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The Scientific Status of Environmental Accounting Methodologies:  
From Ecological Economics to Human Ecology

Arran Gare

I

The Problem

The quest to develop environmental accounting methodologies is a response to the increasingly obvious failure and demonstrated inability of unconstrained markets to register, let alone generate adequate responses to, the deleterious environmental effects of economic activity, and, correspondingly, the false picture of welfare produced by current national accounts in terms of GNP or GDP deriving from measuring market activity. In particular, it is a challenge to the belief of neo-classical economists in the market mechanism as the best and sufficient means to allocate scarce resources between unlimited wants and to promote the forms of life most conducive to human welfare, and to governments who take growth of GNP as their central goal. Traditional national accounts do not take into account ‘natural capital’, or, more broadly, the ecosystems of which we are part and on which we depend. The goal of environmental accounting is to register environmental effects, and to do so in a way that can lead to appropriate responses to threats to environments and to provide a better guide for promoting human and ecological welfare.

If environmental accounting is a challenge to the free market and its apologists, then it must be acted upon. Ultimately, actions must be responses by economic actors, but different forms of accounting can be oriented towards different kinds of actors. The aim might be to influence individuals in their consumption or investment decisions. Or it might be to guide governments in their regulation and management of markets to use them to make people respond properly to the environment. Or it might be to reduce the scope of the market and to put decision-making and economic planning more in the hands of governments, either local, national or international. Or it might be to mobilize political movements, local, national or international, to challenge and change existing power relations between citizens, economic agents and governments, or between localities, countries and regions. Or it might be some combination of these, for instance first influencing people as individuals, then mobilizing them to challenge and change power relations to achieve greater democracy, and then providing democratic communities with the means for decision-making.

So, to different degrees, proposals for environmental accounting are a challenge not only to the validity and influence of current forms of accounting but to the dominant power of international organizations such as the IMF, the World Bank, the WTO, neo-liberal governments, media moguls and transnational corporations which have set the ultimate goal of societies and humanity as economic growth as defined through the market. It is to oppose economic and political actors living according to the logic of markets (striving to maximize their profits) who do not take into account the conditions for their existence, and it is to oppose the power of neo-classical economists who have
gained enormous influence by legitimating such short-sighted greed. In the view of many environmentalists, the market does not lend itself to being extended to encompass and evaluate these conditions, which include the conditions for the continued existence of civilization and humanity.\(^1\) Apart from the indifference to environmental destruction displayed by big corporations and mainstream economists, one only has to think about the incongruity between the claim by the genuinely concerned economists of the Stern Review that global warming could reduce GDP by 20% or more,\(^2\) and James Lovelock’s prediction that by the end of the century only 200 million people will be left alive, living around the North Pole,\(^3\) to appreciate that there is something deeply problematic in thinking about the world through the categories of the market.

The failure of traditional accounting and economic doctrines supporting it has been exposed above all by scientists. Economics is assumed by economists to be the pre-eminent human science. Mainstream economics has been shown by natural scientists to be based on assumptions and to have drawn conclusions inconsistent with thermodynamics, ecology, earth science and climate science. Its scientific credentials are shaky. But this has left us with a quandary. The comparative welfare or well-being of societies and their progress has come to be measured quantitatively as national income (GNP or GDP) per head of population. Although such national accounts date less than a century and really measure economic activity, not welfare, and originally were not developed to measure welfare, they have become so deeply embedded in people’s thinking, particularly in the thinking of governments, that not even the threat of the destruction of most of humanity has shaken people’s belief that these are the objective criteria for measuring welfare, and that nothing must be permitted to stand in the way of economic growth measured through these accounts. To overcome such beliefs it would appear necessary to provide alternative forms of accounting that will provide people and governments with different estimations of well-being, not only of people, but of the ecosystems of which they are part. Those who have exposed the flawed thinking of the economists, if they are to challenge them effectively, must either emulate the economists’ predilection for claiming to provide quantitative measurements of welfare and provide alternative measurements, or strive to overcome this penchant for quantitative measures of welfare and provide some means to validate qualitative judgements. It is in this context that the epistemological status of environmental accounting methodologies must be judged.

This leads us to the basic question being: If current economic accounting has been shown to be fundamentally flawed and alternative accounting is required to replace it, can accounting methodologies be developed which are genuinely scientific? This leads to the question, What does ‘scientific’ mean in such a context? In the heyday of the logical positivists, answering this question might have appeared straightforward. Logical positivists had set out to characterize what is genuine scientific knowledge by showing

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how it is acquired and verified through experience (specifically experience of what can be measured and thereby quantified) and logic (to which it was believed mathematics is ultimately reducible). They strove to provide criteria formulated in abstraction from science by which claims to knowledge could be judged and deemed genuine science, or discarded. Such views remain influential among the general public, in the human sciences and even in the natural sciences, and to a considerable extent account for the triumph of neo-classical economics and its current dominant ideological position. However, logical positivism was demolished by philosophers of science. This demolition vindicated what can best be called ‘dialectical’ understanding of knowledge and science according to which characterizations of knowledge can only be defended in the context of the struggles between rival claims to knowledge.

II

From Logical Positivism to Dialectics

If knowledge cannot be specified independently of the struggle for knowledge, how is a view of scientific knowledge as dialectical to be described? In what follows I will assume the achievements of climate science as described in Spencer Weart’s history of the discovery of global warming as a model of genuine science, and correspondingly, that levels of greenhouse gases, measures of global temperature and measures of greenhouse gas emissions as developed by climate scientists to be valid environmental indicators. This should be borne in mind in this account of dialectical epistemology.

With this in mind, what does it mean then to claim that it is only through dialectics that we can understand science and claims to scientific knowledge? Dialectic originally meant for the Ancient Greeks the argumentative use of language, but soon came to mean the art of constructing explanatory theories and the critical discussion of these theories. In claiming the demolition of logical positivism vindicated the tradition of dialectics (a demolition that had begun within the logical positivist movement by Otto Neurath) I do not mean by this that the opponents of logical positivism identified themselves with the tradition of dialectical thought (although a number of historians and philosophers of science drew upon or began to examine and sometimes explicitly align themselves with dialectics), and I have no wish to identify the tradition of dialectical thinking with any

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7 See Imre Lakatos, Proofs and Refutations, Cambridge: Cambridge University Press, 1981, esp. p.125n1 and p.139n1 where Lakatos’ alignment with dialectics is most clear. Karl Popper considered dialectics as a
particular thinker or political movement. What I mean is that there is a tradition of thought originating with the Pre-Socratic philosophers, Socrates and Plato but greatly enriched by later thinkers the insights of which were rediscovered by the critics of logical positivism, and that appreciating these critics as continuing the tradition of dialectical thought enables their work to be augmented by this tradition. Understanding the achievements of the tradition of dialectical thought makes it possible to overcome what have become the sterile debates between constructivists and realists, relativists and objectivists. So, to evaluate the scientific status of the new accounting methodologies, it is necessary to have some understanding of dialectical epistemology. What does it mean then to embrace a dialectical epistemology?

Central to the tradition of dialectics is acceptance that there are no absolute starting points or foundations for knowledge, no conclusions which are beyond further questioning. The characterization of knowledge can only emerge through competing claims to knowledge in which prevailing assumptions about what is knowledge have been challenged by proposing alternatives. It also involves appreciating that current arguments, including arguments over what is knowledge, take place in the context of traditions of thought and inquiry formed by a history of questioning, investigating, discussing and arguing. To participate in these traditions requires an appreciation of their past achievements and failures, what tradition or traditions are dominant in the present, and why they are dominant.

For dialecticians, inquiry is not seen as a patchwork of empirical investigations that can be later collected together and systematically organized into a coherent logical structure for convenience. Dialecticians assume a commitment to an integral, coherent comprehension of the whole in a much more fundamental way than positivists, and make this commitment explicit, even if they acknowledge that it might be unrealizable. This commitment is, as Alfred North Whitehead wrote, 'the great preservative of rationalistic sanity.' And they assume this commitment in every tradition of enquiry. Any investigation is always seen against the background of the quest to comprehend the totality of which that which is focused upon is a part, and involves a backwards and forwards movement between parts and whole or wholes at different levels, while striving to both characterize the generic features of all that exists while doing justice to the uniqueness of every individual. Ultimately, this means attempting to grasp each


9 See Richard J. Bernstein, Beyond Objectivism and Relativism, Philadelphia: University of Pennsylvania Press, 1983. Bernstein does not use the term dialectics but this is what he is defending.

10 Process and Reality p.6.

particular in the context of the whole of being. In this quest dialecticians are committed to pushing their enquiries to the limit, drawing out all implications of their conception of the world to their logical conclusions and interpreting everything possible in terms of this conception. For this reason, they are particularly concerned with anything contradicting any tentative grasp of the whole, whether these are feelings, experiences, signs, observations, records of observations or different claims to knowledge by others. Unlike the logical positivists who claimed for science and scientists a unique claim to genuine knowledge, dialecticians promote engagement with diverse points of view, within traditions and between traditions, between disciplines within the sciences and with the humanities and the arts, between specialized discourses and practical wisdom, and between people of different cultures. The most valuable inquiries are those focused on areas where contradictions have become apparent, and successes in reconciling or overcoming such contradictions are identified as the most important achievements of inquiry. As opposed to the logical positivists whose conception of knowledge growth through theory reduction led to an implicit commitment to ontological reductionism and thereby a dismissal of the humanities and disdain for practical wisdom, the commitment to comprehensiveness by dialecticians involves an implicit commitment to developing a non-reductionist ontology which makes intelligible the emergence of awareness, consciousness and science itself, and thereby allies science with the humanities.

Recognizing this involves accepting other dimensions to inquiry to which positivistic thought was blind. Participation involves at least a provisional acceptance of a range of assumptions within which disputes take place which are often quite difficult to appreciate as such. A major part of enquiry involves revealing and then questioning these assumptions, making it possible to develop radically different ways of thinking which break sharply with such assumptions. Science does not advance in a straight line. That is, there is a critical and a creative dimension to enquiry to which positivists were oblivious. Revealing taken for granted assumptions is one of the most important and difficult tasks of enquiry. Being able to do this within science generally requires an historical and philosophical perspective on the development of knowledge and some understanding of opposing traditions and different domains of enquiry. The historically ignorant, ultra-specialist is not only an enemy of dialectical thought; in the long run he or she is likely to be an obstacle to the advance of science. Creative thought, or what C.S. Peirce called abduction, requires imagination and is generally associated with the deployment and elaboration of new metaphors, conceptual frameworks and models, ranging from simplified idealizations to fully elaborated models designed to make accurate predictions. It also involves developing new techniques and instruments of observation and interpreting observations. Bringing to light and questioning assumptions and developing radically new ways of thinking is particularly important when a field of enquiry appears to be dominated by the opposition between two sets of incompatible ideas. Often, overcoming such deadlocks involves revealing that both sides in such oppositions share the same assumptions. It is often possible to overcome such oppositions by rejecting these assumptions and positing a new starting point which bypasses the deadlock.

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While positivists, tacitly assuming a Cartesian split between the knowing mind and the world, assumed that the known is causally unrelated to knowledge of it (except in the obvious sense that there must be some kind of correspondence between knowledge and what is known), ‘dialecticians’ see themselves in advancing their understanding of the world as to some extent participating in creating reality, including themselves as participants in the world. New ways of thinking do not merely represent reality, they open the potential and provide an impetus to realizing this potential to change the relationships between people and between humans and nature, thereby changing people and changing nature.

That there are no absolute starting points, that science can only be understood as developing traditions of enquiry and that these traditions are driven by a quest to achieve a comprehensive understanding of the totality of existence, and that this involves openness to diverse perspectives, revealing and questioning the assumptions of these traditions and developing radically new ways of thinking to overcome contradictions, is all clearly revealed in Weart’s study of global warming. So also is the role of ideas in creating the future. If there was a starting point to the discovery of global warming, it was not absolute and it did not concern global warming but the discovery of apparently inexplicable scratches on rocks inconsistent with prior assumptions about the earth, but intelligible if these assumptions were questioned. This led to the conjecture that these scratches were caused by glaciation in the distant past when the earth’s climate was radically different than it now is. This presented a challenge to mainstream science to account for such radical changes in climate, leading to more fundamental questions about why the earth was at its current temperature. In the early nineteenth century the physicist Joseph Fourier, drawing upon and developing recent advances in physics and upholding its commitment to explain everything, asked What determines the average temperature of the earth? This led to the further question, Why didn’t the earth continue absorbing the sun’s energy until was as hot as the sun?

Fourier explained this by showing that the earth emitted heat through an invisible radiation, but through careful calculations showed that the earth should be much cooler than it is. Later in the century John Tyndall, concerned with this problem, conjectured that the opaqueness of gases might account for the higher temperature. He conducted experiments on gases and discovered that coal gas (methane) and carbon dioxide are opaque to infrared radiation and so could function like the glass of greenhouses. All this speculation was concerned with accounting for an Ancient Ice Age. But this opened the possibility that the burning of fossil fuels could change the climate. This hypothesis was suggested by Svante Arrhenius in 1896, who realized that the effect of CO₂ would be amplified by increasing the amount of water vapour in the atmosphere, itself a potent greenhouse gas, and contested, leading to a series of intense debates and tenacious efforts by proponents of different sides to prove their point, with some of the most important figures being amateurs (notably Guy Stewart Callendar) dissatisfied with the conclusions of received science. In the second half of the twentieth century extraordinary careful observations were made using and developing techniques for dating such as carbon

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dating (developed elsewhere for different purposes) and measuring past concentrations of CO₂ and estimating temperatures using the mix of species of fossil shells from ocean floor sediments and the ratio of oxygen isotopes (O-18 and O-16 in these shells and trapped in ice core samples more than a kilometer long from Greenland and Antarctica). In this way, scientists were able to map the relationship between CO₂ and temperature over hundreds of thousands of years, involving the work of scientists and research teams from diverse disciplines. One of the important features of such measuring techniques is that they were only accepted as reliable when correlations, such as the ratio of isotopes of oxygen and temperature, could be explained.

Along with this work, scientists such as the geochemist Vladimir Vernadsky, began treating the atmosphere, hydrosphere, geosphere and ecosphere as a complex of interrelated systems. This opened the way for questions about the kinds of stability and instability in their dynamics, with Mikhail Budyko in 1968 constructing a model with a highly simplified set of equations revealing the possibility of slight changes resulting in radical changes from one regime to another. More recently, using computers and ideas from complexity theory, far more complex models have been developed and tested against past records of climate change. These confirm dire predictions about the future.

Reflecting on the work which led to these insights, Weart wrote:

A scientist publishes a paper with an idea or observation, other scientists usually look upon it with justifiable suspicion. Many papers, perhaps most of them, harbor misconceptions or plain errors. After all, research (by definition) operates past the edge of the known. People are peering through fog at a faint shape, never seen before. Every sighting must be checked and confirmed. Scientists find confirmation of an idea all the more convincing when it comes in from the side, using some entirely different type of observation or line of thought. … Scientists may start with something they learned about the smoke from volcanoes, put it alongside telescopic observations of Venus, notice the chemistry of smog in Los Angeles, and plug it all into a computer calculation about clouds. You cannot point to a single observation or model that convinced everyone about anything. … Everyone is moving in different directions, and it takes a while to see the overall trend.14

However, there was something more involved. Climatology is part of and has contributed to a broader development in science questioning and rejecting traditional assumptions that effects in nature are directly proportional to their causes. This in turn was part of an even bigger shift in science, abandoning the mechanistic world-view and seeing it as consisting of self-organizing processes. This has enabled us to see, as Lovelock suggested, that the Earth is a living organism that evolves to create the best conditions for life by removing species that foul their own nests. Understood dialectically, the global ecological crisis as defined through post-mechanistic science, the greatest failure of the market, as Sir Nicholas Stern of the Stern Review noted, is highlighting not only the failure of the market, but the contradiction between mainstream economics and advanced

science (perhaps most clearly manifest in the propensity for economists to discount future income, on the assumption that unlimited economic growth is possible), and along with this, the failure of the categories by which economists have defined reality and the failure of the forms of existence constituted by these categories. Appreciating and overcoming this contradiction calls for a replacement of these categories, not only as a means to define our situation in the world more adequately, but as a means to reconstitute our relations to each other, to society and to nature. This is effectively what climatologists and scientists like Lovelock are calling for.

Once the importance of conflict in the development of ideas is recognized, particularly conflict involving questioning deep assumptions and proposing radically different ways of thinking, including upholding different ideas about what is knowledge, it soon becomes apparent that the development of ideas involve power struggles between the different proponents of these ideas. This is not simply a matter of people convincing others to accept a particular set of ideas or to adopt a particular research program. Power struggles occur in institutional contexts over the means to develop ideas, carry out research and disseminate ideas, arguments and the results of such research. Particularly important is the struggle over who will occupy positions within institutions, but there are also struggles between institutions. Institutions here can be academies or universities, but they can also be departments of these, established disciplines or journals, or non-academic institutions or communities with their own claims to having knowledge. Ultimately, these are struggles over the power to define reality; but the power to define reality is also part of the means for achieving such power within and by institutions. Such struggles affect the standing of institutions in the broader social and political order and are inseparable from broader power struggles between social classes and political organizations. Ultimately, they are struggles over how society is to be organized and how people are to live. All this has become dramatically evident with the development of climate science, with scientists coming under attack, losing funding and sometimes losing their careers and livelihoods because their research has revealed the untenability of the existing economic, social and political order.

Central to power struggles and their institutional contexts is the concept of science itself. The concept of science is highly contested not simply because of problems in characterizing what is knowledge or what scientists do, but because the claim to be able to define science is a claim to be able to adjudicate on what beliefs should be taken seriously and who should command respect as scientists. While positivists tended to uphold ‘scientism’, the view that science transcended all other forms of knowledge, dialecticians deny such self-sufficiency and acknowledges not only claims to knowledge by the humanities, of people in everyday life and by people in different cultures, but the need for dialogue between diverse claimants to knowledge to reveal limitations in prevailing ways of thinking and to develop new ways of thinking. In response to the imposition of oppressive ideas as ‘scientific’, science as such can be criticized for its pretensions to having privileged access to truth and alternative kinds of knowledge defended.15 From the point of view of dialectics, however, it is more rational and more effective to question the claim of such knowledge to be scientific by upholding openness to questioning from diverse points of view as the defining feature of genuine science.

15 This path was taken by Paul Feyerabend and Bruno Latour.
Recognizing this relation between power, knowledge and the definition of science led some theorists of science to view claims to scientific knowledge as relative to or effects of institutionally supported discourses.\(^{16}\) This was another strategy to weaken the power of such claims. Dialectics offers a different path. Dialecticians have not only recognized the close relation between power, knowledge and science, but extended the notion of rationality to the concepts embodied in institutions and the social order within which such power struggles take place. There is a dialectic between scientific inquiry, institutions and the broader society. That is, it is recognized by dialecticians that questioning prevailing assumptions within science is not merely questioning a set of ideas or ways of thinking, but also the social practices, institutions, institutional structures and power relations which have led to the development and adoption and imposition of such ideas and ways of thinking.\(^ {17}\) The critique of assumptions in science can imply a critique of the social practices entailed by claims to knowledge and, more fundamentally, the role of institutions in society which uphold or impose such practices. It can be a challenge to those who have power not only among researchers, but also to the broader power structures of society. Dialecticians, therefore, are committed to upholding the autonomy of scientific inquiry from external control, and to defending the standing of institutions which support such autonomy and the conditions for this as a condition for questioning the institutions and practices of the broader society, and to developing a conception of the world which makes sense of this commitment.

Dialectics leads to and requires reflexivity. It requires of those engaged in scientific inquiry an appreciation that they are participating in creating reality and, almost inevitably as consequence of this, are participating in power struggles. To avoid distortions in thinking it is necessary for them to recognize that their claims to advance knowledge are simultaneously claims to power. While having the power to define reality, particularly social reality, is the most important aspect of this, it is also necessary to understand the relationship between the kinds of knowledge produced, who will use this knowledge and how. Positivists frequently claimed to be providing value-free knowledge whereas, as the Frankfurt Institute philosophers pointed out, they were providing knowledge to those with power in a form which involved treating people as things to be made predictable and controlled.\(^ {18}\) Despite their protestations, positivists have been deeply committed to reducing people and nature to mere instruments. Dialectics is and needs to be explicitly evaluative, constantly concerned to characterize what ought to be through defining what is, and defining what is through defining what ought to be. Generally, dialectics implies a commitment to developing people’s self-understanding and understanding of the world so that they can become self-determining while mutually recognizing each other as self-determining co-participants in the creation of reality. At the same time, this inevitably involves upholding a more exalted conception of the natural world.

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16 That is, Michel Foucault and his followers.
Putting competing claims to knowledge in perspective in relation to each other, allowing them to be judged and then enabling people to reorient themselves and to live differently, to incorporate new categories into their practices, is achieved through stories or narratives. Narratives, utilizing non-mathematical concepts, provide the broader frameworks which then evaluate and show how to deploy arithromorphic and mathematical concepts, quantitative measurements and mathematical models. The need to appreciate non-mathematical concepts is particularly important when it comes to ecological economics and human ecology, since non-reductionist ontologies which give a place to real emergence, required of a human ecology able to acknowledge both the reality of humans as cultural beings and the dynamics of the global ecosystem. This, as Stuart Kauffman pointed out, implies the impossibility of totally grasping the dynamics of such systems through mathematical models – which generally pre-state a configuration space, including the initial and boundary conditions, to map out what possibilities could be realized in the future, thereby denying the possibility of real creativity. Thus narrative comprehension is more primordial than and the condition for scientific and mathematical reasoning, and for integrating the advances in science with the rest of culture. The narrative offered by Weart and other historians of the environment are important both for the constitution of science as a developing tradition and for re-orienting the general population to live according to a different conception of the world than that which has prevailed hitherto.

Before going on to consider environmental accounting, it should be evident from this account of dialectical epistemology that the recent preoccupation with quantitative indices to the exclusion of qualitative judgements is based on the illusion, at least in part deriving from logical positivism, that we can substitute measurement and the quest for simple correlations between measured quantities for understanding. It is connected also to reductionism, which, as R.H. Bradbury put it, seeks ‘to reduce, to collapse, the dimensionality of some description of a complex system … to make one-dimensional models of systems with hundreds of thousands of dimensions which yet retain some explanatory power.’ As Bradbury wrote of such efforts, ‘Like throwing shadow rabbits on a wall, they can never capture reality. They remain caricatures.’ Indices which are valuable are based on a deep understanding of the nature of reality, as for instance the measures of greenhouse gases as indices of the threat of a global ecological catastrophe are based on the theories of the geo-chemists, oceanographers, meteorologists, ecologists and a host of other disciplines drawn upon and integrated by climate scientists, showing a real relationship between these indices and what they indicate.

III

Evaluating Environmental Accounting: From Ecological Economics to Human Ecology

With all this in mind, what can we say about the new environmental accounting? To begin with, to understand the task of such accounting it is necessary to appreciate the present situation where accounting based on market exchanges supported by neo-classical economics has become the prevailing discourse not only about economics, but about politics and ethics. As I suggested in the introduction, environmental accounting even in its least radical forms is a challenge to the ideological domination of mainstream neo-classical economists, but also to those whose power and practices are legitimated by them. It is also in varying degrees a challenge to theories of knowledge and implicit assumptions about reality presupposed by neo-classical economists. For a challenge to be successful it has to replace what it challenges. In this case, it is not just a matter of showing that there are better accounting methodologies than those now used. It is necessary to provide accounting methodologies to people who can prevail over those who now define all that is good solely through the free market. To some extent, what is required are the development of forms of thinking by which people most affected and most concerned by resource shortages and ecological destruction can see through the mystifications of prevailing ideas and unite in opposition to their proponents, forming a viable social, economic and political order able to act on the basis of the different accounting procedures on offer.

What we see in the present is the revelation of a contradiction in the assumptions of neo-classical economics, the most powerful ideological force in the modern world on one side, and advanced natural sciences on the other. But the claim of mainstream economics to special status as superior to other human sciences has for the most part been based on borrowing from and modeling itself on physics and mechanistic forms of biology, along with theories of knowledge based on the physical sciences. Neo-classical economics, which began by appropriating mathematics from nineteenth century physics, continues to model itself on the image of physics developed by the logical positivists, despite this having been demolished by philosophers of science. In fact economists’ pre-occupation with mathematical models and their deployment of these models in inappropriate contexts, caricatures physics rather than emulating it. Neo-classical economists treat subjective preferences rendered commensurate through being expressed in market behaviour as measures of ‘utility’, equating this vague concept with the theoretically elaborated qualitatively uniform and therefore legitimately commensurable ‘energy’ of nineteenth century physics. However, the most serious failing of economics as a supposed science has been to assume dogmatically a conception of humans and of

nature that had been rendered obsolete both by empirical studies of how people actually behave and by advances in the natural sciences which have abandoned the reductionist materialism assumed in the economist’s conception of nature and human nature. In fact, initially conceived of as inert and indefinitely re-arrangeable, implying the possibility of indefinite economic growth, became almost invisible in neo-classical economists, which is what led them to believe that the economy could dematerialize and largely do without nature. Being totally undialectical, impervious to devastating criticisms from within neo-classical economics, let alone rival schools of economic thought, oblivious to the challenge of other disciplines, including challenges from the natural sciences, and lacking historical knowledge even of economic thought, mainstream economics of the textbooks (or, rather ‘billabong economics’ – a stagnant pond rather than a stream), that is, the ideas at the core of neo-liberalism, is more akin to dogmatic theology than science. Although such accounting can be valuable if it is treated only as a means of measuring output sold in the marketplace, little credence can be given to accounting which purports to measure present or predict future wealth or welfare based on these assumptions.

Given the dominance of neo-classical economic thought, the approach most likely to get a hearing is the least radical, the effort to extend neo-classical economics by working out how to ‘internalize externalities’, that is, to evaluate and measure the ‘costs’ of economic activity not normally borne by economic actors so that regulations, taxes or new markets can be put in place to make economic actors pay these costs. Such costs are usually, but not always measured by surveying people to find their ‘willingness to pay’ for environmental services. The most influential proponent of this form of environmental economics has been David Pearce. Such an approach works with almost all the assumptions of neo-classical economics and before Pearce published his major works had been widely criticized, I will not consider it further.

Ecological economists, such as Nicholas Georgescu-Roegen and Herman Daly, have mounted major critiques of mainstream economics and striven to make economics consistent with modern rather than early nineteenth century science. Their ideas are developed dialectically and as such have far better claim to being genuinely scientific. Daly proposed developing economics as a life-science, using Leontief’s input-output model of the economy, to unite economics and ecology to construe the economy as a

subsystem of a broader ecosystem. On this basis Daly, along with John Cobb Jr. and Clifford Cobb, taking Hicks’ characterization of income as ‘the maximum amount that can be produced and consumed in present without compromising the ability to produce and consume the same amount in the future’, has proposed accounting procedures to measure real economic development, the Index of Sustainable Economic Welfare, later characterized by Clifford Cobb as the Genuine Progress Indicator. The goal of this is to offer a better measure sustainable development understood as improvement of the quality of life while using resources at a rate which does not exceed the regenerative and waste assimilative capacity of the environment. It involves adding the value of such things as the services of household and voluntary labor and the services provided by streets and highways, while deducting the value of such things as defensive expenditures, costs of environmental pollution and costs of depletion of non-renewable resources not offset by investment in natural, physical and human capital.

While this has been valuable in exposing the illusions of mainstream economics, is it really consistent with the natural sciences? Accounting developed with money and the monetary economy, and it was Keynesians who developed national accounts in order to reveal how to control aggregate demand. It was neo-classical economists who took over this accounting and identified GDP per head with human welfare. In this way, the growth of the market, and with it, the growth of corporate welfare, which for the Keynesians was only of interest as a means for maintaining full employment, was effectively identified with the progress of welfare and more broadly, of humanity. The response of Daly and his colleagues is to show that such accounting is not an accurate measure of human welfare and the progress of humanity by supplementing it with more adequate accounting which takes into account physical stocks and flows within ecological systems, thereby recognizing the importance of ‘natural’ capital as well as produced capital. This involves extending a form of thinking deriving from economics and monetary exchanges to the physical and biological world. While such a development can be defended on the basis of the success of the economics metaphor in ecological research, quantitative accounting to measure global well-being can obscure the complexity and qualitative diversity in nature and society, while obscuring qualitative goals of humanity. The accounting used is more objective than the environmental economists ‘willingness to pay’ method, distinguishing between expenditures for goods and expenditures that are really costs (such as traveling to work, repairing damages etc.) and then estimating the costs of returning the environment to its original condition before its exploitation. However, there are almost insurmountable difficulties in judging costs of destruction and what would be required to repair the (possibly irreparable) damage caused by major environmental disturbances such as global warming from CO₂ emissions, loss of soil in agriculture, or

the destruction of forests or ocean ecosystems, and such difficulties then contaminate the final estimate of GPI. Then there is the problem of placing a value on maintaining or recreating species diversity or the preservation of unique ecosystems or ways of life. Finally there are human ends which cannot be valued in monetary terms without debasing them, such as love, liberty and life. Acknowledging the reality of qualitative diversity, of real emergence and the possibility of collapse of ecosystems and death, which are more fully recognized in the ‘population-community’ tradition of ecology than the ‘process-functional’ approach on which Daly draws, brings into question the economists’ predilection for global accounting in which true qualitative diversity is denied and qualitative differences are claimed to be strongly commensurable. More fundamentally, it brings into question categories deriving from the market, such as ‘capital’. ‘Capital’, as the Cambridge economists Piero Sraffa and Joan Robinson showed, cannot be measured independently of distribution and prices. It is a very problematic concept in standard economics. It is an extremely problematic concept when extended to the whole of nature, which would involve estimating the value of the processes which maintain the air we breathe and the climate within which humans can survive. Rather than developing a more encompassing form of accounting, it is possible that what should be brought into question is the extension of global quantitative accounting to judging the welfare of nations and humanity. In fact the originators of this form of accounting, who are strongly influenced by Alfred North Whitehead and his warnings against abstractions being taken for concrete reality (the fallacy of misplaced concreteness), are aware of these problems and do not want the Genuine Progress Indicator to be taken too seriously as a measure of welfare.

Energy and Material Flow Accounting leave behind monetary measures and are more focused. They do not purport to define the ends of humanity. Their value has been demonstrated in revealing the nature of global exploitation of energy, minerals and food and for identifying wastefulness in the use of these. Energy flow accounting is based on a central scientific concept. This accounting has been illuminating in a number of ways. To begin with, it has been important as a means to identify where efficiencies in the use of energy might be made. Revealing the energy costs of ‘producing energy’ has also exposed many of the illusions of those who place their faith in new technologies to solve environmental problems, including the belief that biofuels could replace fossil hydrocarbons. And the study of energy flows has also provided insight into the nature of power as the control of the triggers which release the transformations of energy and through this, the global system of domination and destructive exploitation of peripheries

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in the world economy. Material flow accounting has provided a more detailed analysis of this exploitation, revealing how starvation in peripheral countries is due to their devoting their farming land to cash crops and exporting high quality food to the core zones of the world economy. But some of the same criticisms that have been leveled against environmentalist national accounts can be made against this form of accounting. While energy and material flow accounting can offer general guidelines for judging efficiency (such as Energy Return on Input or Material Input per Unit Service) and for identifying where efficiencies can be made, they can also be misleading because they ignore qualitative diversity, the complexity of interactions involving multiple symbiotic relations, and the emergence and fragility of patterns of interaction both between people and within ecosystems.

As with national accounts, they can lead to the part being taken for the whole, and to taking abstractions as real without recognizing the level of abstraction involved. For such reasons, as with many efforts to achieve efficiency based on quantitative measurement, the results can be counter-productive, especially in the long run, because the complex inter-dependencies of particular situations are ignored. The misidentification of abstractions with reality largely accounts for the failure of command economies, and also for some disastrous failures to manage particular ecosystems. As John Peet argued, ‘if we want to control a complex system (such as a society), design and operation of the controls must fully reflect the system’s complexity.’ More fundamentally, such accounting assumes a perspective outside an essentially passive nature, as though humans were not part of nature and materials and energy are simply existents, waiting to be used by people. The defective nature of this can be clarified by considering energy, a core scientific concept. Firstly, if anything, it is not energy that is used, but, negentropy or exergy. But quite apart from the abstract nature of this concept, obscuring the diversity of ‘useable’ forms of energy – oil, coal, food etc. we do not so much ‘use’ negentropy but are the process by which entropy is being generated as one form of energy is being transformed into another, for instance, in presenting a paper at a conference.

Ecological Footprint accounting has also been very useful for exposing the illusions of mainstream economists and avoids some of the problems with other forms of

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44 On the difficulties with efficiency indicators, see Nigel Jollands, ‘Getting the most out of eco-efficiency indicators for policy’, Sustainable Development Indicators in Ecological Economics, Ch.15.


47 John Peet, ‘Sustainable Development Indicators and Human Needs’, Sustainable Development Indicators in Ecological Economics, p.405.
environmental accounting. It is an attempt to measure the ‘load’ imposed by a given population on nature, representing ‘the land area necessary to sustain current levels of resource consumption and waste discharge by that population.’ Such accounting has been important in revealing not only that individuals and countries have been living at the expense of others, but how humanity is now living beyond its means at the expense of future generations. Ecological Footprint accounting makes no attempt to integrate economics and ecology and offers a measure of unsustainability in purely ecological terms. This makes it less problematic as a scientific measurement than the Genuine Progress Indicator while still offering a single figure for any individual, group, nation or humanity to indicate their viability. It can be used to evaluate individuals, local communities, nation states and humanity, and it can orient people action at every level. Efforts have been made to show how this indicator can be used as a policy guide. While this is the basis of its impact, it still does not take into account the complexities of the inter-relationships between components and the nature of the relationship between people and specific ecosystems. Ecological Footprint counts the renewable, living, resources only. It comprises a calculation of the area theoretically needed for the sequestration of carbon emissions, but no amount of surface can sequester the fossil carbon that we have burned in last three centuries but took two hundred million years to accumulate in totally different environmental conditions. It does not take into account loss of soil on the grounds that this would be too difficult to calculate. And it still fails to account for all other non-renewable resources we are depleting at ever higher speeds, including soils, and does not take into account what levels of stress can be sustained by ecosystems.

William Rees and Mathis Wackernagel, the originators of this Ecological Footprint measures acknowledged this. Rees wrote in a private correspondence:

Part of the reason we do not account for the unsustainable use of nature is the sheer labour intensity of determining erosion and depletion rates of areas in question. The question does arise, however, of how would one use the data were they available? Suppose soil degradation were 30 times the rate of renewal (probably close to the world average). If we inflated the arable land component of the eco-footprint reflect such information per capita eco-footprints would be numbingly large—would anyone would take them seriously?

And again, it still tends to portray humans as interlopers in the world rather than part of nature, although to a lesser extent than other forms of environmental accounting.

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50 On this, see David Rapport and Ola Ullsten, ‘Managing for sustainability: ecological footprints, ecosystem health and the Forest Capital Index’, *Sustainable Development Indicators in Ecological Economics*, Ch.13.
51 Wackernagel, 2006, ibid., p.258.
52 Quoted by Michael Dittmar on 25 May, 2009 as part of an ongoing e-mail exchange between a group, including Bill Rees, committed to solving the problem of global ecological destruction.
The least problematic environmental indicators are those associated with diagnosing the health of specific ecosystems, whether global or local. Here what are taken as indicators are theoretically grounded so that it is intelligible why indicators can function as such. The measures of greenhouse gases and global temperature and the correlation between these, taken as indicators of the disaster that will result from failure to radically change the way people live, and the development of accounting procedures to identify the source and quantity of greenhouse gas emissions, is a clear case of scientifically sound environmental indicators that can and have informed the general public and which can form the basis of policy making.\(^{53}\) Here we are dealing with the diagnosis of the health of a specific ecosystem, the bio-geo-hydro-atmospheric regime which has prevailed on earth for the last 10,000 years. Indicators are related to the growing comprehension of the nature and dynamics of this ecosystem. Another case, this time local, is that of cod fisheries. Both local fisherman and scientists were aware of the catastrophic declines in codfish numbers around Newfoundland which, if the public had been notified, could have mobilized action to protect these fish before they had been almost wiped out.\(^{54}\) While there might be some disagreements over exactly how to estimate numbers and how to relate these to over-fishing, this is clearly a case where scientific research did provide indicators that could have been used by the general public to pressure government officials to put in place the appropriate regulations to sustain this ecosystem. However, scientists were silenced by threats of dismissal. In Iceland, by contrast, where such indicators were identified and acted upon with fisherman and scientists collaborating with each other, a sustainable fisheries industry has been maintained.

However, such approaches focus only on the dynamics of nature, still treating humanity as exogenous. They fail to recognize the place of humanity within nature and identify the real dynamics of environmental destruction. To overcome the contradiction between neo-classical economics and the sciences there is a need to move not only from ecological economics to ecology, but from ecology to human ecology, to extend the natural sciences to encompass and evaluate economic processes.\(^{55}\) Rather than viewing the human impact on nature as a matter of degree, it should be recognized that humans are part of the global ecosystem having co-evolved within it, sometimes augmenting life, and on others, participating destructively in the ecosystems of which they were part, including the global ecosystem. The question should then be, What are the causes of destructive participation and How can humans participate creatively in their ecosystems.

From Market Manipulation to the Struggle for Liberty and Democracy

To understand the root cause of environmental destruction a good place to start is with the work of the eminent ecological historian William McNeill. After having investigated the role of diseases in history, which he characterized as ‘microparasitism’, McNeill


\(^{55}\) This conclusion has been reached within ecological economics by Richard Norgaard. See R.B. Norgaard, *Development Betrayed. The End of Progress and a Coevolutionary Revisioning of the Future*, New York: Routledge, 1994.
turned his attention to ‘macroparasitism’, where some people exploit others.\textsuperscript{56} Macroparasitism is associated with the creation and development of social forms based upon such exploitation which enable the exploiters to make demands on the exploited while avoiding the effects of environmental destruction engendered by their demands, at least in the short term. The outcome can be increasingly intense conflicts as macroparasites struggle to subjugate more people, augment their power over these people, fight over the spoils of macroparasitism and defend themselves against other macroparasites. Such developments almost inevitably result in shortages as reserves are exhausted and resources are damaged, which macroparasites are likely to respond to by increasing their exploitatation of subjugated people, who are then forced into increasingly destructive exploitation of their environments to survive. This appears to be the dynamic which in the past led to a number of collapses, including the collapse of Mayan civilization.\textsuperscript{57} However, such collapses were local. What we now see is a similar dynamic taking place on a global scale. With the disembedding of markets from communities and the subjection of communities to the laws of the market, the market, manipulated by its dominant actors, has enslaved workers and nations, reduced political institutions to its instruments, engendered imperialism and extended itself around the globe, facilitating the most extensive and intensive macroparasitism in history. An extra dimension was added to the environmental destructiveness of this system through the use of hydrocarbons which, as Richard Norgaard observed, ‘have driven a wedge between cultural evolution and the biosphere’.\textsuperscript{58} And as Alf Hornberg has noted, this defective culture has penetrated almost every society around the globe through what appears to be the inexorable advance of machines.\textsuperscript{59} Macroparasitism has driven this wedge between culture and the biosphere, and it has used the machine to drive this wedge.

The most environmentally damaging form of macroparasitism occurs when macroparasites from outside the locality form an alliance with local macroparasites to intensify their parasitism. We now have a world order based on such relations, resulting in the exponential growth of populations among those whose community structures and economic security have been undermined, the hyperbolic growth in the use of materials and the generation of pollution, and the destruction of entire ecosystems. As Stephen Bunker characterized the modern world system:

\begin{quote}
The flow of energy from extractive to productive economies reduces the complexity and power of the first and increases complexity and power in the second. The actions and characteristics of modern states and their complex and costly bureaucracies accelerate these sequences..... Extractive appropriation impoverishes the environment on which local populations depend both for their
\end{quote}

\textsuperscript{58} See Norgaard, \textit{Development Betrayed}, p.47.
own reproduction and for the extraction of commodities for export…. Once the profit-maximizing logic of extraction for trade across regional ecosystems is introduced … price differentials between extractive commodities and the differential return to extractive labor stimulate concentrated exploitation of a limited number of resources at rates which disrupt both the regeneration of these resources and the biotic chains of co-evolved species and associated geological and hydrological regimes… The exchange relations which bind this system together depend on locally dominant groups to reorganize local modes of production and extraction in response to world demand, but the ultimate collapse will be global, not local. The continued impoverishment of peripheral regions finally damages the entire system.60

In the existing world-order the macroparasites have achieved hypercoherence, having so much power that they have become almost totally insensitive to the world they are exploiting.

Consequently, the most important struggles against environmental destruction are local struggles against global macroparasitism. Here, it is often the local knowledge associated with traditional forms of life and technology that has to be defended, pitted against the abstract models of the exploiters with their legions of apologists defending local destruction in the name of ‘economic progress’. What is generally called for is the cultivation of knowledge drawn from local experience combined with and supported by the disciplined work of genuine science, research not corrupted by economic and political manipulation, designed to identify and support environmentally sustainable forms of life. This often involves what Silvio Funtowicz and Jerome Ravetz called ‘Second Order Science’, where ‘facts are uncertain, values in dispute, stakes high and decisions urgent.’61 The struggles of tribal groups and peasants in India, supported by Vandana Shiva and others to defend, maintain and even revive socio-economic forms which augment rather than undermine local and global ecosystems, against politically backed, highly capitalized ventures of profiteers, best illustrates what is required.62 Kerala reveals success at a state level against environmentally destructive macroparasitism.63 Iceland represents the case of a Western nation-state having in this way achieved sustainability of its fishing industry, having successfully defeated Britain in the ‘cod war’ of the 1970s.64 What has been required for ongoing success in such instances has been alliances of local people defending or developing ecologically healthy forms of life with scientists supported by public servants promoting an ecological perspective on environmental

60 Bunker, Underdeveloping the Amazon, p.21f., 47 & 253.
destruction globally, synthesizing local knowledge with scientific knowledge committed to a global perspective in a way which involves mutual questioning and learning from each other.65

However, there is something more involved in this shift from ecological economics to human ecology. Opposing macroparasitism is essentially the struggle for liberty to enable people to work for the common good and subordinate the market to serve the common good. Human ecology makes politics and ethics rather than economics the central focus of environmental action.66 So, as Mark Sagoff has argued, it is in democratic political processes of communities that environmental indicators are most important, not the decision-making of individuals as actors in the market-place or the deliberations of bureaucrats.67 The foundational principle of ethico-political thought, as defined originally by Aristotle, is What is the good life? and How can society be organized so that people can live the good life? It is assumed that in a healthy constitution that all political reasoning is about the common good and how to realize it. The indicators that should be most central to political decision-making, such as those of liberty and justice, are not the kind that can be given a quantitative measure. This is also true of the indicators of the broader common good, the health of the eco-systems of which we are part, although efforts have been made to provide quantitative measurements of this.68 The struggle for liberty against macroparasitism to enable people to augment the life of their ecosystems rather than undermine them, is at the same time a struggle for democracy. What appears to be required throughout the world is the development of strong democracy, democracy in which communities at different levels are empowered by public institutions, that is, institutions of the state, so that they can participate in maintaining both their own integrity and their capacity for collective action and thereby maintain the autonomy of these public institutions from particular interests, transnational corporations and corrupt politicians. As John Peet urged in a recent work on sustainable development indicators, the criteria people use must be selected in accordance with the goal of sustainable living, ‘and also be consistent with a community-based ethic of how best to move towards it.’69

This does not mean that the different forms of quantitative accounting reviewed here are of no importance. I have presented different accounting procedures as dialectical advances beyond the assumptions of neo-classical economics. It is the most advanced ideas in this dialectic that should be embraced, and this means taking human ecology as the main point of reference for characterizing our situation rather than economics. However, we live in a world dominated by macroparasites and the neo-classical economic thought that legitimates their parasitism. Thinking dialectically, it is often necessary to utilize ideas that can expose the illusions of the dominant ideas as steps

66 This is also the conclusion that ecological economists have come to. See Thomas Prugh, Robert Costanza, and Herman Daly, The Local Politics of Global Sustainability, Washington: Island Press, 2000.
69 John Peet, ‘Sustainable development indicators and human needs’, Sustainable Development Indicators in Ecological Economics, p.400f.
towards promoting and implementing more adequate ways of thinking. While it is necessary to keep in mind the ultimate goal, in this case, liberty requiring democratic control of communities over their own destinies, liberty to live for the common good of their own and the broader communities, human and natural, of which they are part, all these accounting procedures are valuable in their own way, and should be utilized accordingly. The Genuine Progress Indicator confirms the feeling of most people in countries dominated by neo-liberalism that growth of GDP is no longer improving the quality life. Material and energy flows accounting together with Ecological Footprint analyses reveal how ecological destructive forms of life are diverting materials and energy from healthy forms of life.

Furthermore, quantitative accounting methodologies will be necessary in a democratic social order which has embraced the primacy of human ecology, resurrected political philosophy and re-embedded the market within a world of communities of communities. However, they are likely to be put to different ends when used by an empowered general public, informed by an open, professional civil service committed to the common good and responsible to the people. There is a huge difference between statistics taken as representations of reality used by managers to impose decisions on a powerless population or workforce where the whole society is organized around the quest to maximize profits, and statistics recognized to be abstractions by a democratically organized population striving for the common good who have been educated to orient themselves and situate themselves in the world through well worked out narratives. In the latter case, such statistics can provide the basis for augmenting this narrative orientation, indicating unhealthy lifestyles and social relations and revealing where efficiencies could be achieved, without this orientation obliterating people’s awareness of the complexity of the real world. Finally, in a genuinely democratic society there will still be a place for economics, but it will be subordinated not only to human ecology but also to politics, and it will not be neo-classical economics. It will be an historical, institutional and evolutionary economics utilizing complexity theory, focused mainly on macro-economics and synthesized with classical economics rather than neo-classical economics, rejecting the idea that factors of production are or should be priced through ‘free markets’. It will be a political economics concerned with understanding how markets work in order to control them and make them serve justice and the common good of communities, societies, humanity and nature.

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71 For work in this direction, see Cobb and Daly, For the Common Good, Lawn, Frontier Issues in Ecological Economics, and from very different perspectives, Arild Vatn, Institutions and the Environment, Cheltenham: Edward Elgar, 2005 and Robin Hahnel, Economic Justice and Democracy, New York: Routledge, 2005.