Attempting to understand the ecological crisis:
Human capacity, self-interest and moral restraint:

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Douglas Macdonald, PhD
Senior Lecturer, School of the Environment, U of T
33 Willcocks St., Room 1016V
Toronto, Ont. M5S 3E8
douglas.macdonald@utoronto.ca
(416) 978-1558

Some scientists claim we live today in the "Anthropocene era" - the latest period in the history of the earth, marked by the fact that the impact of human activity is such that it is "reshaping the planet on a geological scale - but at a far- faster-than-geological speed (Economist, 2011: 17)." Modern awareness of the problem has its origins in the 19th century, in North America through the writings of George Perkins Marsh and observation of impacts such as the extinction of the passenger pigeon and near-extinction of the buffalo. During the past forty-odd years, all academic disciplines have turned their attention to aspects of the human-nonhuman relationship relevant to their area of study (environmental chemistry, environmental politics, nature in English literature, etc). At the same time, an interdisciplinary body of knowledge termed environmental studies or environmental sciences has emerged, which attempts to grapple with the whole of those interconnected aspects. Off the campus, all organizations, from governments, to firms, to churches and beyond have begun to take steps to reduce their environmental impacts. In both thought and action, the environmental problem now ranks with other dominant concerns such as military security, state of the economy, human rights and social welfare. Thought and action are linked, in that research, thinking and writing about environment, both in academe and professional circles, is done primarily in order to contribute to actions which can be taken to reduce the human impact. In these linked areas of thought and practice, two questions are central: 1) what are the causes of the ecological crisis; and, 2) what are the solutions? The questions themselves are connected, since the framing of a problem determines the range of options considered viable for its resolution.

The purpose of this paper is to provide tentative, interconnected answers to both questions. I do not suggest the argument made here is superior to the many others which exist or the only correct basis for action; I merely hope it is another useful way to view the environmental problem and its solution. The subject matter is the global human impact upon environment, and efforts to address that problem, since emergence of the species homo sapiens some two hundred thousand years ago through to the rapid escalation of both global human population and the scale of impacts which has been seen in the past five hundred years. The paper begins with a short statement of the argument, immediately below. The remainder of the paper then unpacks that argument, by first providing a brief summary of current thinking on causes of the environmental problem, followed by my own argument, which does not deny the

importance of any of the causes currently recognized but instead attempts to fit them together into one basic cause. The remainder of the paper examines the implications of that view of one basic cause for possible solutions, based in human self-interest, moral restraint or a combination of the two.

The argument made here starts with the observation that all living organisms have an impact upon their environment - that which lies outside their bodies - because to live they must draw into their bodies resources from that environment and then excrete to it wastes produced by the digestive process. Thus humans as a species and as interacting societies, as well as each individual human, do each day exactly what all other species and individual members of species do - have an impact, no matter how marginal, on their immediate environment, as they go about their basic tasks of eating, reproducing and living. Humans are not "natural aliens" (Evernden, 1985), "rogue primates" (Livingstone, 1994) or inherently evil, as is suggested by some of the more extreme statements of Earth First!. Nor are they intentionally, with malice aforethought, seeking to plunder and destroy the world in which they live. Instead, they are doing what all organisms must do and have done since the beginnings of life on earth. The problem is that total annual production (throughput of all materials and energy) is now occurring on a *scale*, measured spatially, temporally in terms of future duration of impacts, and by severity of the attendant impacts, never before seen on earth.

Why is that? The environmental studies literature provides a number of answers, including population growth, increased affluence resulting from the scientific method, capitalism, technological change and anthropocentric, human-centred values. My argument is that we need to recognize this spectrum of interconnected causes, but need not determine to a precise degree the relative importance of each. Instead, there is value in focussing upon the sum of those causes which can be expressed by the concept of *capacity* - defined as the physical ability of humans to use the resources of the earth, and generate associated wastes, for the production of goods and services. Humans are having such an impact upon their global environment because they are for the first time *able* to have that impact as they pursue the same human ends they have since the species first emerged.

The next step in the argument is that this physical capacity has two primary, interconnected causes. The first is human use of technologies which give access to physical power, in the form of fossil fuel and other energy sources. Until very recently, human production was powered only by the energy of humans themselves, plus that of their domestic animals such as the ox and horse, and to a minor extent by wind and falling water. Tapping into coal and other energy sources during the 18th century Industrial Revolution, later followed by access to nuclear power, has allowed an enormous increase in the physical power available to humans.

The capacity of humans to produce, however, flows also from human *social* power - the ability of humans to influence the thinking and behaviour of other humans. For most of their history, humans lived without significant social power as small groups of hunters and gatherers lived in equitable, sharing relationships with no one group holding dominant power over others. Social power in its current form only emerged some ten thousand years ago as humans in different parts of the world domesticated animals and plants and then began to live in fixed settlements. A sedentary life-style in permanent buildings allowed for the first time accumulation

of a food surplus. This meant some humans were freed from the daily task of supplying food and so could spend their time in religious or governance activities which gave them power over others. They used that power to organize and co-ordinate the activities of those living in the village or city, thus increasing their total ability to achieve a common end. In doing so, they relied upon ideas in the form of assumptions and norms which justified and legitimated their power, but they also relied upon technologies such as writing in order to organize information as a necessary step in organizing human activity.

That social power, and related ability to co-ordinate human activity in ways which increase total available human physical power, took another quantum leap, beginning at the time of the European Renaissance, with the emergence of the modern scientific method, capitalism, the technologies of the Industrial Revolution and then establishment of the two major current organizational forms, the modern state and firm. This vastly increased co-ordinating ability was due in part to technological changes of transportation, communication and military force and also by the steadily increasing material wealth generated by capitalist organization of society. The power of humans to influence nature is directly related to both available physical power and to the power of humans to influence other humans.

This relationship between physical and social power is found at the most basic level, in the definition of the term "technology." Nye (2006, 15) notes that the definition has changed over time and states it is currently "a comprehensive term for complex systems of machines and techniques." Thus the term refers to both the physical artefact and the means of using it. As discussed below, the machine used by labour organized in the factor system provides an illustration of both the definition of the term and the inherent connection between physical and social power.

If we accept my argument that the cause of the environmental capacity can usefully be conceptualized simply as human capacity, it follows logically that the solution is for humans to choose to not exercise the full capacity which they have available. Why would they do that?

The first reason is because they recognize that the harmful impacts they are imposing upon the world around them are also hurting them, for instance through contaminated air and water and depletion of resources such as food and drinkable water. It is this recognition, based in human self-interest, which has been primarily responsible for efforts over the past hundred years or so to reduce human impacts. However, since the early 19th century and first emergence of organized attempts to prevent cruelty to animals, there has always been another motivating factor - recognition of a *moral* obligation to reduce impacts. Humans are motivated, then, by these two concepts of human self-interest and moral restraint. As discussed below, self-interest has to date been unable to solve the problem because, first, those humans with the most power to address the environmental problem, the rich, living in the rich countries, have solved their immediate environmental problems and so self-interest does not effectively motivate them to address the environmental problem in its totality. Secondly, human self-interest does not automatically include the interests of future humans or nonhumans. Nor yet has moral restraint worked to significantly reduce the exercise of capacity because it is a set of ideas which lie at the margins, not the heart, of global values.

As discussed below, while self-interest and moral restraint have not yet succeeded in solving the problem, they are both now fully established as social norms and laws relevant to the environmental problem. Together, they have the potential to bring about technological change and also change in the human goals for which technology is used. Perhaps the easiest way for humans to do that and thus to refrain from exercising their full capacity is found in another concept which is also established, albeit here too at the margins - that of a steady-state economy. If economic growth is not available to address poverty, however, we must instead rely upon on wealth redistribution. Social power must become more equitable in order to allow a more equitable relationship between the human and nonhuman worlds, based in human restraint in using the physical capacity it now holds.

Causes of the environmental problem

The formula Impact = Population x Affluence x Technology (IPAT), first set forth by Ehrlich and Holdren (1971, referenced in Meyer, 1996: 23) is a good starting point for a survey of the interconnected factors which have resulted in humans becoming a significant influence on earth systems. Population has increased because death rates have decreased, due to increases in food supply and improvements in medical practice. Both have their origins in changes in development of the scientific method (empiricism) beginning in the European Renaissance and advances in technology, particularly since science became a source of technological change through the mechanism of the European university system in the 19th century. Global population today is about seven billion and is expected to increase to nine or ten billion by about 2050 when, with luck, it will stabilize and perhaps begin to decline (Withgott and Laposata, 2014). Although huge disparities exist, the average consumption (resources consumed and wastes generated) of each human is increasing at a rate faster than that of population increase. This is because the now globally dominant institutions and values of capitalism, most notably private ownership of property guaranteed by state law, coupled with the goals and identities of consumerism (the belief that happiness comes from material things), are able to generate regular increases in productivity (greater outputs from the same inputs). Thus the IPAT formula might be expanded into:

I = P x A (consumerism + capitalism) x T (science + technology)

The first two elements on the right-hand side, population and affluence, work only to increase the total impact. Technology, and the science which now enables it, on the hand can work to either increase or decrease the impact. As discussed below, throughout history technological change increased the impact but more recently it has begun to decrease it, most notably in the renewable energy technologies which are now starting to replace fossil-fuel energy supplies (Ehrlich and Ehrlich, 2004; Smil 2010).

Other analysts have added other causes. Attfield (2003) also lists the IPAT elements, but breaks affluence into capitalism and economic growth (although without including consumerism as is done above) and then adds three others: absence of markets, patriarchy and values, in terms of anthropocentrism. A good case can be made for each. The absence of markets is linked to absence of property rights and associated externalities and collective action problems, clearly a

cause of global environmental problems such as depletion of fisheries in international waters or global climate change (Carter, 2001). Meyer (1996, 39-40) discusses those issues and then goes a step further and lists institutions as another cause of the environmental problem, like Attfield pointing to the absence of markets.

> Closely intertwined with human numbers, affluence and technological capacity as driving forces of change are many variations in the ways that human beings organize their relations with one another and with the natural world. ... The key ones related to the environment are ... the rules of property, exchange and regulation. ... It is in these institutions, rather than the PAT variables, that many social scientists prefer to seek the human roots of environmental change.

Like Carter and Attfield, Meyer examines externalities and ways they can be brought into market calculations, common-pool resources, the tragedy of the commons and collective-action problems, the tendency of markets to discount future value and to shift environmental problems into the future. This means the equation is expanded, as follows.

I = P x A (consumerism + capitalism) x T (science + technology) x I (institutions + absence of markets)

As noted, Attfield includes anthropocentrism as a cause. Fox (1990) agrees, particularly in its narrow, non-enlightened form which sees nature only in terms of its physical use for humans as a source of resources and is seen as a cause. Other values and ideas are also presented as causes, including Lynn White's 1967 indictment of Christianity and the argument that the original agricultural revolution, followed by mechanization of production and replacement of natural rhythms with the hands of the clock, urbanization, electric light and other aspects of modern living have alienated humans from nature (Evernden, 1985). Thus alienated, they do not care about the damage they cause. Accordingly, we add values to the equation.

I = P x A (consumerism + capitalism) x T (science + technology) x I (institutions) x V (anthropocentrism)

Patriarchy is a cause identified by ecofeminism (Merchant, 2008) and forms part of the larger issue of social power presented here. Ecosocialism (Wall, 2010) adds social power in the form of power relations among classes. Adding these elements, we have this picture of the formula.

I = P x A (consumerism + capitalism) x T (science + technology) x I (institutions) x V (anthropocentrism) x SP (social power, eg patriarchy, class)

Not surprisingly, there is not agreement on the relative importance of these causes. To give just one example, Livingstone (1994, 1; emphasis in original), argues that "human *ideas* propel the flaming juggernaut [of ecological destruction]" - in particular, alienation and anthropocentrism. Meyer (1996, 49), on the idea hand, says that "Research has not satisfactorily demonstrated the clear importance of attitudes [ideas] on a par with the other driving forces."

Beyond that, the equation is becoming cluttered. It might well be possible to add other causes or to break any of these down into other component parts, but it is not possible to say one is clearly more important than the others. To my mind, Meyer (1996, 50) is correct when he says: "In short, none of the social changes put forward as driving forces can be identified as the real and prime root cause of global change, either singly or in combination with others." The environmental problem exists because of the total cumulative effect of all these causes and perhaps others. Accordingly, I suggest there is value in focussing upon that cumulative effect, which can be thought of as simply the physical ability of humans to move earth, dam water, destroy habitat, pollute air, water and land and change the composition of the global atmosphere.

This physical power, as discussed above, comes in the first instance from technologies which give access to and are powered by fossil and nuclear fuels. For most of its history, humanity has only had access to energy coming from human or animal sources, augmented by wind (mills, sailboats) or water (mills). The invention of the steam engine in the 18th century changed all that, meaning that for the first time elites no longer had to rely upon slaves to perform necessary tasks, but instead could use machines (Nikiforuk, 2012). As well as allowing water to be pumped out of coal mines, thus increasing supplies of that energy source, and providing vastly increased transportation ability, by invention of the locomotive, the steam engine powered the early textile factories in England. Those factories could only increase productive capacity (with associated environmental impacts in terms of resources used and wastes generated), however, because large numbers of tenant farmers had been displaced by land clearances and were thus lacking economic and social power. They were vulnerable to the exercise of social power by the factory owner, who did so by organizing their work activity so that it fitted with the design of the machine. The factory is the perfect symbol of capacity which has its origins in a combination of technology and organization. In the next section, we trace the evolution of each.

Historical development of human capacity to influence environment

The purpose of this section is to sketch an overview of the evolution of human capacity to produce, with the side-effect of influencing environment, from the first emergence of our species, when it was minimal, to the present time when by virtue of our global supply of atomic weapons we hold the capacity to virtually eliminate life on earth in the space of an afternoon or, by virtue of climate change and habitat destruction, to eliminate over a longer time period a perhaps smaller but still significant portion of the total life on earth. This increasing capacity is due in the first instance to our progressive development of new technologies which increased human power. That power has always been augmented, however, by our ability to co-ordinate our actions in the achievement of group goals. New technologies which allow communication over distance have increased that organizational ability and, conversely, during the past two centuries organization has been applied to science, which has brought about yet more technological development. Accordingly, this section traces the two-way interaction of technology and organization. It does so by examining four periods in human history: 1) the initial period, from about 200,000 to 10, 000 years ago; 2) the agricultural revolution, 10,000 years ago; 3) the European Renaissance and Industrial Revolution, beginning about 500 years ago; and, 4) very briefly the current era. Table 1 immediately below gives an overview.

Table 1. Overview of four periods, interconnected technological and organizational change

Initial; starting 200,000 years ago	Little technological change	Language increases organizational capacity
Agricultural Revolution; starting 10,000 years ago	Not driven by technological change	Social stratification significantly increases organizational capacity
Renaissance - Industrial Revolution; starting 500 years ago	Rapid technological change	Modern bureaucracy emerges
Current; starting 50 years ago	Technological change now driven by organised science	State and firm as dominant organizational forms

The initial period

Use of technology precedes modern humans. Homo erectus, a forerunner of Homo sapiens, by some 1.6 million years ago had developed hand-held stone tools with edges sharpened by flaking which were used to "cut, scrape, pound and dig" (Jurmain, et al, 2014: 327). Throwing spears used to hunt large animals may have been used four hundred to three hundred thousand years ago and stone tools were then further developed and specialized by the Neandertals (Jurmain, et al, 2014). The other major technological advance was the ability to control fire, which provided light, warmth, security and a means of cooking which by pre-digesting food facilitates the task of ingesting protein. Christian (2004, 194) discusses early use of fire by Homo erectus to shape the landscape "by clearing away underbrush ... [which] also encouraged the growth of new plants that, in turn, attracted browsers that could be hunted."

Organization and social co-ordination is found in other species, such as ants, bees and wolf packs and like technology also predates modern humans. Human forerunners such as Homo erectus lived in families and larger groups and certainly co-operated in securing food and shelter and other tasks. What differentiated early human co-operation from that of other species was the development of language some fifty thousand years ago and its associated implications for thinking and planning. Harari (2014) argues the most important aspect of this language-related change in thinking was the ability to imagine what does not obviously exist. He suggests first that language allowed early Homo sapiens to "develop tighter and more sophisticated type of cooperation "(Harari, 2014: 24). He then goes on to argue that expansion of group size beyond that which can be maintained by continual daily interaction (which he puts at approximately 150 individuals) was only possible because language and associated thought had made possible for humans the ability to imagine what does not exist and, thus, the creation of shared social constructs (Harari, 2014: 27).

> How did *Homo sapiens* manage to cross this critical threshold, [of 150 maximum group size] eventually founding cities comprising tens of thousands of inhabitants and empires ruling hundreds of millions? The secret was probably the appearance of fiction. Large numbers of strangers can cooperate successfully by believing in common myths.

He gives as examples of such "myths" the ideas which underlie religion, law and the state - the institutions (rules) which are used to co-ordinate activity. Beyond institutions, the form of myth

of relevance here is the set of beliefs, such as a right to rule divinely granted by the gods, needed to legitimate power and thus allow elites to control the activities of the mass (Beetham, 1991).

The agricultural revolution

This occurred with the agricultural revolution, some ten thousand years ago, when hunter-gatherer societies first began to domestic plants and animals, such as wheat, barley, dogs, coats and sheep, using technologies such as digging sticks and irrigation (Christian, 2004: 219). Unlike the Industrial Revolution or current period, however, technological change was not the major factor leading to this profound change in the human way of life. Nor yet was it really a revolution, since it occurred slowly over a considerable period of time. Ponting (2007, 39) describes it as an "intensification and combining of existing ways of obtaining food." While analysts point to the fact that this change meant a decrease in variety and nutritional value of diet (Ponting, 2007; Harari, 2014), it did mean that the amount of food which could be obtained from the same geographic area significantly increased, allowing increases in population. Conversely, it was likely prior increases in population, rather than technological change, which was the main motivator for the change from hunting-gathering to agriculture.

Development of agriculture was a profound change in the human relationship with nature. Previously, it had largely been one of human adaptation to nature - domestication of plants and animals, however, meant humans for the first were also able to some degree to control nature, at least in their immediate vicinity. To do that, however, they had to control themselves. Christian (2004, 245) describes the two processes by his chapter title: "From power over nature to power over people." Mann (1986) argues this is also the time when humans began to increase their power over one another, creating what he refers to as the "social cage" - the set of ideas and related practices, including the exercise of coercive force, which held humans in the new towns and cities within the thrall of elites. Ponting (2007, 155) gives a similar picture, saying that: "Gathering and hunting groups had few possessions and were largely egalitarian." That changed with the development of agriculture and a food surplus which could be stored for future use and which freed some humans from food-production tasks, thus allowing the emergence of elites, with the "authority to take and redistribute the food surplus" Ponting (2007, 155). This change from hunter-gatherer to fixed-settlement societies, which occurred independently at approximately the same time in the what is now the Middle East, India and Central America laid the foundation for all future societal evolution, based on control of environment to ensure it produces increasing food supplies needed for growing populations and social control to ensure humans have that necessary ability to control nature. Ponting (2007, 156) argues control of nature and control of humans went hand in hand, as these early fixed settlements faced changing environmental conditions which threatened the food supply and had to be met by increased co-ordination of effort: "It was the environmental problems they encountered and the levels of organization this demanded that was crucial." Christian (2004: 260) gives a similar picture.

> As populations became denser, people, like termites, found that they needed ways of organizing and coordinating their activities. But this meant conceding power to organizers who used that power in ways that benefitted themselves as much as (and often more than) the communities they controlled.

Social stratification emerged in part because elites seized power. However, it also emerged because larger social groups, with a need to control nature as well as adapt to it in order to ensure

food supplies sufficient for larger populations, needed increased co-ordination to achieve group goals.

Once established, social stratification and the exercise of social power by means of coercive force, legitimized by socially constructed values, assumptions and norms, spread geographically to take the form of the city-state and the empire. Technological development, such as writing, the stirrup, wheeled vehicles and Roman roads aided this ability of elites to project power over space. While technology was aiding organization, the reverse was not yet true, since technological change was slow, sporadic and unplanned - the result of tinkering by isolated individuals. That changed with the next great revolution in human affairs which occurred in Europe, starting five or six hundred years ago, with the interconnected emergence of science, capitalism and the state.

The European Renaissance and Industrial Revolution

Desai (1993, 112) defines capitalism as: "a set of economic and legal institutions which together make the production of things for private profit the normal course of economic organization." He argues it consists of four central elements: 1) production by private actors, not the state (as in communism); 2) a legal system, enforced by the state, which protects private property; 3 a legal system which also ensures contracts between buyer and seller can be enforced; and, 4) a legal system which ensures the investor receives a significant portion of profit generated by that investment (although some is taxed by the state). While production may be private, the system cannot exist without a state powerful enough to make and enforce law. It is not a coincidence that capitalism and the modern state emerged together in Western Europe during the course of the past five hundred years.

Saunders (1995) describes capitalism as a "growth machine" - the necessary set of social relations described above which ensures that those investing and taking risk can be assured they will have ownership of any resulting returns. This motivates a continual search for new products, flowing from new technologies, and new markets. Through such things as insurance and the limited liability company, financial risk is bounded and so further encouraged. At the same time, the production process itself is continually changing, with new, more efficient machines; with new sources of power for those machines (such as electrification in the late 19th c.); and new means of organizing labour, such as the assembly line, which also increase efficiency. Productivity (output from the same inputs) increases and that increase is augmented by population growth, which provides both more labour and more consumer demand.

The growth of capitalism was tied to the growth of the modern state over the past two hundred years. Poggi (1990, 19) defines the state as an "organization" which constitutes: "a body of rules, a series of roles, a body of resources." The basic function of the state is to use coercive force in to provide security (and ensure its continued existence) for its citizens living within a bounded territory - security from both external and internal revolt. Spruyt (2002) argues the modern state emerged in Europe after the Renaissance for three reasons - the greater need for co-ordination of more complex societies; changes in military technology which allowed more effective application of centralized force; and the ever-increasing revenues provided by capitalist production. Recognizing this reliance upon those revenues, the modern state directly involves itself in fostering increased productivity in a way previous rulers (who taxed their peasants but otherwise left them alone) had not done (Christian, 2004). In particular, starting in the 19th c.

state-supported universities started to engage in research in such areas as chemistry, metallurgy and engineering which directly led to new commercial products. In 1945, science organized by the state for military purposes gave us the atomic power to end life on earth.

The current era

Today, this basic trilogy of science/technology-capitalism-state has now spread from Europe and its colonies to the entire world. Since the fall of the Berlin Wall in 1989, capitalism has been triumphant throughout, albeit taking the form of state capitalism in countries like Russia and China. The business corporation is the organization used by investors to generate return on capital and it now operates on a global basis. Similarly, the state is the organization used by societal groups to organize their political-economic affairs with close to two hundred in existence and the drive to create new ones, such as in Scotland, unabated. Market production now takes place on a global scale. Due to the power of the territorially-bounded state, however, governance at the global scale is largely ineffective. Regardless, humanity today has access to physical power from machines and the ability to co-ordinate its use of that power, by both state and firm, on a scale out of all proportion to that which existed two hundred (let alone two hundred thousand) years ago. We are in the Anthropocene, where the scale of global production, driven by continually appearing new technologies and feeding a market of seven billion people, is now fundamentally affecting earth systems. Folke (2013) and other scientists claim humanity has already passed the safety threshold for a number of planetary boundaries.

Solutions to the environmental problem

The preceding section has argued that while there are many inter-related causes of the environmental problem, all of which need to be fully understood as a basis for action, there is also analytical value in a focus upon the basic fact of the physical power to have an impact upon earth systems. Framing the problem as one of human capacity or physical power points to an obvious solution - humans must refrain from using the full capacity which is now available to them. What might lead them to do that? Two things seem most important. The first is human self-interest - humans come to realize the harm they are causing hurts them as well as the nonhuman world and for that reason reduce the harm. An example of such restraint is provided by our history to date with nuclear weapons. Over a period of more than fifty years, since they were first developed in the late 1940s, countries possessing them have refrained from using them, presumably because they recognized the concept of mutually assured destruction - it is possible to inflict grievous harm on one's enemies but, despite efforts to develop ballistic shields, not possible to fully prevent the associated reciprocal harm. In this case, self-interest, so far at least, has led nuclear states to refrain from using their physical capacity. As discussed below, self-interest has also been a dominant factor in the field of environmental protection and has led industrialized countries to significantly reduce their vulnerability to harm from toxic chemicals in air, water and food. Self-interest has not, however, been able to motivate effective action in the case of less immediate but far more dangerous threats such as global climate change and biodiversity loss. The reasons for that, and possible means of addressing that problem are discussed below.

The second factor which might restrain human use of its physical power is moral obligation - values and related norms governing action which dictate restraint not only for

reasons of self-interest but also duty. Here, we have many examples, albeit studded with imperfections, stretching back through human history of moral restraint imposed upon those possessing physical power. These include moral obligations that men not use physical force against women, adults against children and that require the state to only use coercive force against its citizens in legitimate, lawful ways. Similarly, the entire apparatus of law which provides security of the person against injury or theft is intended to restrain physical power. Moral restraint has always been present as well in the field of environment. Early 19th c. laws against cruelty to domestic animals were based in a conviction that humans must not used the full physical power they had available. Such laws preceded health legislation in the latter part of that century which was based in a self-interested desire to reduce the threat of urban air and water pollution. In the first part of the 20th c., this moral obligation was extended from domestic animals to those in the wild. The environmental legislation of the late 1960s and 1970s was intended to provide both a self-interested protection of human health and also a disinterested, morally based, protection of ecosystem health. By the 1980s, this moral obligation was most powerfully expressed in the concept of Deep Ecology. Like self-interest, moral restraint has also to date been far from fully effective, also discussed below.

The limits of self-interest

Human self-interest is limited in its ability to restrain human capacity because environmental problems do not threaten all humans equally and do not take the form of pure public goods in which if protection is provided for one it must at the same time be provided for all. Cities like London, New York and Paris have acted on self-interest to improve their urban air quality but that does not help the current smog problem in Beijing. To protect their health, the Chinese are now acting on that problem but at the same time see no immediate self-interested reason to limit their consumption of ivory products and thus help protect African elephants. As the environmental justice movement points out, within countries like the US and Canada, the rich benefit from better environmental quality than do the poor. On a global scale, the rich, industrialized North has been much more able to protect itself from environmental threats than has the poorer South. The group included in self-interested action is always limited by such things as geographic scale or class.

Beyond this problem, self-interested environmental protection as it currently works only minimally protects the interests of the two other groups, beyond humans currently alive, who are affected by the problem - future humans and nonhumans. Climate change is only one issue which directly threatens the former and while "our grandchildren" or "seven generations" are included in the discourse, it is in terms of moral obligation, not self-interest. By definition, human self-interest is limited to those alive today, and while an adult today certainly has a self-interested concern for the wellbeing of his or her child, that child's future grandchild is simply not included. The adult will be dead by the time that great-grandchild reaches maturity and so has no immediate, self-interested concern for harms the great-grandchild will receive eighty or a hundred years from now. In terms of other species living today, the concept of ecological health certainly frames the problem as a need to protect nature from toxic chemical pollution because that is the only way we can adequately protect human health. But once we move to other environmental issues, particularly biodiversity loss and species extinction from habit destruction, the self-interested motivation declines rapidly, since the direct threat to human well being is that much less. To some extent, enlightened self-interest, what Botzler and Armstrong (1998: 310)

refer to as "weak anthropocentrism" (contrasted with strong anthropocentrism which values the nonhuman only for what it directly contributes to meeting human needs) may lead to a self-interested desire to protect nature: "weak anthropocentrists value nonhuman entities for more than their use in meeting unreflective human needs: They value them for enriching the human experience." I want to know wild caribou still exist, even though I may never see them myself and gain no material benefit from their existence.

The human self-interest which is most likely to be able to bring about a significant decrease in the human impact on earth systems is that of the rich and powerful - those in command of states and firms in the industrialized North. Inevitably their tendency is to put their own interest ahead of that of other humans and, no matter how enlightened their self-interest, to give only limited regard to the interests of future humans and nonhumans. Changing their view of their self-interest to make it even more enlightened is certainly part of the solution. A solution, more likely to be effective, however, is to change the distribution of political, economic and social power between them and these three other sets of actors - humans currently living who suffer more from environmental harms than they do; humans not yet born; and other species. For that, we need a change in the institutions of decision making to give those other actors a larger say. That in turn depends upon a change in the values which place a moral constraint on human capacity.

The limits of moral restraint

As noted, humans have always placed moral restraints on their physical power over other humans, presumably because doing so is essential for the social co-operation which has marked the species since it first emerged. The argument that humans should do the same thing in their dealings with nature is now well established, both in the values of animal rights and Deep Ecology and in institutions such as environmental law. The effect of development proposals upon other species, regardless of their material value for humans, is now regularly taken into account in environmental assessment proceedings. Nevertheless, this has led to only the most minimal constraint on human capacity, as witnessed by the growing problems of climate change and species extinction. There are two reasons for this minimal impact: 1) the relevant values are still very much at the margins; and, 2) while the values have been institutionalized for regulatory approvals of individual projects, they have not been for the decisions made in market and state related to economic growth and associated growth in the human impact.

Originally, animal rights concern was limited to domestic animals. It has expanded to include such things as efforts to disrupt the Canadian seal hunt, but its primary concern is still for animals physically controlled by humans, such as pets or those used in research [need citation]. This has led to a situation in which the populations of domesticated species such as dogs and cats are growing alongside growth in human population - and adding to the environmental impact of humans, as they engage in agriculture to feed their pets and their cats kill more and more songbirds. Efforts to extend that moral concern to wild animals are well established, but to date have little impact on societal decision making. Mainstream environmentalism for the most part makes anthropocentric arguments and unabashedly ecocentric groups like Earth First! have much less influence with decision makers. The dominant paradigm of environmental protection, sustainable development, includes concern for future humans, but is thoroughly anthropocentric.

Not surprisingly, legal expression of those values is limited to environmental regulation. The basic project of virtually all countries in the world is a year-after-year increase in productive capacity and associated per capita wealth. A starting point for human restraint would be a deliberate decision to *not* attempt to grow richer next year, as measured by physical products. Here too, there is a body of ideas advocating exactly that (Victor, 2008). But those ideas are at the margins of economic and political thought and have absolutely no legal expression.

Conclusion

The paper has argued that regardless of the relative importance of the many different causes of the environmental problem, analysis can usefully start with the sum total of those causes - the vast increase in the physical power of humans to influence earth systems. That power rests upon two foundations: 1) technologies which give access to physical power in the form of material energy sources; and, 2) social power, which allows co-ordination of human activity and thus increases the ability of those humans to achieve a given goal. The solution is for humans to refrain from using all of the physical power now available to them and it is argued that must come from some combination of enlightened self-interest on the part of elites and a strengthening of values which place moral limits on use of physical power. It is further argued that the focus must be upon physical power used for production - the goal of economic growth must be replaced by the goal of economic stabilization.

Action to protect environment for both self-interested and moral reasons is now seen as legitimate and necessary and has been institutionalized in law. While having had only minimal effect to date, it is likely to increase if for no other reason than the fact worsening environmental conditions will impose a greater threat to elite self-interest. Hopefully it will also increase due to greater enlightenment and continued extension of moral worth to other species. My argument, however, is that to be more effective more quickly, that action needs to focus on the two central variables of technological physical power and social power. How could that be done?

As noted, technology can act either to increase or decrease the human impact. Generation of electricity by burning coal is an example of the former and by using solar or wind renewable sources is an example of the latter. Obviously, part of the solution is to replace harmful with beneficial technologies. There are limits to how much that can achieve, however, which stem from the fact that technological substitution only increases efficiency. The same human goal is achieved with less use of energy and materials and so with less environmental impact. The Jevons or "rebound" effect dictates that increased efficiency will lower cost of the machine, thus increasing demand and use, which takes away part of the benefit. The other problem is that increased efficiency is also undercut by increased use of the machine due to population growth and increased per capita consumption. Doubling the fuel-efficiency of a motor vehicle does not give a net benefit when the total number of vehicles in use triples.

Beyond technological change to increase efficiency, therefore, two other things are needed. The first is the complete abandonment of some technologies, such as fossil fuels. Nye (2006) argues that there is nothing inevitable about appearance and spread of technologies, and that technology does not completely drive culture but in fact is to a large extent shaped by

culture. In terms of abandonment, he points to the example of Japan which adopted the technology of the gun from Portuguese traders in the 16th century, only to then reject it because the powerful samurai class preferred the sword and bow (Nye, 2006: 17). This is admittedly a rare example and efforts to abandon such things as nuclear-weapons technology have to date not been successful. The horse and buggy is only one item in a long list of technologies which have been abandoned, but that has been because new technologies with greater market appeal have replaced them. To abandon an effective technology, such as coal, regardless of availability of alternatives is a major challenge - but one which must be met. Leaving fossil fuels in the ground means walking away from billions of dollars of potential wealth. Can that be done? To answer that, we need to discuss the second technological challenge - changing the human goals for which technology is used. That in turn requires consideration of the other related issue, social power.

The potential economic value of fossil fuels in the ground is dictated in part by the availability and therefore cost of alternative energy sources, but also by total demand for energy. That in turn is decided by total production. If production stabilizes or is reduced, demand for energy decreases and energy prices fall, reducing the cost of leaving fossil fuels in the ground. However, a reduction of production, referred to as "recession" or, worse yet, "depression" involves enormous social costs, in terms of lost financial value, unemployment and related hardships. Nevertheless, reducing total production is the essential task of refraining from full use of current human capacity to influence earth systems. It must be done, but it can only be achieved by not only technological change but also change in the exercise of social power.

The increased capacity to co-ordinate human activity which emerged ten thousand years ago was only possible because of the appearance of marked inequality of social status and related use of coercive force by the elite. That is still the case today. The firm, like the military, relies upon hierarchy and command because that is most effective. The market co-ordinates labour supply and production by means of economic inequality and associated motivation. The state maintains social control by its monopoly on the use of legitimate coercive force. Since the ascendancy of capitalism and the state in Europe five hundred years ago, the dominant values have been individual liberty, efficiency and economic growth. Equality in some cases, such as before the law or access to health services (and in theory at least, equality of opportunity), is also an established value, as is equity in terms of race or gender relations. Neither equality nor equity in terms of economic status of classes, however, is an established value, even at the level of rhetoric. The gap between rich and poor was reduced in the first part of the twentieth century in the democracies and even more so in communist states. In recent years, however, it has widened and today the wealth inequality gap is a major issue of discussion (including another example of enlightened self-interest - the rich may come to see that their own well-being depends upon social cohesion and so come to voluntarily accept the need to transfer some of their wealth to the poor).

As discussed, what is needed is not only technological change, but also a change in the objectives for which technology is used. A prime example is a move from the current goal of economic growth to the goal of a steady-state economy. That can only be done, however, by an accompanying move from the dominant principles of efficiency and individualism to equity and collectivism. If a steady-state economy means poverty cannot be addressed by the rising tide of

economic growth, then it must be addressed by redistribution of wealth, perhaps in the form of jobs provided by the state (Lawn, 2011) - equity, provided by the one inherently collectivist body in society, the state.

A human decision to forego some portion of the physical productive power now available to it - the ability provided by capitalism to every year, with the same inputs, produce more than was done the year before - would reduce the impact upon earth systems. Presumably that decision would be brought about by a combination of enlightened self-interest and a sense of moral obligation. As such, it would constitute a more equitable relationship between the human and nonhuman worlds. It can only happen, however, if we first move to more equitable relationships among humans themselves.

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