, Australia.[12] The evidence for benefits via psychological responses is extensive, but also requires firmer scientific underpinnings.

In rural areas, where nearly half the world's population still live, the need for continued advances in science is not about *whether* soil health is essential for ecological health, or whether ecological health is essential for human well-being; it is incontrovertible that the future well-being of our species will depend heavily on reversing the trend toward ever more degradation of the natural world. As reported by the United Nations in 2014, if farmers don't change their agricultural practices, "most of the soil they rely on to sustain their livelihoods will disappear within 60 years."[13] There are, however, many areas still requiring research on how to restore different areas most effectively and efficiently. The great variety of questions to be researched include how to assess soil health under a variety of circumstances, how to identify species of plants and animals that will be most beneficial in restoration, and then how to introduce or encourage these species. These are not simple matters, but they are doable. While the science is still maturing some actions will head in the wrong direction,, but usually significant ecological recovery can be achieved through a range of actions, some of them more "correct" than others.

This paper is based on the premise that a massive reversal of the interactions between humans and the rest of nature is essential – to turn away from spreading ecological destruction, towards restoration and renewal. The focus of the paper has been on where to find the financial resources required to make the necessary global investments in ecological restoration. It has considered private sources, public funds and government activities, public-private partnerships, the large pools of capital in insurance companies and pension funds, and the support that can come from philanthropic institutions and individuals. It has also touched briefly on the reality that, while local communities often have little access to outside funds, some manage extraordinarily well with their own resources.

It is tempting to try to quantify the size of the effort and the resources, and where they will come from, that are needed to make a strong turn away from global ecological degradation, towards vigorous renewal. To make such an assessment would require answering the following questions:

1. What is the potential for storing more carbon and other greenhouse gasses in soils and plants than is there now? (NB: this paper has not dealt at all with the great question of how much the storage capacity of oceans has been diminished by human actions, and how much it might be increased by changes in behaviour.)
2. In many cases the last 10-20% of a solution is much harder to achieve than the first 80-90%. Guessing that this is likely so in this case, and recognizing the urgency to achieve a large impact as quickly as possible, how can we prioritize where to begin our efforts?

[12] HUMI focuses exclusively on urban areas, including the soils in built areas (e.g., rooftop gardens) as well as natural ones. Their hope is to engage 20 cities around the world in a carefully designed study protocol on the relationship of soil health and human health.

[13] "Industrial-scale agricultural practices lean on polluting machinery and chemicals, which contaminate farmland. Insistence on monoculture–growing a single crop on the same patch of land–saps the soil of nutrients that more diverse crops deliver. And aggressive tilling breaks down soil structure and makes it harder for healthy land to regenerate." Quoted in https://www.fastcompany.com/90313818/general-mills-has-a-plan-to-regenerate-1-million-acres-of-farmland

3. What are the different elements of the job to be done?
4. How can we calculate the cost in money and human effort that will be required to move from the current situation to where half of the potential greenhouse storage in ecosystems is achieved? 80%? 90%?
5. How can we assign the responsibility for this renewal among the different categories of players in this drama?

Others have made a variety of efforts at answering most of these questions, though not necessarily at a global scale. The "4 per thousand" initiative launched by France in 2015 proposes that "An annual growth rate of 0.4% in the soil carbon stocks… per year, would halt the increase in the CO_2 concentration in the atmosphere related to human activities" (4 per 1000, 2018). Although the writing on this initiative sometimes refers generally to soils – most broadly agroecology, agroforestry, conservation agriculture, landscape management, etc. – the focus is on agricultural land, specifying an intention "to demonstrate that agriculture, and in particular agricultural soils can play a crucial role where food security and climate change are concerned" (Ibid.). Thus the reasoning behind the French proposal is a good start on one approach to calculating the GHG storage that might be achieved on agricultural lands, but mostly ignores other lands, such as forests, wetlands, and cities.

This paper has shown just one example of a technology used for prioritization: the linear programing model with multicriteria spatial planning used by Strasburg et al. This approach, or modifications of it, or sometimes quite different, more qualitative approaches, will be required for different cases, at different scales. The IUCN has identified "global hotspots" of extraordinarily high diversity; this is an important value to be included in any prioritization scheme (as it was in Strasburg et al), but there are multiple other values. Other questions to be asked would include: "where is it easiest to mobilize resources?" (e.g., where there is already enthusiasm for ecological restoration), and "where is the biggest bang for the buck?" This could point to the areas closest to more intact lands, from whence natural seeding could occur (both above and below ground); in some cases it might point to the most degraded lands, in others, the least degraded. The scale under consideration will strongly affect the approach to prioritization: and the question of scale will depend on who are the prime movers – e.g., local farmers or forest dwellers, a municipality, a nation…?

The 4 per thousand initiative lists many elements of the job to be done, including the establishment of soil carbon monitoring systems; training programs for farmers and advisors on how to increase soil organic matter; establishment of appropriate public policies and a suitable regulatory environment for the transition of agricultural systems; and opening carbon markets to new sectors such as agriculture and agroforestry. In addition, there is need for a great deal of research to continue expanding our understanding of how the system works. This requires engaging the best of modern science along with serious attention to experiential knowledge, whether that is embodied in first, second or 10^{th} generation workers on the land or in indigenous peoples. Both of these kinds of knowledge will be needed in programs of capacity building, to rapidly increase the number of professionals and students who can engage with restoration work on the ground. Not least is the need to inform the global public of the great importance of ecological restoration, for their own health and wellbeing and that of coming generations. People view electrification, for example, or access to modern transportation or communications media as critical to their wellbeing; global and local ecological restoration is no less important. This message needs to be conveyed, vigorously and credibly.

The answer to question #4 is probably no – we cannot really calculate what it will take to achieve any large fraction, let alone the whole, of the job to be done. And question #5 is equally hard to answer. We know that some portion of the responsibility rests on actors in the public purpose sector – governments and institutions working for the common good; and that governments will doubtless need to play a leading role. As the world is today, the private, for-profit sector must also take on much of the need; it is to be hoped that global cultures and economies will change enough so that they will feel ever more motivated to do so (Great Transition Initiative, 2010). And then there are the individuals and groups who are motivated not by government regulation or incentive, nor by the profit motive, but because they understand how intimately human wellbeing is connected with the health of the earth. Success, to the extent it is achieved, will come from combining local passion and knowledge with global and local science and knowledge, and with financial capital, in ways that work for immediate human needs combined with long-term movement toward ecological restoration.

All people – young and old, rich and poor, rural and urban – are affected by ecological degradation. To address these massive meta-externalities, scientists and planners, as well as those with large financial resources – businesses, governments, investors, and philanthropists – must work with, and support, the needs and the knowledge of the people and communities that are directly interacting with the state of the natural world. How much should each do? The only answer is: as much as they possibly can – which is probably more than they now realize they can.

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