Abstract

This speech was delivered at the meeting of the International Society for Ecological Economics at Reykjiavik, Iceland on 13th August 2014 at the presentation of the 2014 Kenneth E. Boulding Memorial Award. In the speech Peter Victor pays tribute to Kenneth Boulding, one of the pioneers of ecological economics, and then describes his own principal contributions to ecological economics over a period of 45 years. These contributions include environmental applications of input-output analysis, the problematic extension of the concept of capital to nature, the definition and analysis of green growth, and his research on ecological macroeconomics and the challenge to economic growth.

Keywords

Boulding, spaceship earth, input-output analysis, materials balance, throughput, environment, greenhouse gas emissions, sustainable development, natural capital, green growth, system dynamics, LowGrow, ecological macroeconomics.

1. Introduction

I am deeply honoured to receive the Boulding Award for 2014 and I thank the Boulding Award selection committee of the ISEE for recognizing my work in this way. And I am especially pleased to be receiving the award in Iceland, a peaceful country of great beauty.

In 1967, when I first read Boulding's brilliant essay on the Economics of the Coming Spaceship Earth (Boulding, 1966), I realized that it was well ahead of its time. Sad to say, it still is for most economists, present company excepted. As a graduate student at UBC I was very fortunate to hear Boulding speak. Although I can't recall the details of his presentation, I do remember leaving the seminar with aching sides, never having laughed so much, before or since, at an academic meeting, or at any meeting come to think of it. Kenneth Boulding was a very funny man with an impish sense of humour. You may not agree with everything he said, but you sure had fun hearing him say it.

Although Boulding did not describe himself as an ecological economist, he did contribute to its foundations. And he exemplified the importance for ecological economists of having a wide and deep knowledge of economics as well as a solid appreciation of numerous other disciplines and their interconnections. This is why ecological economics is hard but it can also be fun, and no one appreciated that more than Boulding. I have spent my entire career as an academic, public servant, private consultant and development advisor, working on the ecological economics agenda that Boulding set out all those years ago, and I have had plenty of fun along the way. So this award given in Boulding's name is especially meaningful to me.

Boulding's metaphor of the 'spaceman economy', in the language of the day, was inspired by the race in the 1960s between the USA and USSR to land a man on the moon. The space race gave rise to famous photographs of the Earth that, over the years, have changed our perception of ourselves and of our place in the universe. Speaking in particular of economics, Boulding argued that "the closed earth of the future requires economic principles which are somewhat different from those of the open past." (ibid 1966, p.9) In his inspirational essay, he gave important clues about the required changes in economic principles he foresaw. What I want to do in my remarks today is to remind ourselves of his key insights from 50 years ago, and then consider some areas in which we have progressed since his day as we build an ecological economics fit for the twenty-first century.

So what is the foundation that Boulding gave us half a century ago? In describing the economy and its relation to the environment, Boulding distinguished between open and closed systems in relation to matter, energy, and information. He explained that economies are subsystems of the biosphere and considered the significance of the second law of thermodynamics for energy, matter, and information. This was five years before Georgescu-Roegen published his celebrated treatise on *The Law of Entropy and the Economic Process* (1971).

Boulding observed that fossil fuels are a short-term, exhaustible supplement to solar energy, and that fission energy does not change this picture. He considered the prospects for much better use of solar energy enhanced perhaps by the biological revolution. He challenged the conventional wisdom on consumption and its contribution to well-being by suggesting that human welfare should be regarded as both a stock and a flow. He asked, for instance, whether it is “eating that is a good thing, or is it being well fed?” (ibid p. 8)

Boulding wondered what the present generation owes to posterity and why we should care about the future, noting the historical evidence which suggests “that a society which loses its identity with posterity and which loses its positive image of the future loses also its capacity to deal with present problems, and soon falls apart.” (ibid p.11) And he observed our natural propensity to discount the future and that perhaps “conservationist policies almost have to be sold under some other excuse which seems more urgent.” (ibid p.12)

Boulding thought the law of torts was quite inadequate to correct the price system where “damages are widespread and their incidence on any particular person is small”. (Ibid p.14) Corrective taxation, he said, might play a useful role, especially in addressing more immediate problems of environmental deterioration, but he also recognized that human impacts on the environment have spread from the local to the global. He commented that technological change has become distorted through planned obsolescence, competitive advertising, poor quality, and a lack of durability.

Boulding famously summed up his analysis by comparing what he termed a “cowboy” economy, which is designed to maximize throughput (for which gross domestic product (GDP) is a rough measure), with a “spaceman” economy in which stocks are maintained with minimum throughput. He said all this and more in 11 short pages. If there is a better and more succinct account of the principles of ecological economics than the one he gave in 1966 I haven’t seen it.

I will now turn to aspects of ecological economics in which considerable progress has been made since Boulding’s time. I’ll focus on four in which my own work has played a part:

- The extension of input-output models to include materials throughput.
- Sustainable development and the widening definition of capital.
- Utilization of conventional economic tools to examine green growth.
- Managing without growth.

2. Input-Output Analysis and the Environment

In the late 1960s a few economists began to realize that input-output analysis, described by Leontief in the 1930s, could be applied to environmental problems. Leontief himself published a paper in 1970 in which he introduced a pollution abatement sector that purchases goods and services from other sectors and sells the service of pollution abatement. He showed how the model could be used to estimate the price impacts of pollution abatement expenditures.

(Leontief, 1970). However, he did not incorporate the principle of materials balance in his model, though in 1969 Ayres and Kneese had shown how this could be done theoretically within the Walrasian multi-market model. (Ayres and Kneese, 1969). According to the materials balance principle, materials are neither created nor destroyed in an economic process, only their form is changed.

Working independently as a doctoral student at the University of British Columbia in the late 1960s, I realized that the concept of externalities was grossly inadequate to capture the comprehensive links between economies and the environment. Externalities is a microeconomic concept, one that is not up to the task of addressing the macroeconomic problem of scale. I became preoccupied with the materials balance principle: the idea that all materials (including fossil fuels) obtained by an economy from the environment, eventually become waste products. I began to conceive of economies as embedded in the environment and dependent upon it, and I wondered about applying the materials balance principle to an entire economy. Figure 1 shows one of my earliest sketches of an integrated economy-environment system as I struggled to conceptualize the key relationships. There is an economic system in which various stocks (R, K, F and A) are interconnected through material flows. There are also material flows linking each stock to the encircling environment comprised of land (L), air (E) and water (W).

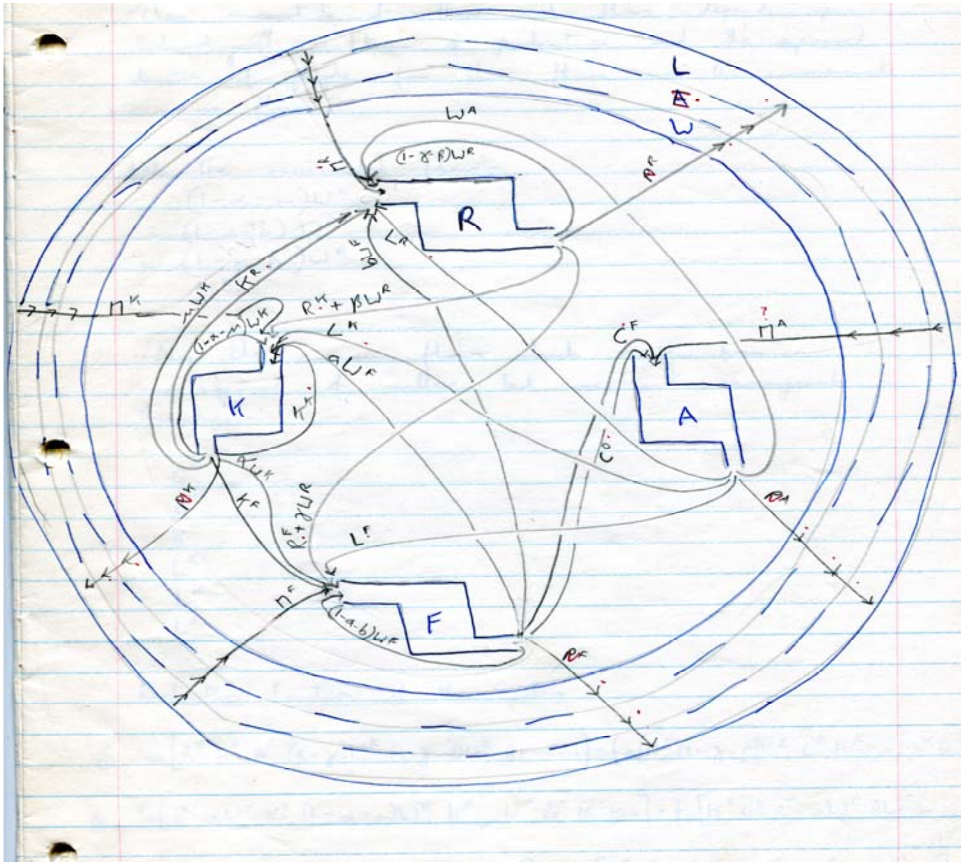
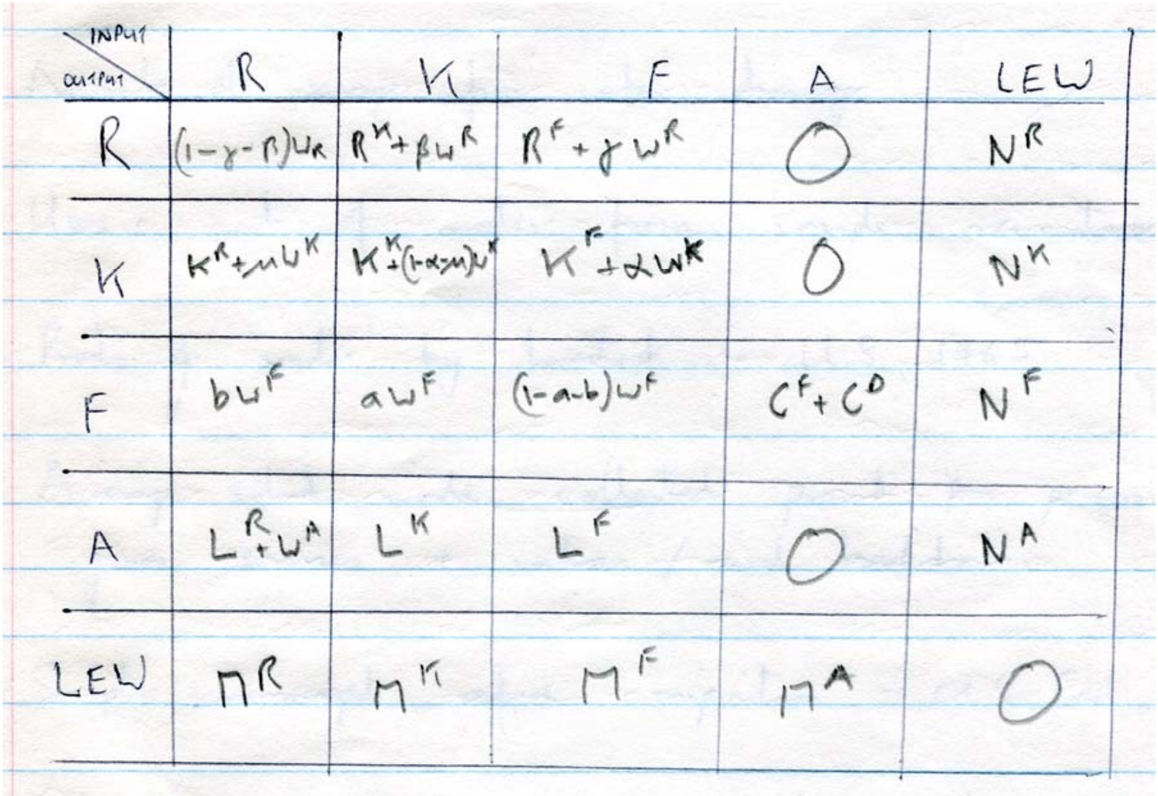


Fig 1. A materials balance framework for a national economy - 1969

A few pages on in my notes is my first rendition of the materials balance framework as an input-output table in which the material flows that connect an economy to the environment are shown (Figure 2). The zero in the bottom right hand cell signifies that the sum of materials used as inputs (row totals) equals the sum of wastes disposed of into the environment (column totals).



OUTPUT \ INPUT	R	K	F	A	LEW
R	$(1-\gamma-\beta)w_R$	$R^K+\beta w^R$	$R^F+\gamma w^R$	0	N^R
K	$K^R+\mu w^K$	$K^K+(1-\alpha-\mu)w^K$	$K^F+\alpha w^K$	0	N^K
F	bw^F	aw^F	$(1-a-b)w^F$	C^F+C^D	N^F
A	L^R+w^A	L^K	L^F	0	N^A
LEW	M^R	M^K	M^F	M^A	0

Fig. 2 Early input-output table based on the materials balance principle - 1969

At the time I drew this table I did not know much about input-output analysis, but by good fortune Professor Gideon Rosenbluth had already agreed to supervise my dissertation and he happened to be an expert in this methodology. It took me less than a minute to explain to him my dissertation proposal: to apply the materials balance principle to the Canadian input-output model, theoretically and empirically. He approved and I was on my way. Relying solely on information sources in the UBC library I completed the dissertation in less than a year and in 1972 it was published as a book: *Pollution: Economy and Environment* (Victor, 1972). I take some pride in the fact that the book is still referred to in publications on environmental extensions of input-output analysis and that the methodology I developed has been taken up and adapted by academics, researchers, public servants and commercially successful companies such as TruCost in the UK.

Figure 3 is a recent example (developed with Brett Dolter and Tim Jackson) of how input-output analysis can be used to examine the relationship between greenhouse gas emissions (GHG) and employment at the sector level. It shows the direct and indirect emissions and employment for $1m spent on final demand in each of 12 sectors. The estimates come from a highly aggregated version of Canada’s input-output model using data for 2010. They illustrate how a suitably modified input-output model can provide detailed, consistent, comprehensive, quantitative measures of key economic and environmental variables and relationships, in this case the direct and indirect GHG emissions and employment arising from $1million of final demand for the output of each sector. The Figure shows substantial variation among the sectors suggesting the possibility of changing the composition of GDP and simultaneously reducing GHG emissions and increasing employment.

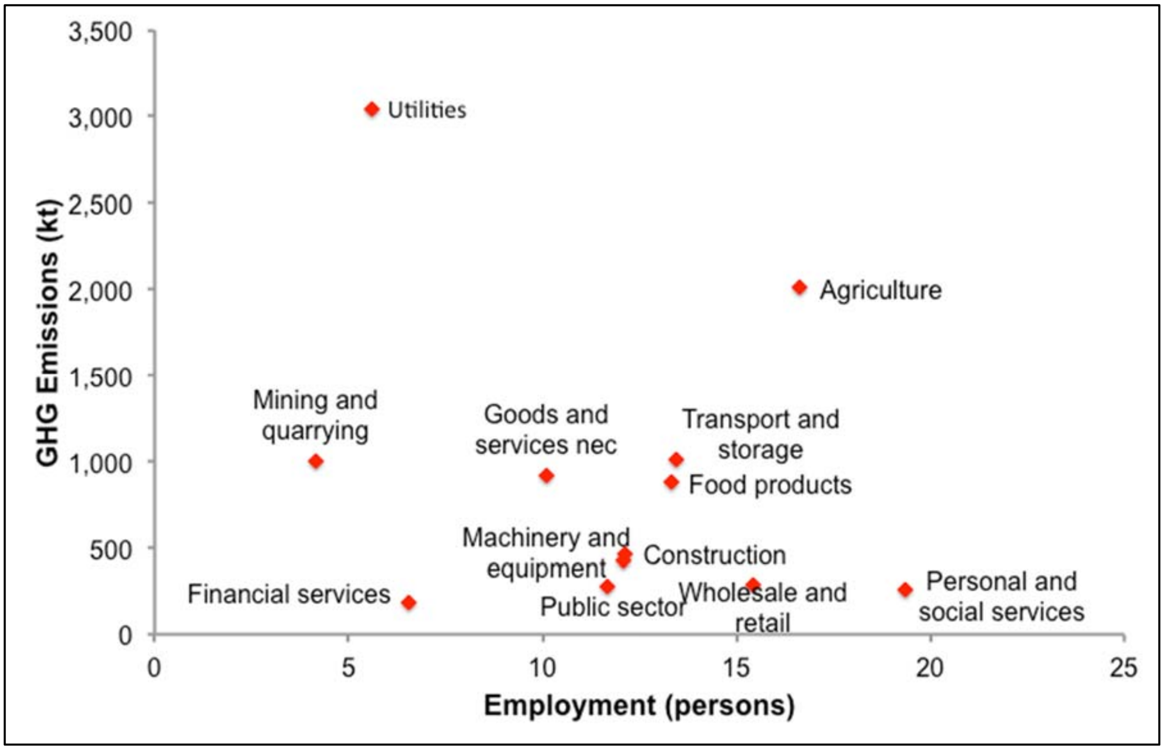


Fig. 3 Canadian employment v GHG emissions 2010 per $m of final demand

The methodology of applying input-output analysis to quantify economy-environment interactions has advanced in the past 40+ years as have the available databases. In particular, there are now global, multi-regional input-output tables that include a range of material flows and which are in the public domain. One such database is the World Input-Output Database (Timmer, 2012). Working with my doctoral student Brett Dolter, we used this database to compare the GHG emissions embedded in the consumption of numerous countries regardless of where the consumed goods and services are produced (their GHG 'shadows'), with their domestic emission of greenhouse gases. (Dolter and Victor, 2014).

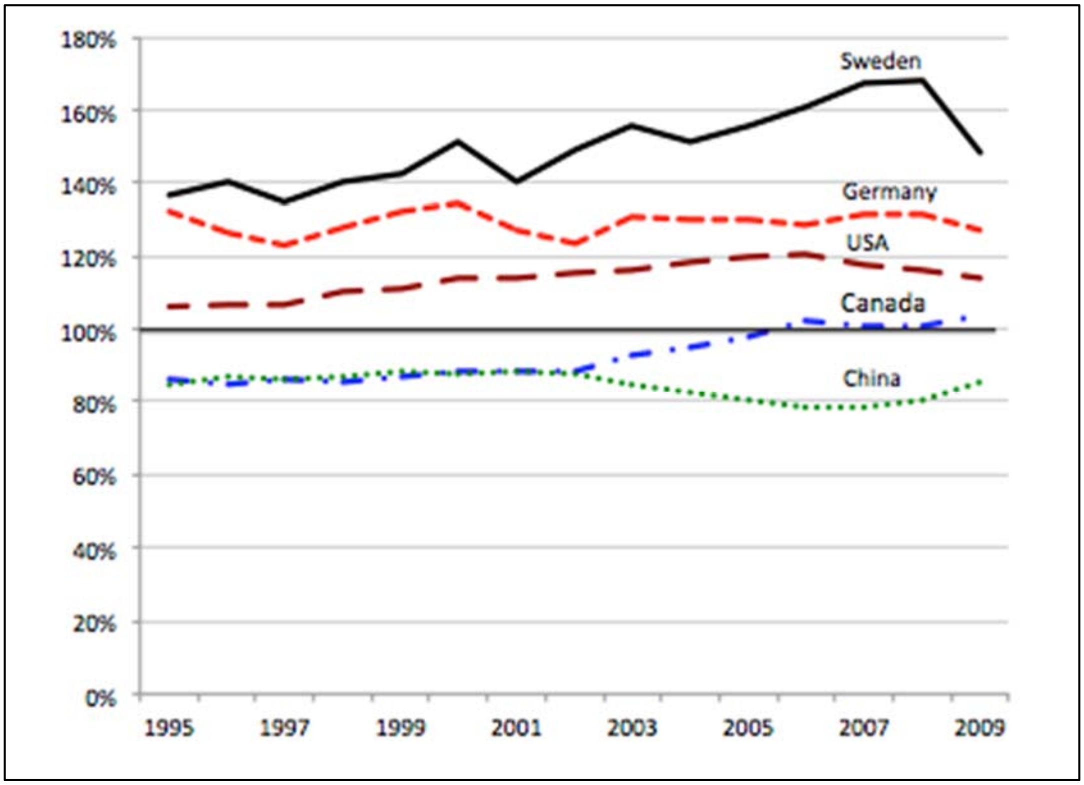


Fig. 4 Percentage of GHG ‘Shadows’ to Domestic GHGs Dolter and Victor, (2014)

Figure 4 shows that throughout 1995-2009 the GHG shadows of Sweden, Germany and the USA exceeded the release of GHGs within their territorial borders, and especially in the case of Sweden, by a very considerable amount. Meanwhile, Canada saw its GHG shadow rise over this period and in 2006 Canada’s GHG shadow surpassed its domestic emissions of GHGs.

The trends in this graph are due to changes in trading patterns and different production technologies in the trading countries. As a major exporter of manufactured goods, China’s GHG shadow is less than its domestic GHG emissions, though since 2006 the gap has begun to close. When the WIOD database is fully updated it will be possible to see whether the most recent trends in comparative GHG emissions have continued.

3. Sustainable Development and Capital

The term ‘sustainable development’ was popularized by the UN’s Commission on Environment and Development in its widely read report, *Our Common Future* (1987). The concept of sustainability has a long history in forestry, for example, where the principles of sustainable forestry were developed over centuries. In the 1980s and early 1990s the idea of ‘living off the interest’ was discussed in the environmental community, and having studied the economics of resource management at UBC years before, this was a concept with which I was quite familiar. But interest stems from capital and in the 1990s the emphasis switched from living off interest to maintaining and enhancing capital. Sustainable development increasingly came to be understood in terms of the transmission of undiminished stocks of capital from one generation to the next. Human capital had been around in economics since the 1960s (e.g. Becker, 1964) and of course, financial and manufactured or built capital were very familiar concepts in economics and business. The new understanding of capital that took off in the 1990s began with ‘natural’ capital and was soon followed by social capital, cultural capital and other types of capital thought by their proponents to be important.

In 1991 I published a paper entitled “Indicators of Sustainable Development: Some Lessons from Capital Theory”, (Victor, 1991). I was motivated by an awareness that importing the concept of capital into the environment and development discussion was being done with little regard to the complexities of the concept of capital which had occupied some of the best and most prominent economists for more than a century. In particular, the famous ‘capital controversy’, which involved a prolonged debate between economists at Cambridge, England and Cambridge, Massachusetts, had drawn attention to the theoretical and practical problems of measuring capital in the aggregate, difficulties that would only be magnified by extending the concept of capital to nature.

My concern about thinking of nature as capital is that the essence of capital is the capacity of human action to change it in various ways: to increase it through investment, to make it more productive through technological change, and to substitute it for other inputs in the economy. To apply the same assumptions to nature is quite a stretch and even goes against the intentions of those who promote the idea of natural capital in the belief that it provides a rationale for its preservation. Capital is made from nature, not vice versa, and it depreciates if not maintained by humans, whereas nature flourishes if left alone. If natural capital can be made more productive through technology, say through GMOs, and if scarce, can be substituted by manufactured capital, as with theme parks and synthetic grass, then why bother to preserve it at all? It is because nature is not well conceived as capital that it’s worth protecting.

Above all, conceptualizing nature as capital invites us to adopt an exploitative attitude towards nature. Manufactured capital has value *only* because of the goods and services it provides to the human economy. Describing nature as capital implies that nature has value for a similar reason: to provide goods and services to humans. Nature as capital is an object not a subject, or collection of subjects, with which humans co-exist. As such it denies, or minimizes, the ethical value of nature itself, of individual and connected ecosystems, of non-human species and their members. These are all just capital to be valued for their utility to humans. And if nature as capital turns out to be worth less than the value derived from its destruction, what then will proponents of natural capital say?

Attempting to solve this problem by claiming that natural capital is only part of a larger framework in which cultural and spiritual values of nature are also recognized risks a contradiction: how to integrate a view of nature based on one view, that of nature as capital, which implies substitutability, with others that do not. This is not just a methodological issue. It runs deeper, to how we conceive of ourselves and how we conceive of the world in which we live, issues I believe that are much in need of more work by ecological economists.[1]

4. From Sustainable Development to Green Growth

The now famous definition of sustainable development in the Brundtland report

[1] For a powerful critique of natural capital along these lines and also stressing how the concept relates to power and vested interests, see Monbiot, 2014.

was one of several. On being awarded the Elizabeth Haub Prize for Environmental Diplomacy in 2006, Jim MacNeill, secretary to the Commission and responsible for writing much of its report, said that “I no longer shock easily but to this day I remain stunned at what some governments in their legislation and some industries in their policies claim to be ‘sustainable development.’ Only in a Humpty Dumpty world of Orwellian doublespeak could the concept be read in the way some would suggest.” (MacNeill, 2006). The lack of clarity in the definition of sustainable development turned out to be more a weakness than a strength. For example, it left wide open the question of whether economic growth could be sustained indefinitely, so much so that the term sustainable growth began to be used synonymously with sustainable development and in some quarters, to displace it.

It’s no surprise, therefore, that the search soon began for new language to supplant sustainable development. One term that has emerged in the past few years is ‘green growth’, promoted strongly by various international organizations and national agencies. Again the issue of definition has arisen. The OECD defines green growth as “fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies.” (OECD, 2011, p.4) Likewise the multi-authored report, *Green Growth in Practice: Lessons from Country Experience* (De Boer, Meier, Bickersteth, 2014) states “Green growth is becoming an attractive opportunity for countries around the world to achieve poverty reduction, environmental protection, resource efficiency and economic growth in an integrated way. Green growth strategies generate policies and programs that deliver these goals simultaneously." (ibid p. 12)

Neither of these reports, and many others like them, provides a clear, unambiguous definition of green growth. Instead they describe desirable economic, environmental and social outcomes and place extraordinary emphasis on gains in productivity and efficiency to achieve them. In contrast to much that has been written about sustainable development in which economic growth has been called into question, the green growth literature insists that we can have it all. Indeed, UNEP tells us that: "a Green Economy grows faster than a brown economy over time, while maintaining and restoring natural capital." (UNEP, 2011, p. 500)[2]

So how should green growth be defined? The minimal requirement of an acceptable definition should include something that grows and something that is green. When UNEP says that a green economy grows faster than a brown one, it is referring to the rate of growth of real GDP. Notwithstanding the well-known critiques and limitations of GDP as a measure of economic success and well-being, GDP remains the key metric for measuring economic growth so I will use it here. Given the already excessive burden of economies on the biosphere, an economy with an increasing GDP can only become genuinely greener if such growth entails an *absolute* reduction in one or more measures of environmental

[2] For a critique of the model on which this result is based see Victor and Jackson, 2012

impact. For instance, a reduction in domestic GHG emissions per unit of GDP (i.e. GHG intensity) without an absolute reduction in total GHG emissions does not warrant the designation ‘green’. And if reductions in domestic emissions of GHGs are achieved through changes in trade thereby shifting the emissions abroad, then the growth is still not green.

By this logic, *green growth can be defined as economic growth that is slower than the rate of reduction in one or more intensities* since only then will environmental impact decline absolutely. Of course, green growth may not be green enough if the decline in environmental impact falls short of reduction targets, but at least it represents movement in the right direction. Likewise, brown growth occurs when the rate of economic growth exceeds the rate of reduction in intensities, and black growth when both scale and intensities increase. As Figure 5 shows, the ‘colours of growth framework applied to domestic GHGs can be applied to degrowth (in GDP terms) as well.

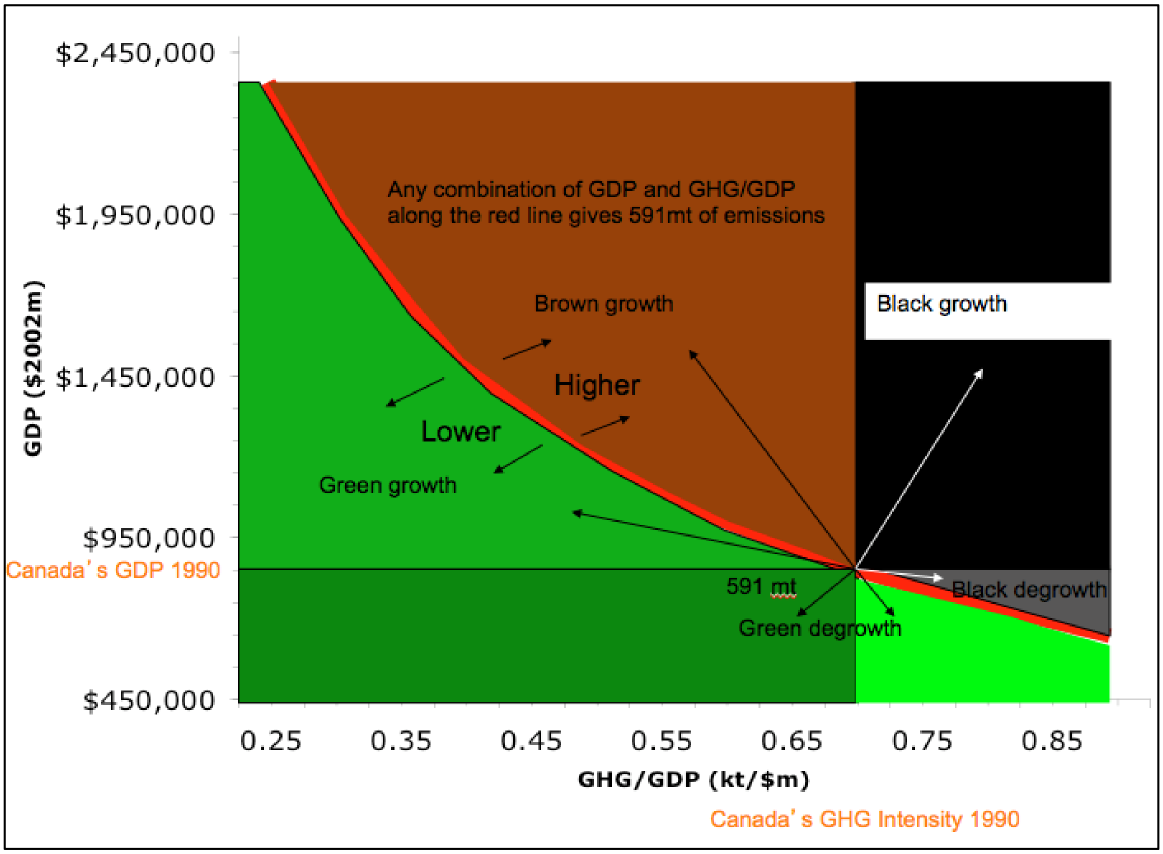


Fig. 5 The Colours of Growth (Victor, 2010, p.241)

Figure 5 provides a scale/intensity framework for assessing the extent to which green growth has been realized in the past and its prospects for the future. In 1990 Canada's GDP was $825,318m (2002$) with a GHG intensity of 0.72 kg GHG/$m (fig. 10). Any combination of scale and intensity on the red line would generate the same 591mt of GHGs. Starting from the particular combination of scale and intensity in 1990 we can describe the particular trajectory of Canada to 2011 as in Figure 6, where the combination of GDP and GHG intensity in each year is shown by a single dot. For Canada it was a period of brown growth: even though Canada's GHG intensity declined, the reductions were overwhelmed by even faster increases in scale.

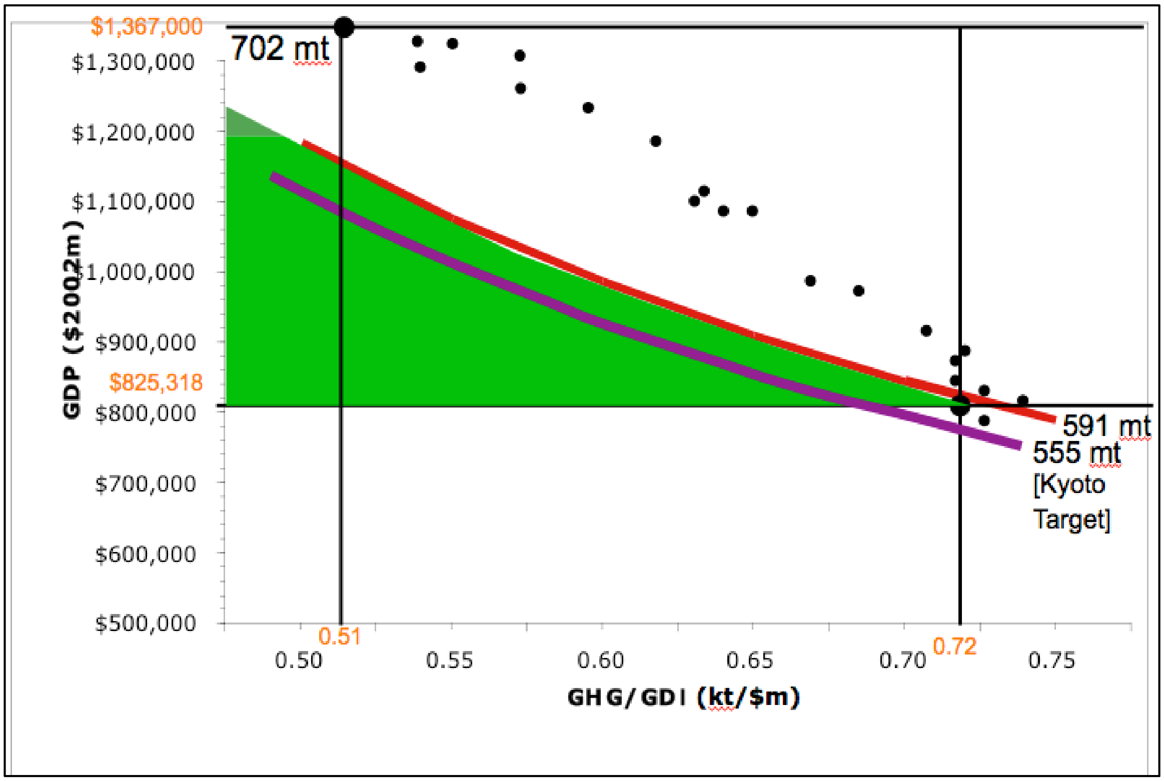


Fig. 6. The Scale and Intensity of Canada's Economic Growth 1990-2011

Starting from the scale, intensity and emissions for 2011, Figure 7 shows what will be required in extent and rate of 'decarbonization' to meet a reduction of 87% in Canadian GHG emissions in 50 years, through various combinations of changes in scale and intensity. In particular, it shows that the faster the economy grows, the faster GHG intensity *must* decline to meet this target, or any reduction target for that matter. Proponents of green growth seem to think that higher rates of intensity reduction are associated with, even result in, faster rates of economic growth although the historical evidence for such a relationship is sparse. (Victor, 2008, pp. 120-122) [3]This is something we need to know more about. In the meantime, we do know that a greater absolute reduction in environmental impact will be achieved from reductions in intensity the slower is the rate of economic growth.

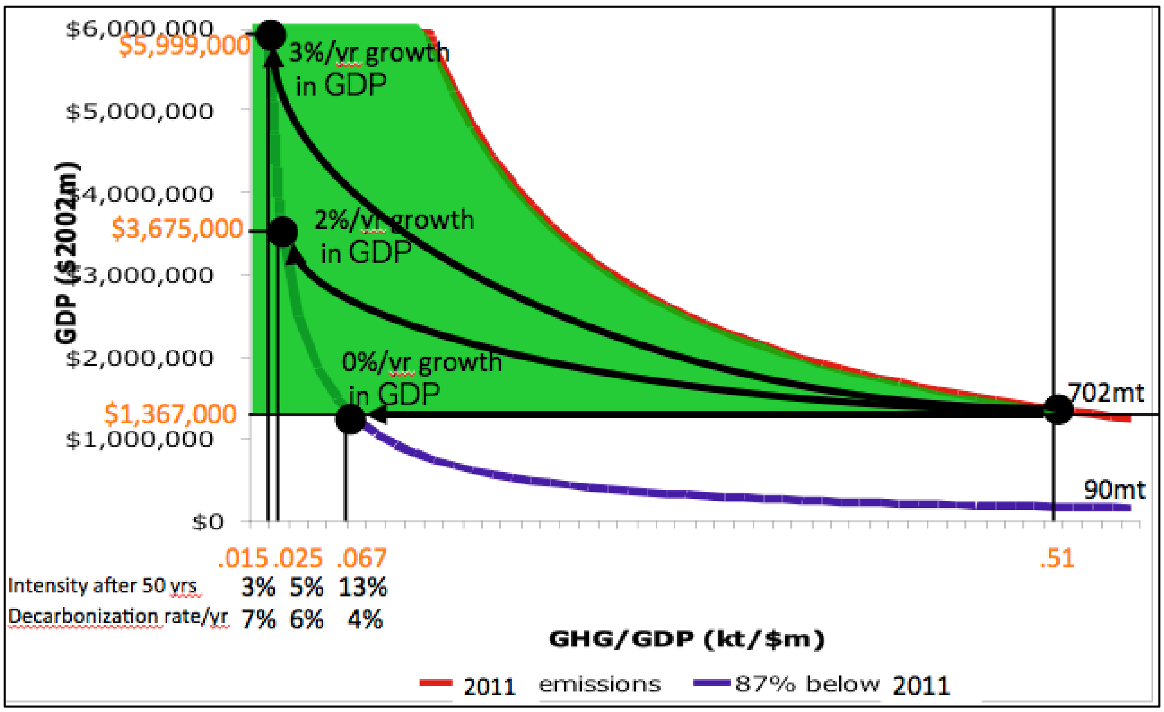


Fig. 7. Scale and Intensity: Achieving an 87% reduction in Canada's GHG emissions from 2011 level in 50 years

4. Managing without Growth

The discussion of green growth entailed an analysis of change over time of three variables: scale, intensity and outcome with two degrees of freedom. It did not

[3] See Smil (2014) for a detailed account of the history of materials and energy decoupling and an assessment of future possibilities. He is not optimistic about the prospects for absolute decoupling.

consider causal or feedback relationships among the variables and gave no insight into the system that the metrics were describing. For that we need something more powerful, such as system dynamics.

Donella Meadows, one of the authors of The Limits to Growth (Meadows et al, 1972) wrote that she had ‘’been lucky enough to run across four Great Learnings in my life, the third of which was dynamic modeling.” (Hannon and Ruth, 1994, p.v) At about the same time that Boulding was using systems concepts to write about spaceship earth, Jay Forester of MIT was developing the theory of system dynamics and Dynamo, a programming language for building system dynamics models on mainframe computers. Subsequently, several software packages were designed for using system dynamics on personal computers, providing researchers with a powerful tool for thinking about systems.

There are several features of system dynamics that make it extraordinarily useful in ecological economics. System metrics are flexible and a variety of metrics, monetary and non-monetary, can be included in the same model. This is very convenient when economic and ecological variables are being considered together. Any system that can be represented as a set of interdependent stocks and flows, with linear and non-linear relationships and feedback loops can be represented with ease in system dynamics.

System dynamics models can also be very data rich. One example is LowGrow, the macroeconomic model I started developing about 10 years ago to investigate whether and under what conditions it would be possible, in the absence of economic growth, to have full employment, no poverty, fiscal balance, and substantial reduction in GHG emissions, This inquiry was triggered by a phone call from Gideon Rosenbluth, then in his eighties, asking me to work with him on the question of growth. We published papers together in the early 2000s, (Victor and Rosenbluth, 2004) which became the foundation for my book *Managing without Growth: Slower by Design, not Disaster* (2008).

The high level structure of LowGrow is shown in Figure 8.

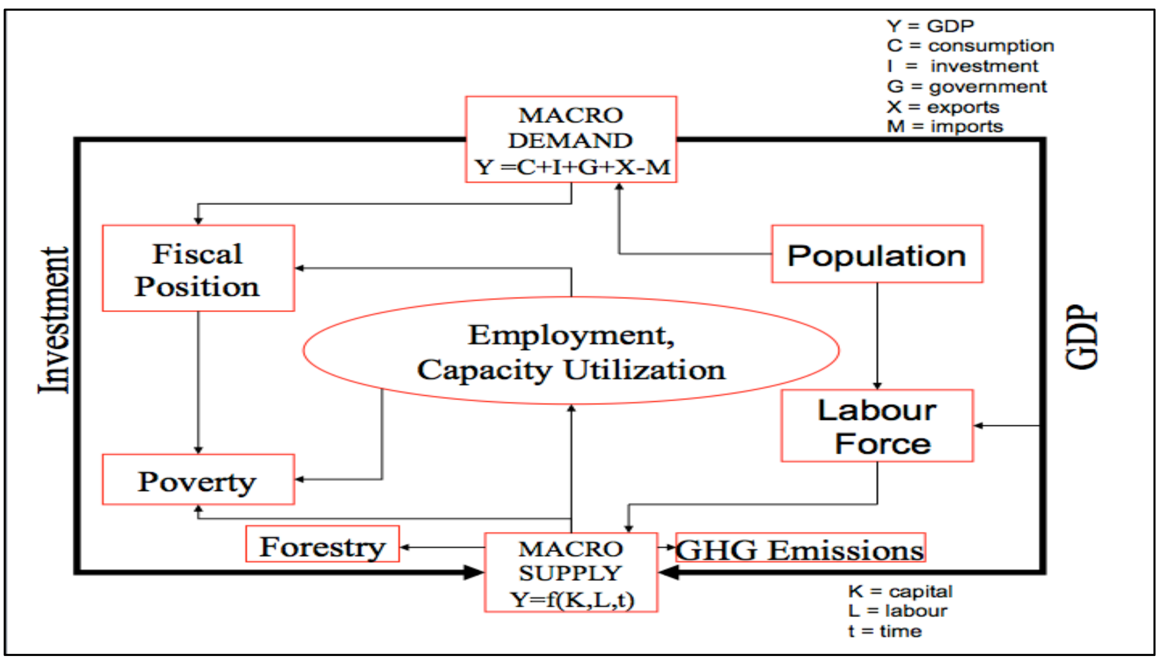


Fig 8. High Level Structure of LowGrow (Victor, 2008)

In LowGrow, aggregate (macro) demand and the Cobb-Douglas production function jointly determine the employment of labour and the utilization rate of the capital stock.[4] Since investment increases the capital stock, increases in aggregate demand are required to avoid increasing unemployment. This is also the case if the labour force increases and/or if capital and labour become more productive over time, other things equal. But other things need not be equal. For example, a decline in the average workweek can mitigate the impact of these pressures on unemployment, a carbon price can induce reductions in greenhouse gas emissions and more generous antipoverty measures can reduce poverty.

LowGrow proved to be very useful for examining possible alternative economic futures in an advanced economy (Canada). Three scenarios are shown in shown in Figures 9, 10 and 11.

[4] All aggregate production functions are problematic as summary representations of production in entire economies. The Cobb-Douglas function is no exception. In LowGrow, energy requirements and GHG emissions associated with production (key components of throughput) are estimated with coefficients that are variables in the system and subject to change. The forestry sector is also linked to the production function via GDP.

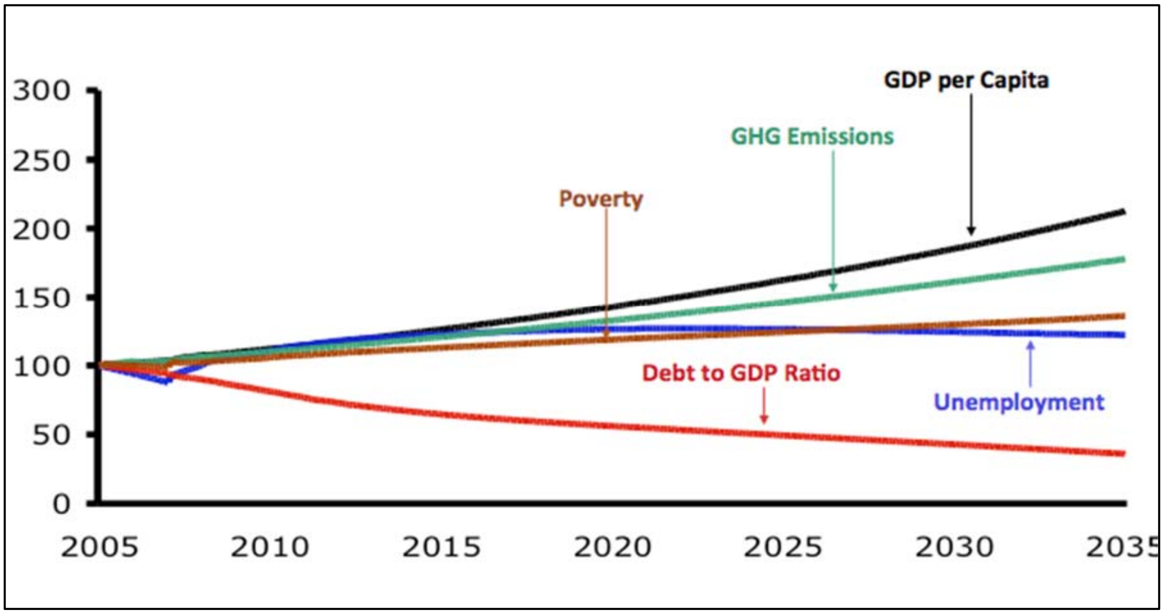


Fig. 9 Business as Usual in the Canadian Economy (Victor, 2008)

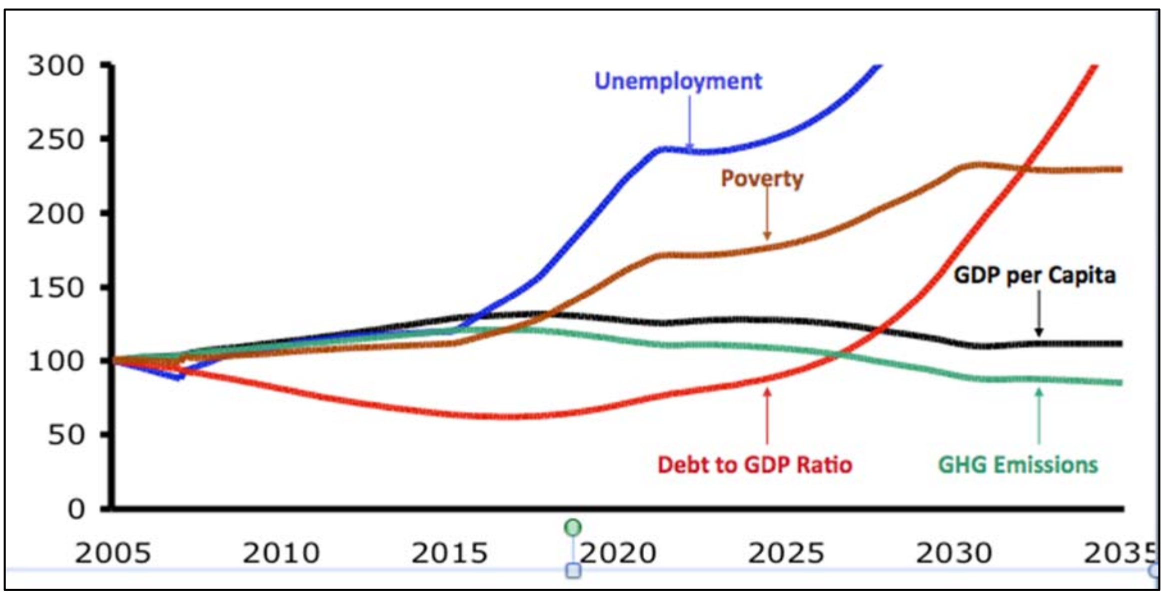


Fig. 10 A No-Growth disaster in the Canadian Economy (Victor, 2008)

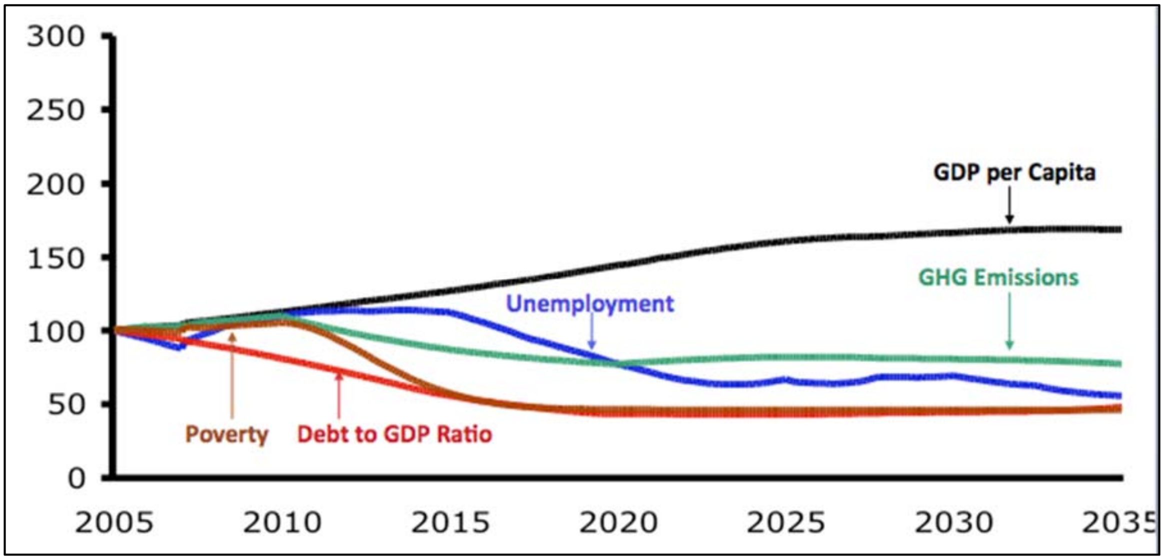


Fig. 11 A Low/No Growth Scenario of the Canadian Economy (Victor, 2008)

Figure 9 shows a business as usual scenario for Canada, assuming that the trends in key variables for the 25 years preceding 2005 were to continue. GDP per capita would double, government debt to GDP ratio would decline (all levels of government combined), GHG emissions would increase nearly 80% and unemployment would rise then decline, ending up 20% higher in 2035 than in 2005. Significantly, after three more decades of steady growth, poverty, as measured by the UN's Human Poverty Index, which is a composite of variables for income, life expectancy and literacy, would rise. The percentage of poor Canadians would remain about the same but because of population growth, there would be more poor Canadians in 2035 than in 2005. With such negative implications for GHG emissions, unemployment and poverty, this BAU scenario is not very appealing.

The second scenario shown in Figure 10 is based on a set of changes such that growth in GDP per capita is extinguished. This is simulated in LowGrow by removing growth from all of the variables in LowGrow that generate economic growth: consumption, investment, government expenditure, a positive trade balance, growth in population and the labour force, and productivity. The changes to these variables are phased in over 10 years starting in 2010 so that by 2030, when they have worked their way through the system, GDP per capita ceases to grow. As Figure 10 suggests, this would be a formula for disaster with unemployment, poverty and the debt to GDP ratio becoming tragically high and GHG emissions remaining about the 2005 level.

Figure 11 presents a more attractive low/no growth scenario, one in which GDP per capita is stabilized well above the level in 2005, while unemployment, poverty, the debt to GDP ratio and GHG emissions are substantially reduced. This scenario comes about as a result of a combination of initiatives including a reduced work year, expanded anti-poverty programs, a revenue neutral carbon tax, stable population and labour force, reduced net investment and balanced trade. Additional, complementary changes in policies, values and institutions would be required to realize a scenario of this sort and although a number of authors, myself included, have written about what would be required, there is much more to be done to prepare the way. (See for example, Jackson, 2009, Speth ,2012)

Of course, proposals for initiatives such as these are not new. What is new, and what makes system dynamics and other similar modeling approaches attractive, is the ability to examine how the initiatives might interact with each other, to estimate quantitatively the nature of these interactions for improved policy design, and to understand more clearly the comprehensive nature of the changes that are required to bring about positive change.

5.1 Ecological Macroeconomics: GEMMA and FALSTAFF

The experience of the financial crisis of 2008/09 taught many economists that it's impossible to make sense of modern economies without placing finance, if not at the center, then certainly in a prominent position in our analysis. LowGrow lacked a financial sector. It also included only very limited elements of throughput, and dealt in national aggregates and averages, limiting its usefulness for analyzing issues at the sub-national level. In 2010, I teamed up with Tim Jackson of the University of Surrey to build a new system dynamics model of national economies encompassing the financial system, the real economy, and material, energy, waste throughput. We drew upon our shared knowledge of system dynamics, input-output analysis, mainstream and heterodox economics, national and international economic and environmental databases and added newly obtained understanding of the financial system and stock flow consistent models relying heavily on modern money theory (Godley and Lavoie, 2007, Wray, 2012) to set about constructing what we have come to call ecological macroeconomics.

Our overall conception of ecological macroeconomics is illustrated in Figure 12. In the models we are developing, all financial assets are balanced by financial liabilities and all financial flows are simultaneously expenditures and incomes. An integrated set of accounts is maintained for five sectors: households, financial corporations, non-financial corporations, government and the rest of the world. These sectors are linked to the real economy represented by a 12 sector input-output model which is connected to the biogeosphere through a wide range of material flows.

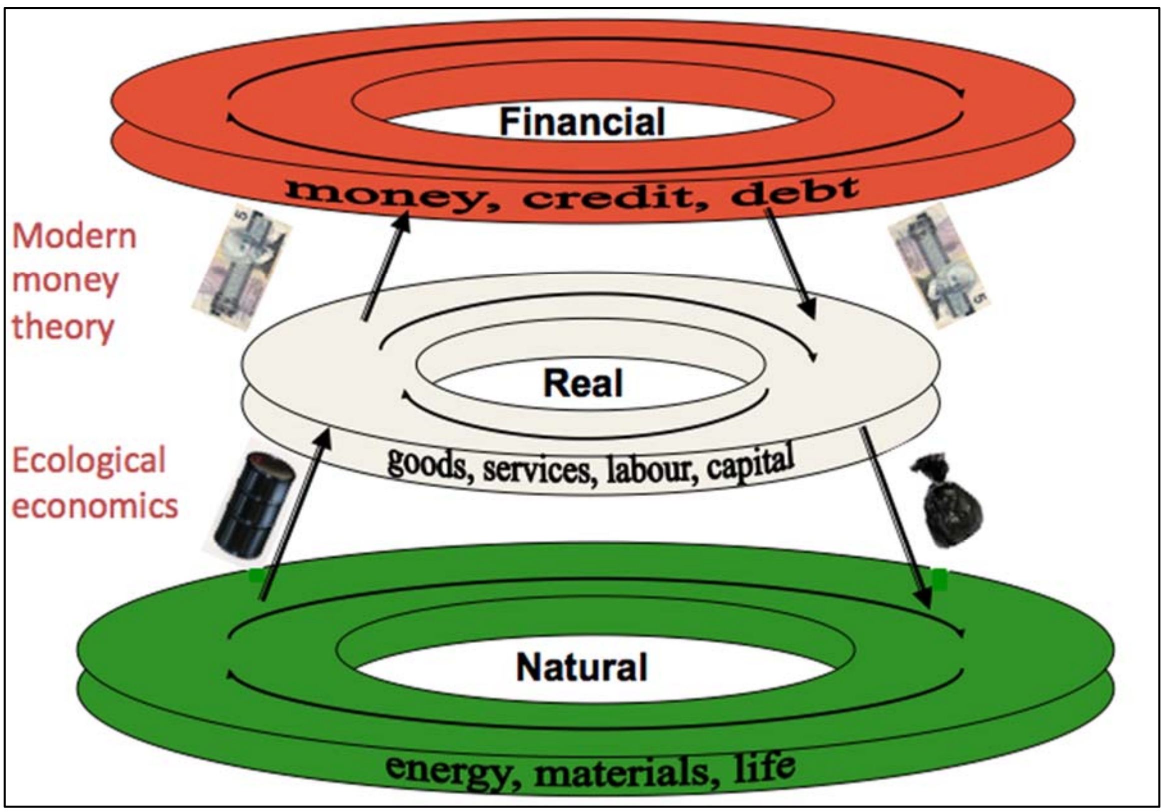


Fig. 12 A schematic of ecological macroeconomics

Working with Tim has been a highlight of my rather long career in ecological economics. We have published a few papers and reports together with more to come in the near future. Time will tell if ecological macroeconomics will fulfill its considerable promise. Its breadth and depth are daunting. But it is fun, and Boulding would have approved of it for that reason alone.

6. What next?

Ecological economics has come a long way since 1966 when Boulding set out his vision for an economics more consistent with our planetary boundaries, (Rockstrom et al, 2009). More than anything, it is the context within which we must do ecological economics that has changed. Environmental issues have expanded from the local to the regional and global. In 1966 the global population was 3.4 billion. Now nearly 7.2 billion of us, and rising, require food, clothing, housing, and everything else essential for a good life. The world's economies are bigger and more intertwined than ever. Increasingly powerful corporations have out grown the capacity of national institutions to control them. We are starting to become aware that we are in the Anthropocene, an era in which humanity has become a geologically significant player through our impact on the biosphere. All these changes demand a response from ecological economics.

A small part of that response is represented by the recently launched project, Economics for the Anthropocene, in which colleagues at McGill University and York University in Canada and the University of Vermont in the USA will train up to 60 PhDs in ecological economics, with numerous partners from the public, private and NGO sectors. Another promising sign is the proliferation of organizations using ecological economics to inform public discourse and policy such as the New Economics Foundation in the UK, the New Economics Coalition and the Centre for Advancement of a Steady Sate Economy in the USA, and the degrowth movement centred in Europe.

The time has come to make some big choices. Ecological economics has done much to outline what these choices are, and provided some useful analytical tools, but more is needed before society at large will be ready to face up to the new realities. If we fail to rise to the occasion then I fear that the future looks very bleak. But despite the limited progress that has been made since I began my own personal journey in ecological economics, I remain hopeful that a brighter future is still available and, as ecological economists, we have much to contribute to its realization.

In closing, and in the spirit of Kenneth Boulding who enjoyed capturing the essence of a conference at its conclusion in a short poem, I offer one of my own as a tribute to him and to all of you working on ecological economics.

Boulding's Vision

When Boulding saw the Earth from Space, it gave him cause to question
The economics he'd been taught, so he made his own suggestion.
He said the day of cowboy thought, had had its time and more.
We need a spaceship economics, for the future that he saw.

We'd take a systems view of things, with science as our guide.

Make planet Earth our reference frame, the economy inside.
Use concepts, data, ethics, and thinking that is logical.
And build an economics that is truly ecological.

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